Guidebook for
Hydrogeomorphic (HGM)–based Assessment
of Oregon Wetland and Riparian Sites
I. Willamette Valley Ecoregion
Riverine Impounding and Slope/Flats Subclasses

Volume IA: Assessment Methods

Oregon Division of State Lands

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Volume IA: Assessment Methods

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Oregon Wetland-Riparian Assessment Project
Oregon Division of State Lands

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Summary

This guidebook contains methods for assessing wetland and riparian systems in the Willamette Valley. The methods address both the functions of sites belonging to these subclasses, and the values of those functions to society for storing flood water, trapping and stabilizing sediment, processing nutrients, maintaining stream temperature, and supporting the habitat of plants, invertebrates, amphibians, turtles, and birds. By considering a broad array of functions and by using reference data collected during 1999-2000 from a large number of sites stratified by hydrogeomorphic subclass, the methods avoid dangerously simplistic assumptions such as "wetter is always better" and "trees and shrubs always indicate healthier systems."

Of necessity, the methods are based on visual observation of indicators during a single site visit. Two options are provided for assessing functions: one, based on a simple descriptive checklist, and the other, based on comparison of observations of indicators at a particular site with data gathered by this project in 1999-2000 from 109 reference sites. The results of an assessment are scores representing 13 functions and their corresponding values on an ordinal scale. The scores are based on descriptive models formulated from scientific literature and workshops of experts, and then calibrated with field conditions at the 109 reference sites. The methods are applicable to two types of sites most common in the region, as defined by hydrologic and landform (hydrogeomorphic, or HGM) characteristics. These two types are (1) slope/flats wetlands, which include wet prairies, ash swales, and many farmed wetlands; and (2) riverine impounding sites, which include floodplain sloughs, beaver impoundments, some riparian areas, and many diked marshes. Development and testing of the function assessment methods involved over 50 resource professionals during 2 field seasons, and has generally complied with guidelines for developing HGM methods as issued by the U.S. Army Corps of Engineers and other agencies.

These methods can be used to assess the functional consequences of altering or restoring wetland and riparian sites, or simply to characterize the present condition of a site. They can be applied in mitigation banking, monitoring of restoration projects, and watershed assessments. They are intended for use by wetland technicians employed by state and federal agencies, conservation organizations, and consulting firms. These methods are no more time-consuming to use than published methods currently used for assessing wetland functions in Oregon. As contrasted to previous methods, they (a) are calibrated to conditions characteristic of particular wetland types in this region, (b) provide a numeric score for functions, while also allowing for a more qualitative checklist-based approach if the user desires, (c) explicitly assess potential values of functions, (d) include a botanical assessment component, and (e) are extensively referenced to regional technical literature and new field data.

This volume is the first of 3 volumes that comprise a guidebook for classifying wetland and riparian sites in Oregon, based on their hydrogeomorphic (HGM) features, and assessing their functions. The second volume -- a technical report -- provides background on the reference sites and presents a statistical analysis of data collected using this first volume. The third volume focuses on the entire state, rather than just the Willamette Valley, and provides profiles of the different HGM classes and their functions in 10 regions of Oregon.

Contents

Section 1. Understanding the Methods and Applications

This guidebook presents organized and consistent methods for classifying and assessing both wetland and riparian resources. Classification is based on hydrogeomorphic (HGM) principles. It is hoped that routine use of the guidebook and complementary methods will help Oregon assess indicators of ecological condition for wetlands (Morlan 2000) and riparian systems (Gregory 2000), as highlighted in Oregon's State of the Environment Report (Risser 2000):

- Change in diversity and distribution of wetland types
- Changes in hydrologic characteristics
- Change in native wetland plant and animal assemblages
- Degree of connectivity with other aquatic resources and upland habitats
- Amount of intact or functional riparian vegetation along streams and rivers

The guidebook's HGM-based methods do not change any current procedures for determining jurisdictional status of wetlands. The methods are intended mainly for assessing the functions and values of individual sites, after jurisdictional status has been determined. Complementary methods will need to be developed to assess fully all the benchmarks listed above, especially in the context of larger areas such as watersheds and ecoregions. However, methods in this guidebook do include indicators (in Section 4) that will help ensure the maintenance of a characteristic diversity of wetland hydrogeomorphic subclasses at the watershed and regional scales. HGM classes such as those recognized in Brinson's (1993) national classification scheme have been shown to be effective in the Willamette Valley for characterizing wetland hydrology (Shaffer et al. 1999) and associated patterns of vegetation succession (Dykaar and Wigington 1999, Dykaar 2000). Geomorphic condition also is fundamental to assessing the long-range stability of this ecoregion's riparian systems (Moses & Morris 2000).

The Oregon Division of State Lands (DSL) and the U.S. Army Corps of Engineers, in cooperation with the U.S. Environmental Protection Agency, are required to make hundreds of decisions each year regarding requests to alter wetlands in the Willamette Valley. Each decision must be made within a limited time period, sometimes with little flexibility to collect detailed data at other seasons. Because decisions are often controversial, the technical reasons for a particular decision must be **explicit** and **consistent** in order to maintain program credibility and public trust. The methods presented in this guidebook provide tools to enable more explicit and consistent decisions. The methods are based on the best current scientific knowledge of wetlands and riparian systems, and have been peer-reviewed and field-tested.

Once users assign a site to a hydrogeomorphic subclass, the guidebook's methods are used to assign a score to the site based on its **functions** and **values**. A "function" is what a site does; especially, the hydrologic, geochemical, and biological processes it can perform without human assistance, such as water storage. "Values" are the economic, ecological, and social expressions of a function as a result of context-related *opportunity* to provide the function and the likely *significance* of the function to local and regional users or resources. For example, in some situations the function "water storage" may have a value such as "control of downstream flood damage" due to the significance of downstream properties and the opportunity for flooding as determined by watershed characteristics. The methods presented in this guidebook attempt to carefully separate values from their functions, because any function may have multiple, sometimes conflicting values, and because assessment of values is considerably more subjective and context-dependent than assessment of functions.

Replacement specifically of altered *functions* is required by the Oregon wetland regulations that DSL administers, including OAR or ORS 196.672(1, 8), 196.825(5), 141-85-0050 (2, 4), 141-85-135(3), and 141-85-0115. Consideration of multiple functions and attributes – not just a few such as rare plants and wildlife habitat support which may be most familiar to the person assessing a wetland -- is also crucial in making permit decisions as part of Section 404 of the Clean Water Act (Ainslie 1994). High apparent biological diversity at a site does not necessarily mean the site is providing multiple functions at full natural capacity.

Functions and values are not the only means of assessing the relative importance of a site. A site's "ecological integrity" or "health" may be assessed by inventorying the <u>species</u> of plants and animals that use a site and their characteristic tolerances to human influences. This information is used to interpret how degraded it is with regard to its ability to support aquatic life. Such bioassessments have yet to realize their full potential because of relatively high cost and time requirements, need for repeated sampling of a site, need for advanced taxonomic skills, and lack of reliable and comprehensive information on species tolerances to human influences. In contrast, methods that use functions and values as the basis for assessment present a broad and balanced perspective, one that not only describes some biological attributes, but also relates hydrogeomorphic attributes to practical *services* wetlands perform on a sustainable basis for society, such as water purification. Sites need not have high ecological integrity to sustainably perform all geochemical functions, and conversely, sites in the best biological condition are not always the highest-functioning for all functions. Thus, whenever practical, bioassessments and function assessments should be applied in a complementary manner. Section 8 of Volume IB contains a more detailed discussion of bioassessment approaches, and results from this project's initial testing of a bioassessment protocol featuring wetland plants.

For some objectives, it may also be helpful to know which sites within a region have previously been most affected by human activities, or are most at risk from ongoing activities. Such knowledge can be used to help target priorities for restoration, conservation, or management. Appendix C is a form for characterizing – but not quantifying or combining – indicators likely to be associated with historical or ongoing impacts.

Moreover, it should be noted that neither bioassessment nor function assessment, nor any rapid method currently available, fully and directly measure the *processes* responsible for supporting a viable wetland, as related to climate, soils, and landscape context, and *sustaining* its functions over long time periods (Bedford 1996). This lack of methods for assessing wetland and riparian "site potential" or "templates" is due partly to a paucity of historical data on wetland diversity and distribution, and partly to the lack of a quantitative understanding of wetland formation and maintenance processes, especially in highly altered landscapes.

The public process by which this guidebook was developed is described in Volume IB. The guidebook's methods are intended for routine use, sometimes in conjuction with other methods and guidance, in the following specific situations:[1]

1. **Impact Assessment.** When an alteration to a wetland or riparian site is proposed, the methods can be used to assess which functions may need to be replaced (compensated for in the mitigation process, and to what degree). This is because the method expresses expected changes in site structure in terms of impacts to functions and values important to society (Brinson and Rheinhardt 1996). These predictions are only as accurate as the predictions of how site structure will change. Multiple sites (including just parts of whole wetlands) can be analyzed rapidly to identify situations that will result in least loss of functions and values.

2. **Mitigation Banking**. To compensate for unavoidable impacts to a wetland, current DSL rules dictate use of a wetland replacement ratio, based on acreage, of 1-to-1 when the replacement involves *restoring* a wetland, 1.5 –to- 1 when the replacement is a wetland *constructed* from upland, and 3 –to- 1 when the replacement involves *enhancing* an existing wetland or *exchanging* it for (converting it to) another HGM subclass; see Devroy (2000) for definitions. This approach only attempts to account for loss of wetland acreage and the risk of project failure (e.g., enhancement being a riskier option). It does not explicitly account for differences in level of function and values between the site proposed for alteration and the proposed mitigation site after mitigation is successfully completed. After additional evaluation of this guidebook's methods by DSL, consideration should be given to using the methods as a "currency" in mitigation banks that address these wetland subclasses, that is, as a unit of measurement useful for expressing "in-kind" tradable mitigation credits or debits. Any such use would be integrated with, not a replacement for, the currently used ratios. Also, many of the indicators in Section 4 of the guidebook should be considered for use in helping define "service areas" for mitigation banks.

3. **Monitoring restoration projects**. Dozens of degraded wetlands are being restored not only as compensation for impacts, but also as part of non-regulatory programs administered by the Natural Resources Conservation Service, Bureau of Land Management, Army Corps of Engineers, Bonneville Power Administration, Wetlands Conservancy, and others. Methods in this guidebook could be applied to such projects to measure progress toward restoration goals, i.e., "success," see Kentula (2000). This could be accomplished by determining HGM function capacity scores before and after project completion or as a restored site matures over time (Good and Sawyer 1997). However, it is anticipated that the guidebook's methods will be less sensitive than bioassessment approaches (see Volume IB, Section 8) for quantifying natural changes of a site over time.

4. **Profiles for wetland project design**. By collecting data from 109 sites, this guidebook project has helped define the range in variability expected in two regional HGM subclasses. In particular, it has quantified some of the features important to functions in the least-altered sites.

[1] These are *potential* applications. As of February 2001, no agency has *required* use of the guidebook's methods to assist decision-making in these situations.

Information from the reference sites could be used to set goals and help design wetlands that best mimic natural conditions and therefore, are likely to function well over long periods of time (Brinson and Rheinhardt 1996). This is discussed in detail in Section 9 of Volume IB. Reference information could be applied to help develop or refine additional mitigation performance standards that could be used to "condition" permits for wetland alteration. This has been done, for example, in western Washington (Azous et al. 1998).

5. **Prioritizing sites**. Appendix E of this volume ranks 109 sites according to their score for each function. When a new site is proposed for protection, restoration, or alteration, its function capacity scores can be computed and compared with those in Appendix E, thus providing one context for assessing its relative importance. This may be useful, for example, for verifying the selection of particular sites as Outstanding State Freshwater Wetlands as defined by DSL (OAR 141-86-360-390). The information could also be useful to citizens involved in private initiatives such as the "Greatest Wetlands Project." Persons who have assessed sites using this guidebook's methods are encouraged to send their completed Assessment Summary Form (p.59) to DSL. The scores might be added to those in the database of 109 sites, to help future users better understand the context of a particular wetland as reflected by its functions. No other wetland/riparian assessment method provides this capability.

6. **Assessing and restoring watershed health**. The area, diversity, and distribution of wetlands is an excellent indicator of overall watershed health or integrity (Bedford 1996, Gwin et al. 1999), and should be included in formal watershed assessments (Watershed Professionals Network 1999) and other activities conducted in support of the Oregon Plan. Wetland diversity can be expressed by the number of *HGM subclasses* present and their distribution, but a more refined and relevant supplemental indicator of watershed health is the variety of *functions* present among a watershed's wetlands belonging to each subclass. With a modest amount of field work, that can be estimated using this guidebook, so long as those wetlands belong to the 2 subclasses addressed by this guidebook. Such information can be used to help establish performance standards at watershed and landscape scales of analysis; that is discussed in more detail in Section 9 of Volume IB. Also, this guidebook's site-scale methods may be used to help verify and supplement watershed-scale, GIS-based methods for classifying and prioritizing wetland and riparian sites for restoration as part of TMDL (Total Maximum Daily Load) planning. That is because many wetlands are effective for assimilating nutrients from surface waters, so wetland restoration may sometimes be a cost-effective approach for improving watershed water quality.

Caution is warranted in applying and interpreting this guidebook's methods. Scientific understanding of wetland and riparian systems is far less than optimal for supporting the indicators and models used in methods such as those in this guidebook. That is equally the case with the most popular alternative: the application of informal "common sense" or "BPJ" (best professional judgment).

Moreover, standardized assessment methods are not immune to attempts of determined users to produce a desired result. Nonetheless, **the *potential* for biased manipulation of methods to achieve a desired result is <u>not</u> by itself a valid reason for failing to use formal methods in wetland decision-making**. Less formal, non-standardized methods are equally or more susceptible to manipulation of results, and manipulation may be less transparent. If bias is suspected, additional documentation and/or an independent assessment should be required.

The numeric scores from the methods should never be used alone to subsume the judgment of wetland specialists because the scores ***reflect only a subset of factors vital to decisions about wetlands.*** Wetland and riparian systems are more than just "bundles of functions" that can be teased apart and scattered around the landscape. In addition to functions and values, factors that must be weighed in many wetland decisions – but which are not necessarily addressed by this guidebook -- include:

- availability of alternatives for the proposed development (potential for impact avoidance)
- availability and cost of appropriate nearby sites for compensatory mitigation
- intrinsic sensitivity of the site to natural and human-related disturbance
- the long-term viability of the site, and cost of any measures required to maintain it
- navigability of the site, or if the site is itself legally considered non-navigable, does it have a perceptible influence on aquatic life (or other "uses" designated by the state) in nearby navigable waters
- relative contribution of the site's flora and fauna to *regional* biodiversity
- special legal status of any of the site's species
- actual or potential ability of the site to produce timber, crops, fur, or other marketable products
- recreational, open space, aesthetic, or educational "use" of the site
- status of the site as a natural hazard area
- status of the site as an interstate water (does it straddle two states?)
- status of the site as hazard or potential hazard due to known accumulations of chemical wastes
- existence of a conservation easement, deed restriction, local zoning designation, or other legal instrument that limits or allows particular uses of the site and/or its contributing watershed
- percent of total site acreage potentially affected by the proposed alteration, and its location within the site
- the magnitude of the proposed alteration, after accounting for the likely reliability of its impact minimization strategies
- technical "replaceability" or "manageability" of the site's functions
- likelihood of compensatory mitigation being physically and biologically successful
- potential for the alteration to create a public nuisance (directly, or through loss of wetland functions) either on-site or (especially) off-site
- potential for the alteration to impose unreasonable burdens on local infrastructure
- potential for cumulative impacts (e.g., consideration of local loss rate of this subclass of wetland)
- rules and policies of agencies involved in reviewing permit applications

The intended users of this guidebook are wetland specialists for government agencies, natural resource organizations, and consulting companies, who are skilled in conducting jurisdictional delineations of wetlands. Many such users have participated in the development of this guidebook. Some basic skills in plant identification are required to assess 2 of the 13 functions: Songbird Habitat and Characteristic Vegetation. Users should be able to identify all the woody plants and the more common herbaceous plants of the region, especially those that are not native. Users lacking such skills may nonetheless assess the other functions and values of a site. Users also should be able to recognize hydric soil features and delineate watershed boundaries from a topographic map.

Although every effort has been made to create rapid methods that provide fairly consistent (repeatable) results among unbiased users, all methods that rely on casual observation rather than measurement of natural phenomena tend to be imprecise. For example, results from two trained teams that tested an HGM method in the Delaware Coastal Plain showed the teams agreed 64% of the time with regard to scores for 28 indicators and 78% of the time with regard to scores for the functions which were based on mathematical combination of the indicator scores in models (Whigham et al. 1999). There exists no widely accepted standard as to what constitutes "adequate" consistency, and this should depend partly on application objective. Perhaps this issue is better stated as: "Is a new method *more* consistent and accountable than the status quo?" – the status quo often being solely the application of unstandardized personal judgments by diverse specialists. Results of preliminary testing of the consistency of this guidebook's methods are reported in Volume IB, and additional testing is planned. Users should anticipate lower consistency for indicators in Section 4 (Value Assessment) and Appendix B (Judgmental Method) than for those in Section 3 (Reference-based Assessment).

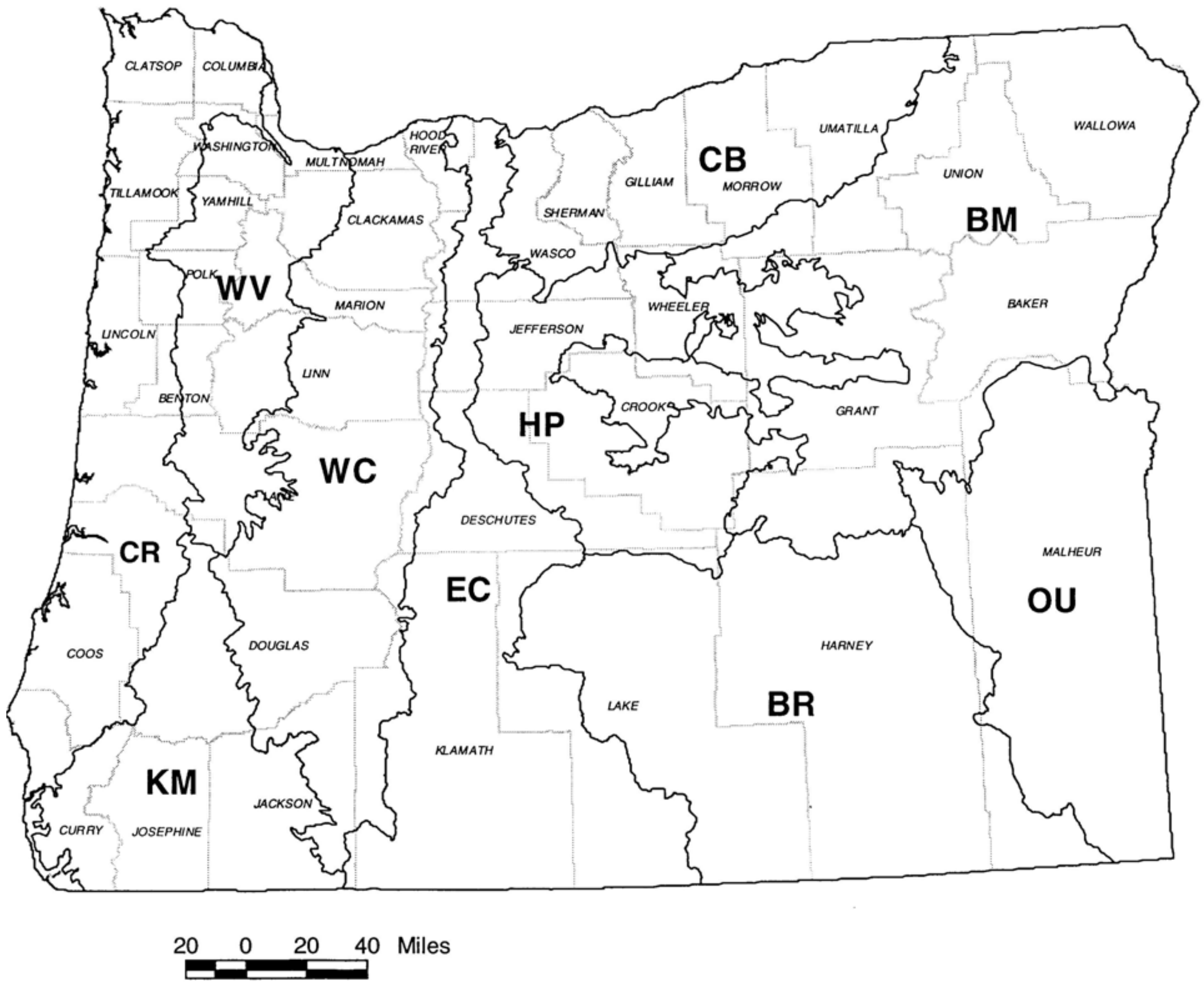
The number of functions that wetlands perform far exceeds those described in this guidebook (see Adamus 2001 for further discussion of this), so the guidebook focuses on a few that are easiest to assess in the short time periods required by the wetland permitting process.
The function indicators and scoring models presented in this guidebook are based on the author's experience and interpretation of scientific literature as well as opinions of experts who attended DSL-sponsored workshops during development of the methods. The models do not measure actual processes or describe the statistical probability of a function occurring. They are not deterministic equations, dynamic simulation models, statistical probability models, or other mathematical representations of processes taking place and constructed of independent variables. The scoring models <u>are</u> numeric representations of systematic qualitative hypotheses and are intended to assist a specific decision-making context. Thus, the scoring models are conceptually more similar to models that economists use to represent the condition of the nation's economy, based on leading economic indicators. As is true of all other rapid assessment methods applicable to this region, the guidebook's scoring models and their indicators have not been validated. That is the case because the time and cost of making the measurements necessary to fully determine model accuracy would be exorbitant.

Nonetheless, **the lack of indicator validation, as well as uncertainty regarding repeatability of results, are <u>not</u> by themselves sufficient reasons to avoid use of these methods** because the alternative – relying entirely on unstructured judgments of wetland technicians – is not demonstrably better. When properly applied, the models and their indicators are believed to adequately describe *relative* levels of function among sites, as well as make some wetland decision-making processes more standardized, accountable, and technically complete. Results of any future scientific studies of functions of the region's wetland and riparian systems should be reviewed carefully and often for ideas for indicators that may improve upon ones now used.

This guidebook's methods differ in several important ways from the Oregon Freshwater Wetland Assessment Method (OFWAM)(Roth et al. 1996), which currently is the method applied most often to assess Oregon wetlands. In comparison to OFWAM, the methods in this guidebook:

- use a similar number of indicators of function, and a process that takes about the same length of time as OFWAM to apply;
- represent functions with a numeric score, rather than categorizing them as "intact,""impacted/degraded," or "lost/not present;"
- are calibrated to actual field data from reference sites (see Volume IB for description);
- address only two subclasses of freshwater wetlands rather than all;
- treat differently sites that were historically prairie vs. historically wooded;
- are intended for use only in the Willamette Valley ecoregion;
- clearly distinguish wetland functions from values by scoring these separately;
- address 13 functions rather than 4;
- do not attempt to address "sensitivity to impact," "enhancement potential," "education," "recreation," or "aesthetic quality"
- reference the indicators to over 170 scientific papers and reports, nearly all from the Pacific Northwest.

The focus of this guidebook is the Willamette Valley ecoregion (Pater et al. 1998), termed the "Western Interior Valleys" ecoregion by some sources (see following figure). This 4800 square mile area contains more than 70% of Oregon's population, most of its industry, and almost half its farmland. The region continues to be developed at a rapid pace, with the human population expected to double in the next 25 years. This region has probably experienced greater losses of wetlands that most other parts of Oregon. Its climate, hydrology, and land cover have been described broadly by Uhrich & Wentz (1999) and Kagan et al. (1999). Recently, the region has been featured in major environmental initiatives sponsored by government agencies and private conservation groups (Allen et al. 1999). Its wetland and riparian habitats are universally recognized as vital elements of the region's ecological and economic health. Nonetheless, at least within the Willamette Valley Plains portion of the region which is the focus of this report, losses of regulated wetlands larger than 0.25 acre continue at an average of 546 acres per year (Daggett et al. 1998, Bernert et al. 1999), with agricultural activities being a significant cause (Shaich 2000).



CR = Coast and Coast Range; **WV = Willamette Valley**; **KM** = Klamath Mountains; **WC** = West Slope Cascades & Cascade Crest; **EC** = East Slope Cascades, Klamath Basin, Modoc Plateau; **HP** = High Lava Plains; **CB** = Columbia Basin; **BM** = Blue, Ochoco, Wallowa Mountains; **BR** = Basin & Range; **OU** = Owyhee Uplands

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Many of the indicators and scoring model configurations used in this guidebook are believed to be appropriate for use in the same wetland subclasses in other regions of the Pacific Northwest. However, before being applied outside the Willamette Valley, the indicator scores and scoring models would need to be re-calibrated by collecting and analyzing data from many reference sites in the new region, and new indicators possibly added.

Section 2. How to Use the Methods

The methods are straightforward:

1. Delimit the *site* boundaries.
2. Assign the site to an *HGM subclass*.
3. Photocopy the field forms and assess the site's *function capacity* using either the Reference-Based Method (Section 3) **or** the Judgmental Method (Appendix B)
4. Optionally, assess the *values* of the site's functions, using the method in Section 4.
5. Report results on the Assessment Summary Form (p. 59)
6. Interpret and apply the results.

These tasks are detailed in subsequent pages. **Before using the methods for the first time, you must read and fully understand Appendix A, which defines several specific terms and their procedures for estimation.** If available, training sessions are highly recommended.

Summary of the data-collecting procedure

During the field visit(s), walk the entire site. While doing so:

- Estimate boundaries of biennial high and low surface water
- Dig at least 3 soil pits and look for hydric soil indicators
- Finalize the site boundary (Section 2.1), and sketch it on the map grid on p. 61
- Be sure you've assigned the correct HGM subclass
- Fill out requested information for each function, e.g.:
  - Identify all woody plants and estimate their relative percent cover across the entire site
  - Identify all herbs that occupy more than 100 sq. ft. (contiguously or not)
  - Find the largest trees and measure their diameter
  - Note the types of dead wood that are present (see p. 77)
- Fill out Values Assessment forms (optional)

Indoors:

- On your computer, check land cover maps on the CD and add the information to your field forms
- Research other information that may improve upon your responses in the field
- Do the math, as explained on the forms you photocopied
- Transfer scores from Sections 3 and 4 to the assessment Summary Form
- Fill out other information requested on that form
- Compare your function scores with those from the reference sites
- Write a short description, discussing the other factors important to decisions at your site.

After using the methods often enough to understand how terms are defined and used, you may wish to use the abbreviated version of the field forms, as contained in Appendix P.

During your site visit, you should bring along the following items if possible:

__ shovel	__yardstick or D-tape (for tree dbh)	__ plastic bags for plant specimens
__ soil color chart	__ maps (topos, wetlands, soils)	__hand lens for plant ID (optional)
__ this guidebook	__ airphotos (enlarged)	__ plant ID guides
__ extra data forms	__rangefinder or transit (if available)	__GPS unit (optional, encouraged)

Assessments of most sites using this guidebook will require less than one day. Whenever possible, assessments should be completed after visits during contrasting seasons. Assessment by a multidisciplinary team is encouraged but not required. The actual length of time required to assess a site will depend on the site's size and complexity and experience of the user with this guidebook. It is recognized that this guidebook's methods will often need to be used at seasons when conditions are less than ideal for observing some indicators of function. Moreover, it is recognized that the "snapshot" kind of portrayal of a site obtained during a single visit is unlikely to assess adequately the long-term natural disturbance regimes that ensure the viability of many sites and their functions.

2.1 Delimit the Site Boundary

The primary spatial unit that is assessed by the guidebook method is the "assessment site" (or simply "site"). The term "site" is synonymous with "Assessment Unit (AU)" used by the Washington Department of Ecology's HGM method (Hruby et al. 1999). Ideally, assess the entirety of a wetland up to its boundaries with upland or a wetland of a different HGM subclass. For slope/flats sites (see Section 2.2 for definitions), the site boundary ideally will be synonymous with the wetland jurisdictional boundary. For riverine impounding sites, the site boundary ideally will be the typical biennial (2-year) high water level. However, practical considerations often necessitate defining assessment sites that are a subset of a whole wetland or bienniel floodplain. For assessment purposes, a wetland or riparian area *may* be divided into multiple sites if any of the following situations occur:

- It contains multiple HGM subclasses, all of which comprise more than 20% of the site area (see Section 2.2 below), or
- It is larger than about 200 acres and has complex vegetation and hydrologic regimes (because such areas usually cannot be adequately assessed during a one-day visit), or
- It contains portions that are inaccessible due to private property or physical restrictions (if such restrictions prohibit access to more than 20% of the wetland, the wetland probably cannot be assessed fairly).

Begin by inspecting existing maps of the wetland, including any prior jurisdictional delineations if available. Review the local wetland inventory if one has been completed (check DSL web sites or contact your town government). A less complete version of wetlands is shown on maps available online from the National Wetland Inventory (NWI):

www.nwi.fws.gov/wetlands_interactive_mapper_tool.htm

A complementary approach is to obtain the county soil survey report, pinpoint the wetland location on the maps, and note the boundaries of the contiguous polygons that contain hydric soils (see p. 75 for a partial list of hydric soils). County soil maps sometimes can also be used as a *very* rough guide for helping distinguish riverine from non-riverine parts of a site. Riverine subclass sites typically are on alluvial soils, but not all sites with alluvial soils are currently classified as riverine.

If you have convenient access to GIS, you might also want to download and examine the following digital maps available for parts of the Willamette Valley:

Oregon Natural Heritage Program ("natural" wetlands): www.sscgis.state.or.us/data/themes.html

Oregon Department of Fish & Wildlife (wetlands included as a land cover class): www.nwhi.org/nhiweb/nhi.html
NRCS (downloadable soils maps, southern Willamette Valley only): www.sscgis.state.or.us/data/themes.html

If you must break out one or more distinct assessment sites from a larger wetland, the key principle to follow is **hydrogeomorphic similarity**. *First*, create separate sites of any spatial units that are of a different subclass than the wetland's predominant HGM subclass, and comprise more than 20% of the whole wetland. For example, if a floodplain wetland abuts a similar-sized wetland being fed by hillslope seepage rather than being fed by floodwater, separate the wetland complex into 2 assessment sites, with each containing no more than 20% of the other subclass. *Second*, separate a wetland into distinct sites at the point where berms, levees, fingers of intruding upland (non-hydric soil), or other features constrain (but do not necessarily block completely) water movement at any season. *Do not* use property lines, fence lines, vegetation communities, seral stages, inundation frequency, mapped soil series, project ("footprint") boundaries, expected impacts, or land use designations as the *sole* means of defining sites, unless no hydrologically-based alternatives are available. Note that for purposes of using this guidebook to assess functions of wetlands, it is *not necessary to delineate the site boundary with the high level of precision customary for jurisdictional determinations.*

Despite the above guidance, deciding when to break out assessment sites and where to specify their boundaries will remain a highly subjective process. Although often ignored, this need, its difficulties, and consequences for assessment results are common among all wetland and riparian assessment methods.

2.2 Classify the Site

Next, classify the site based on its hydrogeomorphic characteristics, using the following key. *Note that although the HGM classification focuses on relative proportions of water sources (groundwater vs. runoff vs. direct precipitation, etc.), you are not required to measure or estimate these – just observe their indicators.* You may use NWI maps, local wetland inventory maps, topographic maps, soil survey maps, and airphotos to assign a preliminary classification, and then finalize the classification after visiting the site. Record the subclass(es) on the Assessment Summary Form (p. 59). Then proceed with assessing functions (Section 3, as described in Section 2.2) ***only* if you have classified the site as being Riverine Impounding or Slope/Flats.**

Key for Level-1 Hydrogeomorphic (HGM) Classification of Willamette Valley Wetland/Riparian Systems

Note: Frequently, areas belonging to one HGM subclass will be situated within or adjacent to an area belonging to another HGM subclass. Normally, each area should be assessed separately. However, for practical purposes the areas may be combined into one site (assessment unit) if the smaller of the two areas comprises less than 20% of their total combined acreage. An example is a perennial channel (Riverine Flow-through subclass) that bisects an ash swale (Slope/Flats) and which, even including the channel's 2-year floodplain, occupies less than 20% of their combined acreage. In this example, for most purposes the entire site should be classified as Slope/Flats.
See Volume IB for background on how the following subclasses were developed.

1. Water levels visibly controlled by daily tidal cycles.

YES: **Estuarine** class

Note that salinity is not considered in this determination. In the Willamette Valley region, it includes the tidal Columbia River and tidally-influenced sloughs and tributaries.
On NWI maps, this includes all sites labeled E and some others with –S, -R, -T, or –V water regime codes.

NO: Go to 2

2. Closely associated with a channel or floodplain. Upland wetted edge of site expands at least once every other year (biennial flood) primarily as a result of overbank flow or channel inflow from a nearby and/or connected or bisecting channel.

Includes active floodplain wetlands, sloughs, and riparian areas.
Does not include sites whose hydrology is merely *influenced by* river levels, unless they also contain a surface water connection at least seasonally and meet the other criteria.
On NWI maps, includes many sites labeled R or PUB, PEM, PSS, or PFO with –A, –C, -F, or -H water regime codes appended, and others.
Includes many of the sites with these soils (list is not diagnostic): alluvium, Brenner, Faloma, fluvents, Rafton, riverwash, Whiteson, others.
Includes many of the sites with these plant species (list is not diagnostic): *Populus balsamifera, Symphoricarpos albus, Tolmeia menziesii, Lysimachia nummularia, Stachys ciliata,* others.

YES: **Riverine** class, Go to 3

NO: Go to 4

3. Water throughout most of site flows visibly during most of wet season. The site may be a channel, an island in a channel, or border a channel or ditch. It should include any channel to the 2 m depth as measured during low water. It often bisects or is bordered by a wetland in another HGM subclass.

YES: **Riverine Flow-through (RFT)** subclass.

Includes scoured floodplains with no seasonal ponding of floodwater, wetlands that comprise entire islands within channels, and some ditches and channels.

NO: **Riverine Impounding (RI)** subclass.

Includes sloughs connected (seasonally or permanently) to main channels, channels dammed by beavers or humans (such wetlands may be broader at their downhill/outlet side), wetlands sustained primarily by water diverted or pumped from offsite channels, river alcoves with seasonally stagnant conditions, and depressions or temporarily ponded areas within active biennial floodplains. Includes many sites of the Ingram geomorphic surface (Reckendorf 1993).

4. Located on margin of or within a lake, i.e., a body of permanent standing water that is deeper than 2 m over an area of >8 hectares (20 acres).

On NWI maps, includes all sites labeled "L" and others with –A, -C, -F, or –H water regime codes that border an L site.

Does not include sites whose hydrology is merely *influenced by* lake levels, unless they also contain a surface water connection and meet the other criteria.

Includes some sites with these plant species (list is not diagnostic): *Sparganium eurycarpum, Scirpus acutus, Scirpus tabernaemontani, Typha latifolia, Utricularia macrorhiza,* others.

YES: **Lacustrine Fringe** class

NO: Go to 5

5. Consists of >10% cover of *Sphagnum* moss over an area of >0.25 acre, and has a mean annual water pH of <5.5. Usually situated in a depression with little if any standing water.

Includes some sites with these plant species (list is not diagnostic): *Vaccinium caespitosum, Salix geyeriana, Salix hookeriana,* others.

YES: **Depressional Bog (DB)** subclass

NO: Go to 6

6. Located on or near base of a slope, but the slope may be barely perceptible. Inlet channel absent or very short. Outlet channel frequently present. Shallow sheet flow may be visible at land surface, especially during wet months. Downhill side of site sometimes partly blocked by berm or dam (natural or manmade). Fed by runoff and precipitation but with a proportionally large (compared with other wetlands) component of lateral subsurface flow or discharging groundwater. Soil moisture (and surface water, if present and shallow) tends to persist longer into the summer than in other wetlands of similar size, depth, climate, and soil type. Ratio of wetland surface area to area of the apparently contributing watershed is relatively large.

On NWI maps, includes many sites labeled PEM, PSS, or PFO with –B water regime codes, and less often with –A, -C, or –F codes.

Includes many of the sites with these soils (list is not diagnostic): Bashaw, Delena, Grande Ronde, Panther, Pengra, Wollent, Willanch, others.

Includes many of the sites with these plant species (list is not diagnostic): *Juncus effusus, Typha latifolia, Lysichiton americanum, Fontinalis antipyretica, Scirpus microcarpus, Athyrium filix-femina, Oenanthe sarmentosa,* others.

YES: **Slope** class.

Includes springs, seeps, some sites sustained in summer mainly by seepage (not runoff) from upslope irrigated fields, some sites with water impounded seasonally by push-up dams at their downhill side, excavated springs on noticeable slopes, and some ash swales.

NO: Go to 7 (usually in flat or moderately flat terrain. Has no outlet channel).

7. Fed mainly by overland runoff (sheet flow) which enters from all 3 or 4 compass directions, and/or by stormwater pipes, drainage ditches. Usually in a deep (>2 ft.) basin, which may have been deepened by excavation. Usually is inundated permanently. Often in natural depressions in rolling or hilly terrain.

On NWI maps, includes many of the sites labeled PUB or PAB, some L, and a few others.

Includes many of the sites with these soils (list is not diagnostic): Conser, Courtney, Minniece, others.

YES: **Depressional** class.

Includes some sites that historically may have belonged to another HGM subclass, e.g., some sloughs, cutoff meanders, and gravel pits that no longer are flooded biennially by rivers, as well as some closed basins excavated to the depth of static groundwater and not located on a noticeable slope.

NO: Go to 8

8. Fed mainly by direct precipitation, secondarily by lateral subsurface flow or surface runoff. Precipitation may be "ponded" at the site due to surrounding natural levees (ridge-swale topography) or constructed dikes; and/or due to soils with subsurface layers that strongly impede infiltration; and/or due to high water table due to subsurface seepage from nearby river, lake, or irrigated fields. Usually in a shallow (<2 ft.) basin situated on a broad flat terrace (e.g., Calapooyia geomorphic surface, Reckendorf 1993).

In their unaltered state, many Flats contain complex ("hummocky") microtopography and are inundated only seasonally.

Altered (diked) Flats sites may function similarly to Depressional class, but their only significant water comes from runoff from dike surfaces and direct precipitation, so they should be classified as Flats.

On NWI maps, includes many sites labeled PUS, PEM, PFO, or PSS with –A, -B, or -C water regime codes.

Includes many of the sites with these soils (list is not diagnostic): Amity, Awbrig, Concord, Dayton, Labish, others.

Includes many of the sites with these plant species (list is not diagnostic): *Brodiaea* sp., *Camassia quamash, Carex densa, Deschampsia cespitosa, Beckmannia syzigachne, Downingia elegans, Eryngium petiolatum, Grindelia integrifolia, Juncus patens,Plagiobothrys figuratus, Fraxinus latifolia,* others.

YES: **Flats** class

Includes most vernal pools, wet prairie, some ash swales.

NO: Reconsider choices and if necessary collect additional information, or assign a joint classification using classes that best fit the site, e.g. **Slope/Flats**[1].

2.3 Assess Function Capacity

The term "function capacity" (Smith et al. 1995) is synonymous with "potential functional performance" used by the Washington Department of Ecology's HGM method (Hruby et al. 1999). To assess function capacity, you must first decide whether to use the guidebook's Judgmental Method or its Reference-based Method. Both methods require a site visit, and the indicators used are almost the same in both methods. The indicators are based on the author's interpretation of scientific literature as well as opinions of experts who attended indicator development workshops sponsored by DSL in 1999. Some indicators are used to assess multiple functions.

The **Judgmental Method** (Appendix B) presents the indicators of each function as a qualitative checklist. You then must decide how to estimate, scale, and combine the indicators into a numeric estimate of function capacity. Compared with the Reference-based Method, the Judgmental Method is more flexible, perhaps faster to use, and (as its name implies) requires more subjective interpretations. Its primary advantage is that it allows you to incorporate some of your own understanding of wetland/riparian functions into the assessment process. Because understanding of functions varies among individuals and functions, whenever feasible the

[1] In this guidebook pertaining to the Willamette Valley, such a joint classification has been used because it was not possible to distinguish these classes at many of the reference sites. We have termed this joint classification -- slope/flats – a subclass rather than a class because it does not correspond exactly to the national list of HGM classes.

Judgmental Method should be used by a *team* of wetland specialists, rather than an individual. Also, before using the Judgmental Method you should know the definitions and procedures for estimating each indicator as described in Appendix A. The Judgmental Method is similar in concept to the US Bureau of Land Management's "PFC Method" (Pritchard 1994), descriptive methods developed in Wisconsin and New England (US Army Corps of Engineers 1995), and the Washington Department of Transportation's qualitative "Wetland Functions Characterization Tool" (Null et al. 2000). Instructions and forms for using the Judgmental Method begin on p. 86.

Whenever feasible, the **Reference-based Method** (Section 3) is the recommended choice. You estimate the indicators quantitatively, and select from multiple numeric categories (which are specific to each indicator and subclass) to standardize your numeric estimate to a 0-to-1 scale. You then mathematically combine the standardized estimates into a *function capacity* score using prespecified *scoring models*, and standardize the model output by dividing by the score of the site or sites that have the highest function score and/or are believed to represent the least-altered condition. The Reference-based Method provides a relatively high level of consistency. Scoring is based on direct comparison with indicator data from a large set of sites that were assessed in 1999-2000, providing a fairly high level of realism. The derivation of the indicator scales is described in Volume IB. The Reference-based Method is conceptually similar to the Washington Department of Ecology's HGM methods (Hruby et al. 1999) and follows most of the guidelines provided for HGM method development issued by the U.S. Army Corps of Engineers (Smith et al. 1995, Smith et al. *in draft*). Instructions and forms for using the Reference-based Method begin on p. 20.

Before using the Reference-based Method, you will need to choose from two options: ***Highest-functioning Standard*** or ***Least-altered Standard.*** The difference is this: when you use the former, you are comparing your site's function capacity score to the *highest* score found among all sites in the same subclass during the 1999-2000 field work. When you use the latter, you are comparing your site's function capacity score to the highest score found among a few sites of the same subclass that were considered (before fieldwork began) to be among the least-altered sites in the Willamette Valley. Although as a whole the 1999-2000 sites identified as least-altered were higher functioning (for most functions) than those that were not, they were not *always* the highest functioning of all sites partly because of the pervasiveness of wetland degradation in the region -- see Volume IB for details. No recommendation is made herein regarding which standard to use, because considerable difference of opinion exists among reputable scientists (see, for example, Hruby 1997, Brinson et al. 1998). Our data suggest that for most sites, using different standards will have only a minor statistical effect on the final function capacity score and site ranking. To verify this, you may calculate using both options. *Regardless of the option you choose, be sure to report* ***which*** *you used on the Assessment Summary Form.*

When applying the Reference-based Method to slope/flats sites, you also will need to make an assumption regarding likelihood of the site being wooded or not during the 1800's. You will base your assumption on information from land surveys conducted around 1850, and viewable in map form on the CD-ROM that accompanies this guidebook. The guidebook includes this consideration of 1800's conditions because in the Willamette Valley wet prairies were a stable feature of the wetland landscape, being maintained for centuries by native American cultures

(Boyd 1986). Thus, in this guidebook, (a) indicators applicable mainly to wooded sites are not included in the scoring models for slope-flat sites that historically were not wooded, and (b) scores of wet prairie sites (a type of slope-flat site) are standardized by comparison to the highest-functioning (or least-altered) *wet prairie* sites – not to all slope-flats sites. By doing this, the tendency of existing wetland assessment methods to set unrealistic or undesirable expectations for performance of wet prairie sites is avoided.

Regardless of whether you're using the Reference-based Method or the Judgmental Method, the following apply:

1. Enter your function assessment data and score calculations directly on a photocopy of Section 3 (Reference-based Method) or Appendix B (Judgmental Method), as well as on a photocopy of the Assessment Summary Form.

2. If information requested for an indicator seems inapplicable (e.g., a request for "percent herb cover in the permanent water zone," when your site totally lacks permanent water), write N/A (not applicable) in the relevant place rather than reporting as a "0." When asked to average the standardized score from this indicator with the standardized scores from others, only take the average of indicators that have scores, i.e., are not "N/A."

3. Never sum or otherwise combine the function capacity scores (or value scores) from a site in order to produce a single function capacity score. This is invalid because (a) functions are not of equal social or ecological importance, and (b) each standardized function capacity score has a different statistical distribution, thus implicitly giving more weight to some functions. If for some reason it is imperative to represent a site's function capacity by a single number, consider using the *highest rank* of the site for any function, where "rank" represents where the site would fall in the listing of reference sites in Appendix E, with "1" being the highest rank attainable.

4. If your objectives require you to assess only <u>part</u> of a site, e.g., just the portion that will be directly altered by construction, you may use these methods, but we recommend you also apply the methods to the entire site, and report <u>both</u> results.

5. Some methods suggest multiplying the standardized function capacity scores by site *area* to yield "capacity-per-acre" estimates for each function, and a column on the Assessment Summary Form provides for that. However, caution is required in interpreting the products because:

> (a) Often only a small portion of an entire site is responsible for supporting a function, e.g., in a large floodplain site, only the vegetated substrate significantly supports the thermoregulation function;
>
> (b) The relationship of function to area cannot necessarily be assumed to be linear, as is implied by simple multiplication. For example, for birds the first few acres of vegetation contribute much more to avian diversity of a site than the thousandth acre. Moreover, a small site may be more important than a large site to wildlife if it is located near a wetland of a different type, or if it provides a crucial link in a corridor of natural areas;
>
> (c) In addition to function capacity, function *value* (see Section 2.4 below) may be of considerable importance and should be formally accounted for in some manner.

Nonetheless, site acreage is frequently the best overall predictor of site function, so it should always be reported and factored into decisions.

6. Some users have expressed an interest in scoring site functions based *only* on indicators that are estimated *within* a site – not in the surrounding landscape. This is of practical concern because wetland managers and property owners sometimes are virtually powerless to improve conditions in the surrounding landscape. The following indicators of function pertain mainly to offsite conditions:

Access to anadromous fish
Surrounding land cover
Land cover in contributing watershed
Distance to nearest busy road

In addition, nearly all indicators of site *value* (Section 4) pertain mainly to offsite conditions. If you are interested in knowing only the contribution of onsite conditions, you will not only need to delete the above indicators from the function scoring models, but also re-calibrate the models, i.e., standardize the function scores. The abbreviated models will also be less accurate.

7. Before reporting the assessment results, review again the potentially important factors listed on page 5. Present your results in the larger context of those considerations.

2.4 Assess Values

Wetland values are the economic, ecological, or social manifestations of the functions that wetlands perform. Section 4 of this guidebook is a method for assessing values of functions at wetland and riparian sites. The results of using this method are not expressed in dollars, but as scores from the same type of 0-to-1 scale used in the function capacity assessment. The guidebook includes this valuation method partly because of a common complaint that function-based HGM assessments, by using least-altered sites to anchor the scoring scale, undervalue urban sites. Urban sites do tend to have *relatively* low capacity for many functions, but what wetlands do exist are often highly valued by the public partly because of the scarcity of wetlands in urban settings. Very few function-based assessments of wetland value have been conducted in the Willamette Valley. Exceptions include Marshall's (1986) analysis of the Jackson-Frazier wetland in Corvallis, and the review by Coulton et al. (1996) of the Willamette River floodplain's natural flood storage.

This guidebook's valuation method is presented in a qualitative checklist format similar to that used by the Judgmental Method (Appendix B) and described earlier. This is done because of the need for flexibility and the great subjectivity inherent in assessing values. Indicators used to assess value reflect concepts such as the scarcity of similarly-functioning sites, likelihood of functions being manifested as "services" to offsite people or resources, existence of official designations, and opportunity to perform particular geochemical functions (Adamus 1983). Instructions and forms for using the value assessment method begin on p. 47. When using resulting value scores, keep in mind the following:

- Because of the subjectivity involved, assessments of the value of a site's functions should preferably be conducted by multiple individuals independently or as a team. Even so, low repeatability will be typical rather than exceptional.

- Because the scores representing values of functions are relative, and because the functions they represent are not traded on an open market, the value scores cannot be directly converted to market price (dollars).
- Use of the value scores in some contexts can lead to such absurdities as recommendations to develop a wetland's contributing watershed so that the wetland has more opportunity to perform water purification functions, making it more "valuable." Thus, value scores should never be used in project design or for pre/post analysis of impacts. However, they may be used to help select mitigation sites which, by virtue of their location, are more likely to confer the most services to society and ecosystems.
- This guidebook's valuation method assesses many values of the functions of wetland and riparian sites, but is not necessarily comprehensive. The method does not consider several values that are unrelated to the functions of sites but which potentially may be worthy of consideration as part of a public interest review process.

2.5 Interpret and Apply the Results

Summarize your assessment results using the form, p. 59. When interpreting the scores, keep in mind the following, in addition to issues discussed in previous sections:

- The scores are relative, not absolute. For example, a function capacity score of 1.0 (the highest possible) for Nitrogen Removal does not necessarily mean a site is removing more nitrogen from surface water than it contributes. It only means that this guidebook's indicators are suggesting that, of all the sites in this subclass in this region, few or none are likely to remove nitrogen *more effectively than* this site.
- No qualitative descriptors have been associated with particular score intervals. For example, we cannot state that a function capacity score of 0.6 or 0.8 or whatever means the function is "intact" or "highly probable" or "recoverable" or "viable" at a particular site. Similarly, we cannot conclude that a site with a score of 0.6 performs the specified function twice as effectively as a site with a score of 0.3. If a context is needed for interpreting scores, the best approach is to see where your site fits among the reference sites whose scores are given in Appendix E.
- Scores should normally not be compared or combined among sites belonging to different subclasses. For example, a score of 0.2 for Invertebrate Habitat in a Riverine Impounding site cannot be considered the same as a 0.2 for Invertebrate Habitat in a Slope/flats site. This is because different sets of reference sites, with different statistical distributions of scores, were used for these two subclasses.
- Expect that typically, no site will rank highly among all sites for *all* functions. This is because conditions that are optimal for some functions are normally less than optimal for some others.

Interpretation of scores on the Assessment Summary Form also will depend on the intended application. Potential applications of this guidebook's methods are discussed beginning on p. 3.

Section 3. Assessment of Function Capacity: Reference-based Method

The following pages of this section contain a method for rapidly assessing the capacity of a site for 13 functions. In each subsection, the function is defined, and indicators and scoring models are presented, with space for entering your data. To see the reasons particular indicators were (or were not) used, and a rationale for the configuration of the model, see Appendix D. For a description of the process used to select and test these indicators, see Volume IB.

3.1 Function Capacity: Water Storage and Delay

Definition: *The capacity of a wetland or riparian area to store or delay the downslope movement of surface water for long or short periods*, and in doing so to *potentially* influence the height, timing, duration, and frequency of inundation in downstream or downslope areas. This usually has positive economic, social, and ecological implications for the affected areas downstream or downslope. If measured, this function could be expressed as:

cubic feet of water stored or delayed within a wetland per unit time

Instructions: For each indicator in the table on the following page, insert your best estimate ("Raw Datum") in column 4 (See the pages referenced in column 3 for indicator definition and instructions for estimating the indicator correctly). Then compare your estimate with the scale either in column 5 (if you classified your site as Riverine Impounding) or in column 6 (if classified as Slope/Flat), and write one number – the scaled datum – in the last column. You may enter more than one number per box (separated by a slash) if you are comparing two sites, or comparing conditions at one site before and after impact or restoration. For example:

Example of filled-out tables and calculations for a particular Riverine Impounding site:

Step 1. Enter estimates in columns 4 and 7:

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
A	Percent of site that is inundated only seasonally	p. 81	80	<10 =.1 10-30 =.3 30-60 =.5 60-90 =.7 > 90 = 1.0	none = 0 1-10 =.1 10-25 =.6 25-50 =.8 > 50 = 1.0	.7
B	Vertical increase in surface water level (ft) in most of the seasonal zone	p. 82	3	<2 =.2 2-3 =.4 4-6 =.6 7-10=.8 >10=1.0	0 = 0 .1 - .4 =.25 .5- 1.0 =.5 1 - 2 =.75 >2 = 1.0	.4

Step 2. Insert numbers from column 7 into scoring model shown for this function below, and compute:

A x B = 0.7 x 0.4 = **0.28**

Step 3. Divide as shown:

Scale To:	Riverine Impounding (RI)	Slope/flats (SF)
Highest Functioning standard	divide by 1 = ***0.28 / 1 = 0.28***	divide by 1 =
Least Altered standard	divide by 1 = ***0.28 / 1 = 0.28***	divide by .85 =

Indicators and Scoring Model:

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
A	Percent of site that is inundated only seasonally	p. 81		<10 =.1 10-30 =.3 30-60 =.5 60-90 =.7 > 90 = 1.0	none = 0 1-10 =.1 10-25 =.6 25-50 =.8 > 50 = 1.0	
B	Vertical increase in surface water level (ft) in most of the seasonal zone	p. 82		<2 =.2 2-3 =.4 4-6 =.6 7-10=.8 >10=1.0	0 = 0 .1 - .4 =.25 .5- 1.0 =.5 1 - 2 =.75 >2 = 1.0	

Combine the scores in the last column according to the following formulas, where the letters refer to the indicators above:

Function Capacity score = A x B

To calculate a *Standardized* Function Capacity Score, divide the above Function Capacity Score in the manner indicated below, depending on whether the site is RI or SF, and whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**	**Slope/flats (SF)**
Highest Functioning standard	divide by 1 =	divide by 1 =
Least Altered standard	divide by 1 =	divide by .85 =

Note: If the resulting value after division is >1.0, you must replace it by 1.0 (Smith et al. 1995).

Report the resulting score on the Assessment Summary Form (p.59, column 2).

3.2 Function Capacity: Sediment Stabilization and Phosphorus Retention

Definition: The capacity of a wetland or riparian area to intercept suspended inorganic sediments, reduce current velocity, resist erosion of underlying sediments, minimize downstream or downslope erosion, and/or retain any forms of phosphorus. This is of economic and social interest because phosphorus and excessive suspended sediment (turbidity) in water are usually considered to be pollutants, and because unnatural rates of bank erosion can adversely affect streamside vegetation, habitat, and property. Phosphorus is partly responsible for instigating oxygen-depriving growths of algae (Rickert et al. 1977, Hines et al. 1977, Rinella et al. 1981). If measured, this function could be expressed as:

> *percent of the grams of total, incoming, waterborne phosphorus and/or inorganic solids (sediment) that are retained in substrates or plant tissue, per unit wetland area, during a single typical growing season*

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
A	Score from Water Storage & Delay assessment	p. 21	(from p. 21)			(same as Raw Value)
B	Maximum annual extent (%) of hummocks	p. 74, p. 75		N/A	none = 0 1-10 =.6 10-90 =.8 >90 = 1.0	
C	Percent & distribution of pools at *biennial high water* Note: If site is >1 acre, select the condition that *predominates* in 1-acre subunits of the site	p. 79		A = 0 B =.1 C =.2 D =.3 E =.4 F =.5 K =.6 H =.7 I =.8 J =.9 G = 1.0	A = 0 B =.6 C =.65 D =.7 E,F =.75 K =.8 H =.85 I =.9 J =.95 G = 1.0	
D	*Predominant* soil texture: **GC**= gravel or cobble **SA**=sand, sandy loam, or loamy sand **L**= loam, silty loam, gravelly loam **C**= clay, sandy clay, silty clay, clay loam, silty clay loam **O**= organic particles<1mm	p. 82		GC =.1 SA =.2 L =.8 C/O = 1.0	GC =.1 SA =.2 L =.8 C/O = 1.0	
E	Percent of site currently affected by soil compaction (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	
F	Percent of site affected by soil leveling	p. 80		100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	
G	Percent of site affected by soil mixing, including plowing (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
H	Percent of seasonal zone that is *bare* during most of the dry season. (answer "0" if no seasonal zone)	p.79		>80 = 0 60-80 =.2 40-60 =.4 20-40 =.6 1-20 =.8 0 = 1.0	>80 = 0 60-80 =.2 40-60 =.4 20-40 =.6 1-20 =.8 0 = 1.0	

Combine the scores in the last column according to the following formula:
Function Capacity Score = A + (max: B,C) + D + (min: E,F,G) + H

* "max" and "min" indicate you should take the maximum or minimum of the ***scaled data*** of those indicators.

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score in the manner indicated below, depending on whether the site is RI or SF, and whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**	**Slope/flats (SF)**
Highest Functioning standard	divide by 3.45 =	divide by 3.75 =
Least Altered standard	divide by 2.7 =	divide by 2.9 =

Note: If the resulting value after division is >1.0, you must replace it by 1.0 (Smith et al. 1995).

3.3 Function Capacity: Nitrogen Removal

Definition: The capacity of a wetland or riparian area to remove nitrogen from the water column and sediments by supporting temporary uptake of nitrogen by plants and by supporting the microbial conversion of non-gaseous forms of nitrogen to nitrogen gas (denitrification). This is of economic and social interest because nitrogen in water is usually considered a pollutant, inasmuch as it sometimes can trigger excessive growths of oxygen-depleting algae and cause illness in humans (Rickert et al. 1977, Hines et al. 1977, Rinella et al. 1981). If measured, this function could be expressed as:

percent of the grams of total, incoming, waterborne nitrogen that are retained in substrates or plant tissue, or gasified by denitrification, per unit wetland area, during a single typical growing season

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
Note: Proceed with assessing this function only if you note *hydric soil features* (e.g., mottles, gleying, concretions, oxidized root zones, low chroma, sulfidic odor) which indicate that oxygen deficits are present in at least part of the site, and thus denitrification may occur.		p. 76				

#	**Reference-based Indicator**	**How to Estimate**	**Raw Datum**	**Scale for RI**	**Scale for SF**	**Scaled Datum**
A	Percent of site that is inundated only seasonally	p. 81		none = 0 1-10 =.1 10-30 =.3 30-60 =.5 60-90 =.7 > 90 = 1.0	none = 0 1-10 =.1 10-25 =.6 25-50 =.8 > 50 = 1.0	
B	Difference between biennial high and low *predominating* water levels: 0) = no change 1) = difference of one class 2) = difference of 2 classes 3) = difference of 3 classes 4) = difference of 4 classes	p. 71		0) = 0 1) =.3 2) =.5 3) =.8 4) = 1.0	0) = 0 1) =.3 2) =.5 3) =.8 4) = 1.0	
C	Percent of site currently affected by soil compaction (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	
D	Percent of site that was constructed from non-hydric soil: 6 = recent, >90% of site 5 = recent, 10-90% of site 4 = recent, 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	
E	Number of kinds of dead wood	p. 77		none = 0 1 =.1 2/3 =.2 4/5 =.3 6/7 =.5 8/9 =.7 10/11 =.9 12 = 1.0	none = 0 1 =.1 2/3 =.2 4/5 =.3 6/7 =.6 8/9 =.8 10/11 =.9 12 = 1.0	
F	Diameter of largest trees (inches)	p. 71		none = 0 1-12 =.1 13-19 =.25 20-27 =.5 28-44 =.75 45-52 =.9 >52 = 1.0	none = 0 1-5 =.1 6-9 =.25 10-17 =.5 18-25 =.75 26-35 =.9 >35 = 1.0	
G	Maximum annual extent (%) of hummocks	p. 74, p. 75		N/A	none = 0 1-10 =.6 10-90 =.8 >90 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
H	Percent of site affected by soil leveling	p. 80		100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	
I	Percent & distribution of pools at *biennial low water* Note: If site is >1 acre, select the condition that predominates in 1-acre subunits of the site	p. 79		A = 0 B,C =.3 D =.4 E,F =.5 G =.6 H =.7 I =.8 J =.9 K = 1.0	A = 0 B,C =.3 D =.4 E,F =.5 G =.6 H =.7 I =.8 J =.9 K = 1.0	
J	Burned or harvested	p. 72			no = 0 yes = 1.0	
K	Land cover in the vicinity of the site in 1800's: 1= wooded; 2= nonwooded	p. 74				

Combine the scores in the last column using whichever formula below is more appropriate:
If K = 2 (site was historically not wooded), use this ("avg." = average):
Function Capacity Score = (avg.* of A,B) + C + D + (avg: G,H) + I + J
If K = 1 (site is RI or was historically wooded), use this ("avg." = average):
Function Capacity Score = (avg.* of A,B) + C + D + (avg. of E,F) + (avg: G,H) + I

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on (a) whether the site is RI or SF, (b) whether you wish to compare the results to the highest functioning or least-altered condition (see p.15), and (c) whether the site was historically wooded or not.

Scale To:	**Riverine Impounding**	**SF – historically not wooded**	**SF – historically wooded**
Highest Functioning standard	divide by 5.2 =	divide by 4.05 =	divide by 4.15 =
Least Altered standard	divide by 5 =	divide by 4.05 =	divide by 4.15 =

Note: If the value that results after division is >1.0, you must replace it by 1.0.

3.4 Function Capacity: Thermoregulation

Definition: *The capacity of a wetland or riparian site to maintain or reduce water temperature.* Water temperature is of considerable importance to the survival of salmonid fish, as well as being important to many ecological processes and conditions, particularly those sensitive to oxygen availability. Although this function occurs primarily in riverine sites, slope/flats sites occasionally have permanent connections to other surface waters and then can provide this function. If measured, this function could be expressed as:

> *the decrease in temperature of water exiting a site via surface flow or infiltration, compared with temperature of the water when it enters the site via surface flow*

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scaled Datum
	<u>**Note 1**</u>: This function should be assessed only for riverine sites at which part of the site is *permanently* inundated and connected by surface water during all or part of summer to other water bodies. <u>**Note 2**</u>**:** At least in riverine environments, the indicators and models below should be considered to be much less accurate than some of the more data-intensive mathematical models currently available for estimating thermoregulation functions (e.g., Levno and Rothacher 1967, Brown and Krygier 19667, 1970, Brown et al. 1971, Adams and Sullivan 1990, Beschta and Weatherred 1984).				
A	Percent of permanent zone shaded by woody or aquatic plants	p. 80		1-10 =.4 10-20 =.6 20-40 =.7 40-60 =.8 60-80 =.9 >80 = 1.0	
B	*Predominant* depth category during *biennial low water*	p. 82		<1" = .1 1-2" =.2 2-24" =.3 24"- 6' =.9 >6ft = 1.0	

Combine the scores in the last column according to the following formula:
Function Capacity Score = A x B

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as follows, depending on whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**
Highest Functioning standard	divide by 0.7 =
Least Altered standard	divide by 0.7 =

<u>Note</u>: If the value that results after division is >1.0, you must replace it by 1.0.

3.5 Function Capacity: Primary Production

Definition: *The capacity of a wetland or riparian area to use sunlight to create particulate organic matter (e.g., wood, leaves, detritus) through photosynthesis.* The sustained production of organic matter by vascular plants and algae is of economic, social, and ecological importance because it forms the basis of animal food webs as well as potentially providing many products directly useful to people. If measured, this function could be expressed as:

grams of carbon gained (from photosynthesis) per unit area of wetland per year

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
A	Percent of site currently affected by soil compaction (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	
B	Number & distribution of vegetation forms	see figure, p. 77		A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	
C	Maximum annual extent (%) of hummocks	p. 74, p. 75		N/A	none = 0 1-10 =.6 10-90 =.8 >90 = 1.0	
D	Percent of site affected by soil leveling	p. 80		100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	
E	Percent & distribution of pools at *biennial low water*	p. 79		A = 0 B =.1 C =.2 D =.3 E =.4 F =.5 K =.6 H =.7 I =.8 J =.9 G = 1.0	A = 0 B =.6 C =.65 D =.7 E,F =.75 K =.8 H =.85 I =.9 J =.95 G = 1.0	
F	Percent of land cover in <u>*contributing watershed*</u> & within 200 ft that is not cropland, lawns, pavement, or buildings	p. 79		<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-100 = 1.0	<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-100 = 1.0	
G	Percent of seasonal zone that is bare during most of the dry season (answer "0" if no seasonal zone)	p.79		>80 = 0 60-80 =.2 40-60 =.4 20-40 =.6 1-20 =.8 0 = 1.0	>80 = 0 60-80 =.2 40-60 =.4 20-40 =.6 1-20 =.8 0 = 1.0	
H	Land cover in the vicinity of the site in 1800's: 1= wooded; 2= nonwooded	p. 74				

Combine the scores in the last column using whichever formula below is more appropriate:

If H = 1 (site is RI or was historically wooded), use this:
Function Capacity Score = A + B + (avg. C,D) + E + F + G
If H = 2 (site was historically not wooded), use this:
Function Capacity Score = A + (avg. C,D) + E + F + G

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on (a) whether the site is RI or SF, (b) whether you wish to compare the results to the highest functioning or least-altered condition (see p.15), and (c) whether the site was historically wooded or not.

Scale To:	**Riverine Impounding**	**SF – historically not wooded**	**SF – historically wooded**
Highest Functioning standard	divide by 5.35 =	divide by 4.1 =	divide by 4.8 =
Least Altered standard	divide by 5.25 =	divide by 4 =	divide by 4.8 =

Note: If the value that results after division is >1.0, you must replace it by 1.0 (Smith et al. 1995).

3.6 Function Capacity: Resident Fish Habitat Support

Definition: *The capacity of a wetland or riparian site to support the life requirements of most of the non-anadromous (resident) species that are native to the Willamette Valley* ecoregion as shown in Appendix B of Volume IB. If measured, this function could be expressed as:

sum of native non-anadromous fish recruited annually from within the site

The scoring model below does not equally reflect the habitat needs of all local resident fish species. Use of models for particular species (if available) may be warranted in some situations.

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	**Reference-based Indicator**	**How to Estimate**	**Raw Datum**	**Scale for RI**	**Scaled Datum**
NOTE: This function may be assessed only if part of the site is permanently inundated and the subclass is RI					
A	*Predominant* depth category during *biennial low water*	p. 82		<1" =.1 1-2" =.2 2-24" =.7 24"-6' =.9 >6ft = 1.0	
B	Percent of surface water in the 2-6 ft depth category during *biennial low water*	p. 80		0 = 0 1-10 =.4 10-30 =.6 >30 = 1.0	
C	Type of connection to associated channel: PPD= permanent *diffuse* to/from an onsite permanent pool PPC= permanent *constricted* connection from an onsite permanent pool SPD= seasonal *diffuse* connection to/from an onsite permanent pool	p. 71, 85		PPD =.25 PPC =.5 SPD =.75 SPC = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scaled Datum
	SPC= seasonal *constricted* to/from onsite permanent pools				
D	Percent of site that is inundated only seasonally	p. 81		none = 0 1-10 =.1 10-30 =.3 30-60 =.5 60-90 =.7 > 90 = 1.0	
E	Presence of logs &/or boulders	p. 83		absent = 0 present = 1.0	
F	Percent of land cover in <u>*contributing watershed*</u> & within 200 ft that is not cropland, lawns, pavement, or buildings	p. 79		<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-99 =.9 100 = 1.0	

Combine the scores in the last column according to the following formula:
Function Capacity Score = A + B + C + D + E + F

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**
Highest Functioning standard	divide by 4.4 =
Least Altered standard	divide by 4 =

<u>Note</u>: If the value that results after division is >1.0, you must replace it by 1.0.

3.7 Function Capacity: Anadromous Fish Habitat Support

Definition: *The capacity of a wetland or riparian site to support some of the life requirements of anadromous fish species* as listed in Appendix B of Volume IB. If measured, this function could be expressed as:

sum of native anadromous fish using the site annually for spawning, feeding, and/or refuge

The scoring model proposed below does not equally reflect the habitat needs of all local anadromous fish species. Use of models for particular species (if available) may be warranted in some situations.

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scaled Datum
	<u>Note 1</u>: Proceed with assessing this function only if part of the site is *accessible to anadromous fish* during seasonal inundation **<u>Note 2</u>:** At least in riverine environments, the indicators and models below should be considered to be much less accurate than some of the more data-intensive methods and models currently available for estimating habitat suitability for particular anadromous fish species.	p.			
A	Type of connection to associated channel: SPC= seasonal *constricted* connection to/from onsite permanent pools PPC= permanent *constricted* connection from an onsite permanent pool SPD= seasonal *diffuse* connection to/from an onsite permanent pool SSC= seasonal *constricted* connection to/from onsite seasonal pools PPD= permanent *diffuse* connection to/from an onsite permanent pool SSD= seasonal *diffuse* connection to/from onsite seasonal pools	p. 71, 85		none = 0 SPC =.2 PPC =.4 SPD =.6 SSC =.8 PPD/SSD = 1.0	
B	Percent of site that is inundated only seasonally	p. 81		none = 0 1-10 =.1 10-30 =.3 30-60 =.5 60-90 =.7 > 90 = 1.0	
C	Percent of part of the site that is inundated only seasonally and contains a *closed canopy*	p. 80		0 = 0 1-20 =.7 20-80 = 1.0 >80 = .9	
D	Percent & distribution of pools at *biennial high water* <u>Note</u>: If site is >1 acre, select the condition that predominates in 1-acre subunits of the site	p. 79		A = 0 B =.1 C =.2 D =.3 E =.4 F =.5 K =.6 H =.7 I =.8 J =.9 G = 1.0	
E	Presence of logs &/or boulders extending above the surface of permanent water	p. 83		absent = 0 present = 1.0	
F	Number of types of dead wood	p. 77		0 = 0 1-3 =.3 4-8 =.6 9-10 =.9 11-12 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scaled Datum
G	Percent of land cover in <u>*contributing watershed*</u> & within 200 ft that is not cropland, lawns, pavement, or buildings	p. 79		<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-99 =.9 100 = 1.0	

Combine the scores in the last column according to the following formula:
Function Capacity Score = A + B + C+ D + E + F + G

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**
Highest Functioning standard	divide by 5.9 =
Least Altered standard	divide by 5.5 =

<u>Note</u>: If the value that results after division is >1.0, you must replace it by 1.0.

3.8 Function Capacity: Invertebrate Habitat Support

Definition: *The capacity of a wetland or riparian site to support the life requirements of many invertebrate species characteristic of such habitats in this* ecoregion, for example, midges, freshwater shrimp, some caddisflies, some mayflies, some butterflies, water beetles, shore bugs, snails, and aquatic worms. Such organisms contribute importantly to regional biodiversity, and are essential as food for fish, amphibians, and birds. If measured, this function could be expressed as:

> *number of invertebrate species and guilds (functional feeding groups) per unit of sediment, soil, water, and colonizable vegetation within a wetland area*

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
A	Percent of site that is inundated permanently and contains herbs	p. 72		0 = 0 1-10 =.9 >10 = 1.0	0 = 0 1-10 =.9 >10 = 1.0	
B	Percent of site that is inundated only seasonally	p. 81		none = 0 1-10 =.1 10-30 =.3 30-60 =.5 60-90 =.7 > 90 = 1.0	none = 0 1-10 =.1 10-25 =.6 25-50 =.8 > 50 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
C	Type of connection to associated channel: SSC/SSD = seasonal connection to/from onsite seasonal pools PPC/PPD = permanent connection to/from onsite permanent pools SPC/SPD = seasonal connection to/from onsite permanent pools	p. 71, 85		none = 0 SSC/SSD =.4 PPC/PPD =.8 SPC/SPD = 1.0	N/A	
D	*Predominant* depth category during *biennial low water*	p. 82		0 =.1 1-2" =.4 2-24" = 1.0 >24" =.8	0 =.1 1-2" = 1.0 2-24" =.8 >24" =.2	
E	Percent & distribution of pools at *biennial high water* Note: If site is >1 acre, select the condition that predominates in 1-acre subunits of the site	p. 79		A = 0 B =.6 C =.65 D =.7 E,F =.75 K =.8 H =.85 I =.9 J =.95 G = 1.0	A = 0 B =.6 C =.65 D =.7 E,F =.75 K =.8 H =.85 I =.9 J =.95 G = 1.0	
F	Maximum annual extent (%) of hummocks	p. 74, p. 75		N/A	none = 0 1-10 =.6 10-90 =.8 >90 = 1.0	
G	Percent of site affected by soil leveling	p. 80		100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	
H	Percent of site currently affected by soil compaction (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	
I	Mapped soil series is hydric (not simply a hydric inclusion)	p. 75		1= yes 0= no	1= yes 0= no	
J	Percent of site that was constructed from non-hydric soil: 6 = recent, >90% of site 5 = recent, 10-90% of site 4 = recent, 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	

#	**Reference-based Indicator**	**How to Estimate**	**Raw Datum**	**Scale for RI**	**Scale for SF**	**Scaled Datum**
K	Number & distribution of vegetation forms	see figure, p. 77		A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	
L	Percent of surrounding land cover within 200 ft that is not cropland, lawn, buildings, or pavement	p. 81		<10 = 0 10-20 = .1 20-40 = .3 40-90 = .5 90-100 = 1.0	<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	
M	Percent of land cover in <u>*contributing watershed*</u> & within 200 ft that is not cropland, lawns, pavement, or buildings	p. 79		<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-99 =.9 100 = 1.0	<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-99 =.9 100 = 1.0	

Combine the scores in the last column according to the following formula:
Function Capacity Score = (A x B) + (avg. of C,D,E,F,G) + (avg. of H,I,J,K) + L +M

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on whether the site is RI or SF, and whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**	**Slope/flats (SF)**
Highest Functioning standard	divide by 4.56 =	divide by 4.11 =
Least Altered standard	divide by 4.53 =	divide by 4.11 =

<u>Note</u>: If the resulting value after division is >1.0, you must replace it by 1.0.

3.9 Function Capacity: Amphibian & Turtle Habitat

Definition: *The capacity of a wetland or riparian site to support some of the life requirements of several of species of amphibians and turtles that are native to the Willamette Valley* ecoregion:

> Northwestern Salamander, Long-toed Salamander, Roughskin Newt, Pacific Treefrog, Red-legged Frog, Western Pond Turtle, Painted Turtle

These species contribute importantly to regional biodiversity, as well as helping cycle energy within and between aquatic and terrestrial ecosystems. If measured, this function could be expressed as:

> *sum of native amphibians and turtles that use the site annually for feeding, reproduction, and/or refuge*

The scoring model below does not equally reflect the habitat needs of **all** local amphibian and turtle species. Use of species-specific models (if available) may be warranted in some situations.

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
A	Percent & distribution of pools during *biennial high water* <u>Note</u>: If site is >1 acre, select the condition that predominates in 1-acre subunits of the site	p. 79		A = 0 B =.1 C =.2 D =.3 E =.4 F =.5 G =.6 H =.7 I =.8 J =.9 K = 1.0	A = 0 B =.6 C =.65 D =.7 E,F =.75 G =.8 H =.85 I =.9 J = .95 K =1.0	
B	Maximum annual extent (%) of hummocks	p. 74, p. 75		N/A	none = 0 1-10 =.6 10-90 =.8 >90 = 1.0	
C	Percent of site affected by soil leveling	p. 80		100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	100 =.1 10-99 =.3 1-10 =.6 0 = 1.0	
D	Mapped soil series is hydric (not simply a hydric inclusion)	p. 75		no = 0 yes = 1.0	no = 0 yes = 1.0	
E	Difference between biennial high and low *predominating* water levels 0) = no change 1) = difference of one class 2) = difference of 2 classes 3) = difference of 3 classes 4) = difference of 4 classes	p. 71		4) = 0 3) =.3 2) =.5 1) =.8 0) = 1.0	4) = 0 3) =.1 2) =.3 1) =.9 0) = 1.0	
F	Percent of site currently affected by soil compaction (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	
G	Presence of logs &/or boulders extending above the surface of permanent water	p. 83		absent = 0 present = 1.0	absent = 0 present = 1.0	
H	Number of types of deadwood	p. 77		0 = 0 1-2 =.1 3-5 =.25 6-8 =.5 9-11 =.75 11-12 =1.0	0 = 0 1 =.1 2 =.25 3-4 =.5 5-7 =.75 >7 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
I	Diameter (inches) of the largest trees	p. 71		none = 0 1-12 =.1 13-19 =.25 20-27 =.5 28-44 =.75 45-52 =.9 >52 = 1.0	none = 0 1-5 =.1 6-9 =.25 10-17 =.5 18-25 =.75 26-35 =.9 >35 = 1.0	
J	Number & distribution of vegetation forms	see figure, p. 77		A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	
K	Percent of site that was constructed from non-hydric soil: 6 = recent, >90% of site 5 = recent, 10-90% of site 4 = recent, 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	
L	Herbs as a percent of the parts of the site that are inundated only seasonally (answer N/A if no seasonal zone)	p. 72		0 = 0 1-20 =.1 20-40 =.6 40-60 =.75 60-80 =.85 80-100 = 1.0	0 = 0 1-30 =.1 30-50 =.6 50-70 =.75 70-100 = 1.0	
M	Percent of permanent zone that is open water (i.e., lacking herbs) (answer N/A if no permanent water zone)	p. 79		100 =.1 80-99 =.8 60-80 = 1.0 40-60 =.8 20-40 =.4 0-20 =.2	100 =.1 80-99 =.3 60-80 =.6 40-60 =.8 20-40 = 1.0 0-20 =.8	
N	Distance (ft) to nearest busy road	p. 71		<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 = 1.0	<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 =1.0	
O	Percent of surrounding land cover within 200 ft that is not cropland, lawn, buildings, or pavement	p. 81		<10 = 0 10-20 = .1 20-40 = .3 40-90 = .5 90-100 = 1.0	<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
P	Evenness (ratio) of wooded and natural grass cover classes within 200 ft of the site	p. 71		<.1 =.1 0.1-0.8 =.6 0.8-1.2 = 1.0 1.2 –2.0 =.6 >2.0 =.1	<.1 =.1 0.1-0.8 =.6 0.8-1.2 = 1.0 1.2 –2.0 =.6 >2.0 =.1	
Q	Percent of land cover in <u>*contributing watershed*</u> and within 200 ft that is not cropland, lawn, buildings, or pavement	p. 79		<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-99 =.9 100 = 1.0	N/A	
R	Land cover in the vicinity of the site in 1800's: 1 = wooded; 2= nonwooded	p. 74				

Combine the scores in the last column according to one of the following formulas:
If R = 2 (site was historically not wooded), use this:
Function Capacity Score = (avg: A,B,C,D,E,F) + K+ (max: L,M) + (avg: N,O) +P+Q
If R = 1 (site is RI or was historically wooded), use this:
Function Capacity Score = (avg: A,B,C,D,E,F) + (avg: G,H,I,J) + K+ (max: L,M) + (avg: N,O) +P+Q

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on (a) whether the site is RI or SF, (b) whether you wish to compare the results to the highest functioning or least-altered condition (see p.15), and (c) whether the site was historically wooded or not.

Scale To:	**Riverine Impounding**	**SF – historically not wooded**	**SF – historically wooded**
Highest Functioning standard	divide by 6.44 =	divide by 5.97 =	divide by 5.6 =
Least Altered standard	divide by 6.3 =	divide by 5.97 =	divide by 5.58 =

<u>Note</u>: If the value that results after division is >1.0, you must replace it by 1.0.

3.10 Function Capacity: Breeding Waterbird Support

Definition: *The capacity of a wetland or riparian site to support the requirements of many waterbird species during their reproductive period in the Willamette Valley* ecoregion. Species included are listed in Appendix D of Volume IB. These species are important contributors to regional biodiversity, as well as supporting economically significant recreation (hunting and birding) and cycling energy within aquatic ecosystems at both regional and local scales (Haig et al. 1997). If measured, this function could be expressed as:

sum of waterbirds that use the site during breeding season for nesting, feeding, and/or refuge

The scoring model below does not equally reflect the habitat needs of all breeding waterbird species. Use of species-specific models (if available) may be warranted in some situations.

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	**Reference-based Indicator**	**How to Estimate**	**Raw Datum**	**Scale for RI**	**Scale for SF**	**Scaled Datum**
	<u>Note 1</u>: Proceed with assessing this function only if the site plus any contiguous waters contain >0.5 acre of stagnant surface water that remains until July 1 most years and is wider than 10 ft. If this condition is not met, assign a score of "0" to the function.					
A	Percent & distribution of pools during *biennial low water* <u>Note</u>: If site is >1 acre, select the condition that predominates in 1-acre subunits of the site	p. 79		A = 0 B =.1 C =.2 D =.3 E =.4 F =.5 K =.6 H =.7 I =.8 J =.9 G = 1.0	A = 0 B =.6 C =.65 D =.7 E,F =.75 K =.8 H =.85 I =.9 J =.95 G = 1.0	
B	Percent of site occupied by the most extensive depth category during *biennial low water*.	p. 81		100 = 0 80-100 =.1 50-80 =.4 30-50 =.8 <30 = 1.0	100 = 0 80-100 =.1 50-80 =.4 30-50 =.8 <30 = 1.0	
C	Number of depth categories during *biennial high water*. Categories are: ___ 1 - 2 inches ___ 2 - 24 inches ___ 2 – 6 ft ___ > 6 ft	p. 77		1 = 0 2 =.3 3 =.6 4 = 1.0	1 = 0 2 =.3 3 =.6 4 = 1.0	
D	*Predominant* depth category during *biennial low water*	p. 82		0 = 0 1-2" =.6 2-24" = 1.0 2-6 ft =.8 >6 ft =.6	0 = 0 1-2" =.6 2-24" =.8 2-6 ft =1.0 >6 ft =.8	
E	Difference between biennial high and low *predominating* water levels 0) = no change 1) = difference of one class 2) = difference of 2 classes 3) = difference of 3 classes 4) = difference of 4 classes	p. 71		4) = 0 3) =.3 2) =.5 1) =.8 0) = 1.0	4) = 0 3) =.1 2) =.3 1) =.9 0) = 1.0	
F	Herbs as a % of the parts of the site that are inundated permanently (answer N/A if no permanent water zone)	p. 72		0 = 0 1-10 =.4 10-30 =.8 30-60 = 1.0 60-90 =.9 >90 =.4	0 = 0 1-10 =.4 10-30 =.8 30-60 = 1.0 60-90 =.9 >90 =.6	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
G	Distance (ft) to nearest busy road	p. 71		<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 = 1.0	<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 = 1.0	
H	Frequency (score) of humans visiting on foot	p. 72		100-200 = 0 200-300 =.3 300-400 =.7 400-500 =1.0	100-200 = 0 200-300 =.3 300-400 =.7 400-500 =1.0	
I	Percent of surrounding land cover within 200 ft that is water or wetland (not including this site)	p. 79		none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	
J	Percent of surrounding land cover that is water or wetland, averaged among 3 zones (200, 1000, and 5280 ft)	p. 81		none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	
K	Percent of surrounding land cover that is not cropland, lawn, buildings, or pavement (average of 200 and 1000 ft zones)	p. 81		<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	

Combine the scores in the last column according to the following formula:
Function Capacity Score = A + (avg: B,C) + D + E + F + G + H + (avg: I,J) + K

To calculate a standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on whether the site is RI or SF, and whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**	**Slope/flats (SF)**
Highest Functioning standard	divide by 8.2 =	divide by 5 =
Least Altered standard	divide by 5.65 =	divide by 4.6 =

Note: If the resulting value after division is >1.0, you must replace it by 1.0.

3.11 Function Capacity: Wintering & Migrating Waterbird Support

Definition: *The capacity of a wetland or riparian site to support some of the life requirements of several waterbird species that spend the fall, winter, and/or spring in the Willamette Valley* ecoregion. Those species are listed in Appendix D of Volume IB. These species are important contributors to regional biodiversity, as well as supporting economically significant recreation such as hunting and birding (Bonneville Power Administration 1999) and cycling energy within aquatic ecosystems at both regional and local scales (Haig et al. 1997). If measured, this function could be expressed as:

sum of waterbirds that use the site during fall, winter, and/or spring for feeding, roosting, and/or refuge

The scoring model below does not equally reflect the habitat needs of all wintering and migrating species. Use of species-specific models (if available) may be warranted in some situations.

Indicators and Scoring Model: Complete the following table as explained on p. 20.

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
A	*Seasonal zone* as percent of site in sites that also contain *permanent* surface water (answer "0" if no permanent water zone)	p. 81		none = 0 1-20 =.5 20-40 =.7 40-60 =.8 60-80 =.9 >80 = 1.0	none = 0 1-20 =.5 20-40 =.7 40-60 =.8 60-80 =.9 >80 = 1.0	
B	Maximum annual extent of vernal pools/ shorebird scrapes and mudflats: A = none B = 1 – 100 sq. ft. C = 100-1000 sq. ft. D = 1000 – 10,000 sq. ft. E = >10,000 sq. ft	p. 72		A = 0 B =.7 C =.8 D =.9 E = 1.0	A = 0 B =.6 C =.7 D =.8 E = 1.0	
C	Maximum annual extent (%) of hummocks	p. 74, p. 75		N/A	none = 0 1-10 =.6 10-90 =.8 >90 = 1.0	
D	Percent & distribution of pools during *biennial high water* <u>Note</u>: If site is >1 acre, select the condition that predominates in 1-acre subunits of the site	p. 79		A = 0 B =.1 C =.2 D =.3 E =.4 F =.5 K =.6 H =.7 I =.8 J =.9 G = 1.0	A = 0 B =.6 C =.65 D =.7 E,F =.75 K =.8 H =.85 I =.9 J =.95 G = 1.0	
E	Number of depth categories during *biennial high water.* Categories are: ___ 1 - 2 inches ___ 2 - 24 inches ___ 2 – 6 ft ___ > 6 ft	p. 77		4 = 1.0 3 =.6 2 =.3 1 =.1	4 = 1.0 3 =.6 2 =.3 1 =.1	
F	Difference between biennial high and low *predominating* water levels 0) = no change 1) = difference of one class 2) = difference of 2 classes 3) = difference of 3 classes 4) = difference of 4 classes	p. 71		4) = 1.0 3) =.75 2) =.5 1) =.25 0) = 0	4) = 1.0 3) =.75 2) =.5 1) =.25 0) = 0	
G	Mapped soil series is hydric (not simply a hydric inclusion)	p. 75		no = 0 yes = 1.0	no = 0 yes = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
H	Percent of surrounding land cover that is water or wetland, averaged among 3 zones (200, 1000, and 5280 ft)	p. 79		none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	
I	Percent of surrounding land cover within 200 ft that is water or wetland (not including this site)	p. 79		none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	none = 0 1 – 10 =.4 10-20 =.8 >20 = 1.0	
J	Percent of surrounding land that is grassland or row crops, averaged among 3 zones (200, 1000, and 5280 ft)	p. 81		<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	
K	Percent of surrounding land within 200 ft that is grassland or row crops	p. 81		<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	

Combine the scores in the last column according to the following formula:
Function Capacity Score = A + B + (avg: C, D, E, F, G) + (avg: H, I) + (avg: J,K)

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on whether the site is RI or SF, and whether you wish to compare the results to the highest functioning or least-altered condition (p.15):

Scale To:	**Riverine Impounding (RI)**	**Slope/flats (SF)**
Highest Functioning standard	divide by 3.88 =	divide by 3.72 =
Least Altered standard	divide by 2.71 =	divide by 2.76 =

Note: If the resulting value after division is >1.0, you must replace it by 1.0.

3.12 Function Capacity: Songbird Habitat Support

Definition: *The capacity of a wetland or riparian site to support the life requirements of many native non-waterbird species that are either seasonal visitors or breeders in the Willamette Valley* ecoregion. Those species are listed in Appendix D of Volume IB and include all songbirds categorized as "neotropical migrants." All the included species are important contributors to regional biodiversity, as well as supporting economically significant recreation (birding), helping maintain lower numbers of agricultural pests, and cycling energy within aquatic and terrestrial ecosystems. If measured, this function could be expressed as:

> *sum of native songbirds that use the site at any time of the year for breeding, feeding, roosting, and/or refuge*

The scoring model below does not equally reflect the habitat needs of all non-waterbird, wetland-associated species. Use of species-specific models (if available) may be warranted in some situations.

Indicators and Scoring Model. Complete the following table as explained on p. 20.

#	**Reference-based Indicator**	**How to Estimate**	**Raw Datum**	**Scale for RI**	**Scale for SF**	**Scaled Datum**
A	Percent vegetated	p. 82		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
B	Percent woody vegetation	p. 82		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
C	Percent of site with closed-canopy woods	p. 80		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
D	Percent understory shrub & vine cover in wooded areas (answer "0" if no wooded areas)	p. 82		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
E	Number of woody species	p. 82		unwooded = 0 1-3 =.1 4-7 =.25 8-11 =.5 12-14 =.75 15-20 =.9 >20 = 1.0	unwooded= 0 1-2 =.1 3-4 =.25 5-6 =.5 7-9 =.75 10-18 =.9 >18 = 1.0	
F	Number of deadwood types	p. 77		0 = 0 1-2 =.1 3-5 =.25 6-8 =.5 9-10 =.75 11-12 =1.0	0 = 0 1 =.1 2 =.25 3-4 =.5 5-7 =.75 >7 = 1.0	
G	Diameter (inches) of largest trees	p. 71		no trees = 0 1-12 =.1 13-19 =.25 20-27 =.5 28-44 =.75 45-52 =.9 >52 = 1.0	no trees = 0 1-5 =.1 6-9 =.25 10-17 =.5 18-25 =.75 26-35 =.9 >35 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
H	Number &distribution of vegetation forms	see figure, p. 77		A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	
I	Percent of surrounding land cover within 200 ft that is woodland	p. 81		0 = 0 1-10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	0 = 0 1-10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
J	Percent of surrounding land cover that is wooded (average of 200, 1000, & 5280 ft zones)	p. 81		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
K	Percent of site affected by soil mixing (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	
L	Percent of site currently affected by mowing or extreme grazing	p. 81		>90 = 0 10-90 =.2 1-10 =.4 none = 1.0	>90 = 0 10-90 =.2 1-10 =.4 none = 1.0	
M	Maximum annual extent (%) of hummocks	p. 74, p. 75		N/A	none = 0 1-10 =.6 10-90 =.8 >90 = 1.0	
N	Percent of surrounding land cover within 200 ft that is grassland or water/wetland	p. 81		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
O	Percent of surrounding land cover that is grassland or water/wetland (average of 200 & 1000 ft zones)	p. 81		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	

#	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
P	Presence of permanent surface water	p. 82		absent = 0 present = 1.0	absent = 0 present = 1.0	
Q	Frequency (score) of humans visiting on foot	p. 72		100-200 = 0 200-300 =.3 300-400 =.7 400-500 =1.0	100-200 = 0 200-300 =.3 300-400 =.7 400-500 =1.0	
R	Distance to nearest busy road	p. 71		<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 = 1.0	<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 = 1.0	
S	Land cover in the vicinity of the site in 1800's: 1= wooded; 2= nonwooded	p. 74				

Combine the scores in the last column according to the following formula[1]:
If S = 1 (site is RI or was historically wooded), use this:

Score = {max of: [avg: (avg: B,C,D,E,F,G,H) + (avg: I,J)] <u>or</u>
[avg: (avg: K,L,M) + (avg: N,O)] }
+
(avg: Q,R) + P + A

If S = 2 (site was historically not wooded), use this:

Score = [avg: (avg: K,L,M) + (avg: N,O)] + (avg: Q,R) + P + A

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on (a) whether the site is RI or SF, (b) whether you wish to compare the results to the highest functioning or least-altered condition (see p.15), and (c) whether the site was historically wooded or not.

Scale To:	**Riverine Impounding**	**SF – historically not wooded**	**SF – historically wooded**
Highest Functioning standard	divide by 3.81 =	divide by 3.88 =	divide by 3.72 =
Least Altered standard	divide by 3.68 =	divide by 3 =	divide by 3.47 =

<u>Note</u>: If the value that results after division is >1.0, you must replace it by 1.0.

3.13 Function Capacity: Support of Characteristic Vegetation

Definition: *The capacity of a wetland or riparian site to support the life requirements of many plants and plant communities that are native to the Willamette Valley* ecoregion. Plants are one

[1] As in algebra, work outward from the innermost operations. In other words, in the first formula, first separately take the averages of BH, IJ, KM, NO, QR. Then average the averages enclosed in [ ]. Then take the maximum of the averaged averages BJ or KO as indicated by { }. Finally, add to this the average QR and the indicators P and A.

of the largest contributors to regional biodiversity, and play major roles in all other functions. If measured, this function could be expressed as:

> *dominance (relative to non-native species) of native herbs and woody plants that are characteristic of the* ecoregion*'s wetlands*

Indicators and Scoring Model. Complete the following table as explained on p. 20.

	Reference-based Indicator	**How to Estimate**	**Raw Datum**	**Scale for RI**	**Scale for SF**	**Scaled Datum**
A	Percent vegetated	p. 82		<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	<10 =.1 10-20 =.2 20-40 =.4 40-60 =.6 60-80 =.8 >80 = 1.0	
B	Number & distribution of vegetation forms	see p. 77		A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	A = 0 B2 =.60 C2 =.65 B1 =.70 C1,D =.75 E2 =.80 F2 =.85 E1 =.90 F1 =.95 G = 1.0	
C	Mapped soil series is hydric (not simply a hydric inclusion)	p. 75		no = 0 yes = 1.0	no = 0 yes = 1.0	
D	Spatial predominance of non-native herbs A = Non-natives predominate B = Cannot determine (about equal) C = Natives predominate	p. 84		A = 0 B =.5 C = 1.0	A = 0 B =.5 C = 1.0	
E	Percent of common herb species that are non-native	p. 80		100 = 0 85-99 =.1 75-84 =.25 63-74 =.5 50-62 =.75 34-49 =.9 0 -33 = 1.0	100 = 0 80-99 =.1 67-79 =.25 60-66 =.5 25-59 =.75 1-24 =.9 0 –33 = 1.0	
F	**Number** of native woody species	p. 78		0 = 0 1-3 =.1 4-5 =.25 6-8 =.5 9-12 =.75 13-15 =.9 >15 = 1.0	0 = 0 1 =.1 2-3 =.25 4-5 =.5 6-9 =.75 10-13 =.9 >14 = 1.0	
G	**Percent** of woody **species** that are native (answer "N/A" if no woody vegetation)	p. 82		0 = 0 1-56 =.1 57-72 =.25 73-78 =.5 79-85 =.75 86-99 =.9 100 = 1.0	0 = 0 1-57 =.1 58-66 =.25 67-74 =.5 75-79 =.75 80-99 =.9 100 = 1.0	

	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
H	Percent of woody **cover** within *stratum* that is comprised of non-native species (Use the greater of the tree, understory shrub, or open shrub *stratum*'s percent) (Answer "N/A" if no woody vegetation)	p. 82		100 = 0 40-99 =.1 20-39 =.25 10-19 =.5 5-9 =.75 1-4 =.9 0 = 1.0	100 = 0 80-99 =.1 30-79 =.25 10-29 =.5 5-9 =.75 1-4 =.9 0 = 1.0	
I	Number of deadwood types	p. 77		0 = 0 1-2 =.1 3-5 =.25 6-8 =.5 9-11 =.75 11-12 =1.0	0 = 0 1 =.1 2 =.25 3-4 =.5 5-7 =.75 >7 = 1.0	
J	Diameter (inches) of largest trees	p. 71		no trees = 0 1-12 =.1 13-19 =.25 20-27 =.5 28-44 =.75 45-52 =.9 >52 = 1.0	no trees = 0 1-5 =.1 6-9 =.25 10-17 =.5 18-25 =.75 26-35 =.9 >35 = 1.0	
K	Percent of site that was constructed from non-hydric soil: 6 = recent, >90% of site 5 = recent, 10-90% of site 4 = recent, 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	6 = 0 5 = .1 4 = .2 3 = .3 2 = .4 1 = .5 none = 1.0	
L	Percent of site currently affected by soil compaction (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	
M	Percent of site affected by soil mixing (score): 6 = recent, at >90% of site 5 = recent, at 10-90% of site 4 = recent, at 1-10% of site 3 = >5 years ago, >90% of site 2 = >5 years ago, 10-90% of site 1 = >5 years ago, 1-10% of site 0 = none	p. 81		5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	5/6 =.1 4 =.2 3 =.4 2 =.6 1 =.8 0 = 1.0	

	Reference-based Indicator	How to Estimate	Raw Datum	Scale for RI	Scale for SF	Scaled Datum
N	Percent of site currently affected by mowing or extreme grazing	p. 81		>90 = 0 10-90 =.2 1-10 =.4 none = 1.0	>90 = 0 10-90 =.2 1-10 =.4 none = 1.0	
O	Frequency (score) of humans visiting on foot	p. 72		100-200 = 0 200-300 =.3 300-400 =.7 400-500 =1.0	100-200 = 0 200-300 =.3 300-400 =.7 400-500 =1.0	
P	Distance to nearest busy road	p. 71		<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 = 1.0	<100 = 0 100-300 =.3 300-600 =.5 600-1200 =.7 1200-2400 =.8 2400-4800 =.9 >4800 = 1.0	
Q	Percent of land cover in <u>*contributing watershed*</u> that is not cropland, lawn, buildings, or pavement	p. 79		<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-99 =.9 100 = 1.0	<10 = 0 10-20 =.1 20-40 =.3 40-90 =.5 90-99 =.9 100 = 1.0	
R	Percent of surrounding land cover within 200 ft that is not cropland, lawn, buildings, or pavement	p. 81		<10 = 0 10-20 = .1 20-40 = .3 40-90 = .5 90-100 = 1.0	<10 = 0 10-20 = .1 20-40 = .3 40-80 = .5 80-90 = .7 90-100 = 1.0	
S	Land cover in the vicinity of the site in 1800's: 1= wooded; 2= nonwooded	p. 74				

Combine the scores in the last column according to the following formula:
If S = 2 (if site was not historically wooded), use this:
Function Capacity Score =(A+B+C+D+E) + (avg: K,L,M,N,O,P,Q,R)
If S = 1 (if site is RI or was historically wooded), use this:
Function Capacity Score = (A+B+C+D+E) + (avg: F + G+H+I+J) + (avg: K,L,M,N,O,P,Q,R)

To calculate a Standardized Function Capacity Score, divide the above Function Capacity Score as indicated below, depending on (a) whether the site is RI or SF, (b) whether you wish to compare the results to the highest functioning or least-altered condition (see p.15), and (c) whether the site was historically wooded or not:

Scale To:	**Riverine Impounding**	**SF – historically not wooded**	**SF – historically wooded**
Highest Functioning standard	divide by 6.21 =	divide by 5.79 =	divide by 6.61 =
Least Altered standard	divide by 6.21 =	divide by 5.59 =	divide by 6.38 =

<u>Note</u>: If the value that results after division is >1.0, you must replace it by 1.0.

Section 4. Qualitative Assessment of Values of Functions

Directions: In each row of the following tables, indicate with a checkmark if your site looks more like the "highest function value" condition or the "minimal function value" condition. Then circle a number on the scoring line below the table, based on your overall impression of the site's capacity to support this function. Alternatively, instead of checkmarks, you can assign a 0 (minimal capacity) -to- 1.0 (highest capacity) score to each row in the "Suggested Score" column, and then combine the row scores in a manner of your choosing, perhaps weighting some rows more than others. Assess indicators of value as they exist currently. Note that the listing of values associated with each function may not be comprehensive. When appropriate, you may add new indicators of value for particular functions. See Glossary (Appendix A) for definitions of some of the terms, especially ones in italics.

Note: If a site does not support the named function *at all*, consideration of the site's value for that function is moot and you should not perform a value assessment, unless you are only examining the site's potential for restoration.

4.1   Value of Water Storage and Delay

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
***Opportunity* to store or delay runoff:**		
___ Size of the site is large relative to the area of its *contributing watershed*, and groundwater inputs are minor		___ Size of the site is small relative to the area of its *contributing watershed*
___ *Contributing watershed* is extensively paved (Laenen 1980, Hubbard 1992, Horner et al. 2000, Reinelt & Taylor 2000)		___ *Contributing watershed* is covered almost entirely by natural vegetation
___ The time that runoff reaches the site from the *contributing watershed* has been greatly accelerated by channels, ditches, gutters, subsurface tile, or stormwater pipes (Laenen 1980, Hubbard 1992)		___ Runoff in *contributing watershed* has not been greatly accelerated by channels, ditches, gutters, and stormwater pipes
___ No dikes or diversions immediately above the site interfere with runoff that otherwise would reach it		___ All runoff that otherwise would reach the site has been redirected by dikes and diversions
___ *Contributing watershed* is steep throughout (Swift 1966)		___ *Contributing watershed* is almost flat
___ *Contributing watershed* is narrow, from ridgeline to ridgeline (Tolle 1978)		___ *Contributing watershed* is quite broad, from ridgeline to ridgeline, promoting storage of much runoff before it reaches the site
___ *Contributing watershed* upslope from this site contains few or no other water control structures, ponds, lakes, or wetlands (Coulton 1996). This is often true of headwater sites, and sites situated between developed areas and floodplains.		___ *Contributing watershed* upslope from this site contains effective water control structures or a large proportion of ponds, lakes, and wetlands. This is often true of sites along major channels and/or within their floodplains.
___ Precipitation amounts are relatively large (Oster 1968, Laenen & Risley 1997)		___ Precipitation amounts are relatively small

Highest Function Value	Suggested Score:	Minimal Function Value
___ Precipitation intensity (inches/hr) is typically large, with much of the annual rainfall occurring during discrete storm or snowmelt events (Lowery 1980)		___ Precipitation intensity is low, with nearly all rainfall occurring lightly over protracted periods (hours or days)
___ Output data from statistical models (e.g., Harris et al. 1979) or validated computer models of watershed runoff processes indicate runoff entering the site at a relatively rapid rate		___ Output data from validated computer models of watershed runoff processes indicate runoff entering the site at a relatively gradual rate
***Significance* of water storage or delay by this site (assuming it occurs):**		
___ The site is near the headwater of a small stream.		___ The site is along a large river (where its individual effect, if any, will be dwarfed by the river's large discharge)
___ Economic losses potentially associated with flooding of areas downslope* of the site are enormous		___ Economic losses potentially associated with flooding downslope* of the site are minor
___ Downslope* channels are experiencing rates of erosion and severe downcutting that are far greater than historically, due to unnatural focusing of runoff events		___ Erosion in downslope* channels is not significantly greater than what occurred historically
___ Downslope* base flows and water table levels are much lower than historically due to much less detention in the watershed than occurred historically		___ Downslope* base flows and water tables have not changed significantly from their historical condition
___ Other factors suggest that storage or delay of water by this site is of unusually great importance to biological resources located onsite or downslope* (describe below)		___ Other factors suggest that storage or delay of water by this site is not atypically important to biological resources located onsite or downslope* (describe below)
___ The site is one of only a few, or is one of the largest ones, of its subclass in this watershed & that store or delay water to this degree		___ Sites of this subclass and size that store or delay water to this degree are abundant in this watershed both locally and regionally

* When weighing the significance, consider the proximity of the site to these areas, including areas to at least one-quarter mile away, and the availability of other runoff storage mechanisms. These areas must be located in the same watershed as the site being assessed. For watershed boundaries, see the land cover map in the CD accompanying this guidebook.

Your Judgments of **Value** of This Site's Capacity to Store & Delay Water:
Value score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

4.2 Value of Sediment Stabilization and Phosphorus Retention

Highest Function Value	Suggested Score:	Minimal Function Value
Opportunity to stabilize sediment and/or retain phosphorus:		
___ This site's opportunity for storing or delaying runoff was considered among the highest (p. 47)		___ This site's opportunity for storing or delaying runoff was considered among the lowest (p. 47) (Horner et al. 2000)

Highest Function Value	Suggested Score:	Minimal Function Value
___ The *contributing watershed* is almost entirely occupied by land uses that potentially export high loads of nutrients and/or sediments in runoff or windborne dust, especially P-fertilized and plowed cropland (Laird 1981), dirt roads, heavily used pastures, gravel mining operations, urban areas (Miller 1987), and overloaded waste treatment facilities (Wert 1970)		___ The *contributing watershed* is almost entirely occupied by natural land cover (Horner et al. 2000)
___ Potential nutrient-exporting land uses adjoin or are located very nearby & upslope of the site (Simmons 1980)		___ Potential nutrient-exporting land uses, if any, are located distant from the site
___ Soils in the *contributing watershed*, especially those closest to the site, are intrinsically very erodible (Brown et al. 1979, Klingeman 1979) and/or contain high phosphorus levels, e.g., high fertility (Reckendorf 1993, Abrams & Jarrell 1995, McCarthy 2000)		___ Soils in the *contributing watershed*, especially those closest to the site, are not intrinsically very erodible and do not contain high phosphorus levels, e.g., low fertility
___ Groundwater, if a significant source of water to the site, contains high levels of phosphorus (Bonn et al. 1995, 1996)		___ Groundwater, if a significant source of water to the site, does not contain high levels of phosphorus
___ Part of the *contributing watershed*, especially the part closest to the site, is designated as "water quality limited" or similar designation (303d or other published list) due to excessive nutrients or sediment runoff. See: waterquality.deq.state.or.us/wqlmaps/ wqlmapshome.htm or (secondarily): http://map2.epa.gov/enviromapper/		___ Water quality has been assessed in the *contributing watershed*, and no areas have been designated as "water quality limited" or similar designation (303d or other published list) due to excessive nutrients or sediment runoff
___ Severe erosion and/or frequent & extensive blooms of algae are apparent in connected waters immediately upslope of the site		___ Severe erosion and/or frequent & extensive blooms of algae are absent from connected waters upslope of the site
___ Output data from validated computer models of watershed processes indicate major net export of sediment and/or nutrients to this site		___ Output data from validated computer models of watershed processes indicate little or no export of sediment and/or nutrients to this site
Significance of stabilizing sediment and/or retaining phosphorus (assuming this occurs):		
___ The site is near the headwater of a small stream.		___ The site is along a large river (where its individual effect, if any, will be dwarfed by the river's large discharge)
___ Downslope* water bodies are experiencing much greater rates of sedimentation than occurred historically (Moore 1985)		___ Downslope* water bodies are experiencing rates of sedimentation well within their historical range
___ Downslope* waters are in violation of published criteria for phosphorus or total solids		___ Downslope* waters are not in violation of published criteria for phosphorus or total solids
___ Phosphorus is not the most limiting nutrient for native biological communities in downslope* water bodies (MacDonald et al. 1991)		___ Phosphorus is known to be the most limiting nutrient for native biological communities in downslope* water bodies
___ Outstanding fish spawning areas are located in connected waters downslope*		___ Outstanding fish spawning areas are not present downslope*, or wetland has no surface water outlet

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Other factors suggest that phosphorus retention or stabilization of sediments by this site is of unusually great importance to biological or human resources located onsite or downslope* (describe below)		___ Other factors suggest that phosphorus retention or stabilization of sediments by this site is not atypically important to biological or human resources located onsite or downslope* (describe below)
___ The site is one of only a few, or is one of the largest ones, of its subclass in this watershed that stabilize sediment or retain phosphorus to this degree		___ Sites of this subclass and size that stabilize sediment or retain phosphorus to this degree are abundant in the watershed locally or regionally

* Consider the proximity of the site to these areas, and the availability of other sediment and phosphorus retention mechanisms, when weighing the significance.

Your Judgments of **Value** of This Site's Stabilizing of Sediment and Retention of Phosphorus:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.3 Value of Nitrogen Removal

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
Opportunity to remove nitrogen:		
___ This site's opportunity for storing or delaying runoff was considered among the highest. (p. 47)		___ This site's opportunity for storing or delaying runoff was considered among the lowest (p. 47)
___ The *contributing watershed* is almost entirely occupied by land uses and land cover types that potentially export high loads of nitrogen, e.g., ammonia-fertilized cropland, heavily used pastures, overloaded waste treatment facilities, thickets of nitrogen-fixing alder (*Alnus* sp.). (Binkley et al. 1992)		___ The *contributing watershed* is almost entirely occupied by natural land cover (except alder), and even the inputs of nitrogen from vehicular exhaust are minimal
___ The potential nitrogen-exporting land uses and land cover types adjoin or are located very nearby & upslope of the site		___ Potential nitrogen-exporting land uses, if any, are located distant from the site
___ Soils in the *contributing watershed*, especially closest to the site, are not hydric		___ Soils in the *contributing watershed*, especially those closest to the site, are "hydric"
___ Part of the *contributing watershed*, especially the part closest to the site, is designated as "water quality limited" or similar designation (303d or other published list) due to excessive nutrients. See: waterquality.deq.state.or.us/wqlmaps/wqlmapshome.htm or (secondarily): http://map2.epa.gov/enviromapper/		___ Water quality has been assessed in the *contributing watershed*, and no areas have been designated as "water quality limited" or similar designation (303d or other published list) due to excessive nutrients
___ Downslope* waters or groundwaters within 1 mile are in violation of published criteria for nitrate		___ Downslope* waters or groundwaters within 1 mile are not in violation of published criteria for nitrate
___ Extensive blooms of algae are apparent in connected waters immediately upslope of site		___ Blooms of algae are absent from connected waters upslope of the site

Highest Function Value	Suggested Score:	Minimal Function Value
___ Groundwater, if a significant source of water to the site, contains high levels of nitrogen (e.g., Wondzell & Swanson 1996, Griffith et al. 1997)		___ Groundwater, if a significant source of water to the site, does not contain high levels of nitrogen
Significance of this site's removal of nitrogen (assuming this occurs):		
___ The site is near the headwater of a small stream.		___ The site is along a large river (where its individual effect, if any, will be dwarfed by the river's large discharge)
___ Nitrogen is not the most limiting nutrient for native biological communities in downslope* water bodies		___ Nitrogen is known to be the most limiting nutrient for native biological communities in downslope* water bodies (e.g., Dieterich 1993, Dodds and Castenholz 1988).
___ Other factors suggest that removal of nitrogen by this site is of unusually great importance to biological or human resources located onsite or downslope* (describe below)		___ Other factors suggest removal of nitrogen by this site is not atypically important to biological or human resources located onsite or downslope* (describe below)
___ The site is one of only a few, or is one of the largest ones, of its subclass in this watershed that remove nitrogen to this degree		___ Sites of this subclass and size that remove nitrogen to this degree are abundant in the watershed locally or regionally

* Consider the proximity of the site to these areas, and the availability of other N-retention mechanisms, when weighing the significance.

Your Judgments of **Value** of This Site's Removal of Nitrogen:
Value score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

4.4 Value of Thermoregulation

Highest Function Value	Suggested Score:	Minimal Function Value
Opportunity to reduce water temperatures:		
___ Most runoff entering the site has traveled slowly across unvegetated areas, e.g., urban or cropland watersheds with no streamside buffers (Risley 1997)		___ Most runoff entering the site has traveled through areas continuously covered with dense (especially evergreen) vegetation
___ Parking lots, industrial outfalls, and other sources of heated water are located very nearby & upslope of the site		___ Potential sources of heated water are located distant from the site
___ All of the site's water is from direct precipitation and runoff. None is comprised of groundwater or subsurface lateral flow that feeds the site directly		___ The site is fed directly by groundwater, and it comprises nearly all of the site's water budget
___ Part of the *contributing watershed*, especially the part closest to the site, is designated as "water quality limited" or similar designation (303d or other published list) due to high water temperature. See: waterquality.deq.state.or.us/wqlmaps/wqlmapshome.htm		___ Water quality has been assessed in the *contributing watershed*, and no areas have been designated as "water quality limited" or similar designation (303d or other published list) due to high water temperature

Highest Function Value	Suggested Score:	Minimal Function Value
___ Frequent direct measurement of surface water temperature as it enters the site indicates temperatures that are consistently far above normal for the situation		___ Frequent direct measurement of surface water temperature as it enters the site indicates temperatures that are consistently normal for the situation
Significance of this site's reducing of water temperature:		
___ The site is near the headwater of a small stream.		___ The site is along a large river (where its individual effect, if any, will be dwarfed by the river's large discharge -- Zwieniecki & Newton 2000)
___ The site is located immediately upslope of* areas identified as "water quality limited" or similar designation (303d or other published list) due to elevated water temperature		___ Downslope* from the site, there are no areas identified as "water quality limited" or similar designation (303d or other published list) due to elevated water temperature
___ The site is connected by surface water to, and is located immediately upslope of*, areas identified as essential to native coldwater fish species		___ The site is not connected by surface water to areas occupied by native coldwater fish species
___ Other factors suggest that reduction or maintenance of water temperature by this site is of unusually great importance to biological resources located onsite or downslope* (describe below)		___ Other factors suggest that reduction or maintenance of water temperature by this site is not atypically important to biological resources located onsite or downslope* (describe below)
___ The site is one of only a few, or is one of the largest ones, of its subclass in this watershed that maintain or reduce water temperature to this degree		___ Sites of this subclass and size that maintain or reduce water temperature to this degree are abundant in the watershed locally or regionally

* Consider the proximity of the site to these areas, and the availability of other thermoregulation mechanisms, when weighing the significance.

Your Judgments of **Value** of This Site's Reducing of Water Temperature:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.5 Value of Primary Production

Highest Function Value	Suggested Score:	Minimal Function Value
Opportunity for primary production: Not assessed because all sites receive about equal amounts of solar radiation. They vary mainly in their ability to convert it efficiently into organic matter.		
Significance of primary production from this site:		
___ No downslope* water bodies experience major oxygen deficits as a result of excessive accumulation of decomposing organic matter		___ Downslope* water bodies experience frequent and extensive oxygen deficits as a result of excessive accumulation of decomposing organic matter
___ Production of native plants at this site is commercially and sustainably grazed or harvested (e.g., hay, timber) and the economic value is probably substantial (McAllister 1996, Julin & Meade 1997)		___ Plant production at this site is not commercially grazed or harvested directly and sustainably

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Upslope areas* in the *contributing watershed* are largely devoid of vegetation		___ Upslope areas* in the *contributing watershed* are well-vegetated
___ Other factors suggest that primary production from this site is of unusually great importance to food webs located onsite or downslope*		___ Other factors suggest that primary production from this site is not atypically important to food webs located onsite or downslope*
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that supports primary production to this degree		___ Sites of this subclass and size that support primary production to this degree are relatively abundant both locally and regionally

* Consider the proximity of the site to these areas when weighing the significance.

<u>Your Judgments of **Value** of This Site's Primary Production</u>:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.6 Value of Invertebrate Habitat Support

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ In the Willamette Valley ecoregion, site is one of a very few known to be used by a particular invertebrate species		___ All invertebrate species known from this site are widespread in the Willamette Valley ecoregion
___ Site is one of a very few that contains unusual but natural physical or chemical conditions (e.g., hot spring) that often are associated with presence of unusual invertebrate species		___ Site does not contain unusual physical or chemical conditions that often are associated with presence of unusual invertebrate species
___ All upland areas near this site have very limited capacity to support invertebrates, e.g., largely devegetated, chemical contamination, frequent soil disturbance		___ Upland areas near this site have considerable capacity to support invertebrates, e.g., land cover is mostly unaltered
___ Other factors suggest that invertebrate species or densities produced at this site are of unusually great importance to food webs or ecological processes located onsite or in the region generally		___ Other factors suggest that invertebrate species or densities produced at this site are not atypically important to food webs or ecological processes located onsite or in the region generally
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that support invertebrates to this degree		___ Sites of this subclass and size that support invertebrates to this degree are relatively abundant both locally and regionally

<u>Your Judgments of **Value** of This Site's Invertebrates</u>:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.7 Value of Resident Fish Support

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ In the Willamette Valley ecoregion, site is one of a very few known to be used by a particular resident fish species, e.g., Oregon chub		___ All fish species known from this site are widespread in the Willamette Valley ecoregion
___ Site is one of a very few that contains physical or chemical conditions identified as optimal for a particularly rare native fish species		___ Site does not contain unusual physical or chemical conditions typically associated with presence of a particularly rare native fish species
___ Site provides some of the most consistently productive fishing for species native to the Willamette Valley		___ Site does not provide atypically productive fishing for any species native to the Willamette Valley
___ Other factors suggest that resident fish species or densities produced at this site are of unusually great importance to food webs or ecological processes located onsite or in the region generally		___ Other factors suggest that resident fish species or densities produced at this site are not atypically important to food webs or ecological processes located onsite or in the region generally
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that supports resident fish to this degree		___ Sites of this subclass and size that support resident fish to this degree are relatively abundant both locally and regionally

Your Judgments of **Value** of This Site's Resident Fish:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.8 Value of Anadromous Fish Support

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Site is vital to an anadromous fish stock or species that is, in the Willamette Valley ecoregion, particularly uncommon and has a possibly declining population, e.g., Chinook salmon and others classified by Oregon Natural Heritage Program as S1, S2, G1, or G2 (see Appendix D of accompanying *Profiles* report).		___ Site is not used by any anadromous fish species
___ In the past, considerable funds have been expended to restore anadromous fish support functions of this particular site		___ In the past, no funds have been expended to restore anadromous fish support functions of this particular site
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that supports anadromous fish to this degree		___ Sites of this subclass and size that support anadromous fish to this degree are relatively abundant both locally and regionally

Your Judgments of **Value** of This Site's Anadromous Fish:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.9 Value of Amphibian & Turtle Habitat

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Site is vital to a native amphibian or turtle species that is, in the Willamette Valley ecoregion, particularly uncommon and has a possibly declining population, e.g., Red-legged Frog and others classified by Oregon Natural Heritage Program as S1, S2, G1, or G2 (see Appendices E, F of *Profiles* report).		___ All amphibian and turtle species known from this site occur widely in the Willamette Valley ecoregion, and in uplands as well as in wetlands, and none are known to be declining in the ecoregion
___ Site is one of a very few that contains physical or chemical conditions identified as optimal for a particularly rare native amphibian or turtle species (e.g., see St. John 1987)		___ Site does not contain unusual physical or chemical conditions typically associated with presence of a particularly rare native amphibian or turtle species
___ Other factors suggest that amphibian/turtle species or densities at this site are of unusually great importance to food webs or ecological processes located onsite or in the region generally		___ Other factors suggest that amphibian/turtle species or densities at this site are not atypically important to food webs or ecological processes located onsite or in the region generally
___ In the past, considerable funds have been expended to restore specifically the amphibian/turtle support functions of this particular site		___ In the past, no funds have been expended to restore specifically the amphibian/turtle support functions of this particular site
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that supports amphibians and/or turtles to this degree		___ Sites of this subclass and size that support amphibians and/or turtles to this degree are relatively abundant both locally and regionally

Your Judgments of **Value** of This Site's Native Amphibians & Turtles:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.10 Value of Breeding Waterbird Support

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Site is consistently used by, or is vital to, many nesting waterbird species that are regionally uncommon and/or have declining populations in the Pacific Northwest, e.g., species classified by Oregon Natural Heritage Program as S1, S2, G1, or G2 (see Appendix G of accompanying *Profiles* report).		___ All waterbird species that nest consistently at this site occur widely in the Willamette Valley ecoregion, and none are known to be declining in the ecoregion
___ Site is one of a very few that contains habitat conditions identified as optimal for nesting of one or more particularly rare and/or regionally declining waterbird species		___ Site does not contain habitat suitable for nesting by any particularly rare and/or regionally declining waterbird species

Highest Function Value	Suggested Score:	Minimal Function Value
___ Other factors suggest that waterbird species or nesting densities at this site are of unusually great importance to food webs or ecological processes located onsite or in the region generally		___ Other factors suggest that waterbird species or nesting densities at this site are not atypically important to food webs or ecological processes located onsite or in the region generally
___ In the past, considerable funds have been expended to restore specifically the suitability of this particular site for nesting waterbirds		___ In the past, no funds have been expended to restore specifically the suitability of this particular site for nesting waterbirds
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that support breeding waterbirds to this degree		___ Sites of this subclass and size that support breeding waterbirds to this degree are relatively abundant both locally and regionally

Your Judgments of **Value** of This Site's Breeding Waterbirds:
Value score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

4.11 Value of Migratory & Wintering Waterbird Support

Highest Function Value	Suggested Score:	Minimal Function Value
___ Site is consistently used by, or is vital to, many migrating/wintering waterbird species that are uncommon and/or have declining populations, e.g., Dunlin		___ All waterbird species that migrate/winter consistently at this site occur widely in the Willamette Valley ecoregion, and none are known to be declining in the ecoregion
___ Site is one of a very few that contains habitat conditions identified as optimal for migration/wintering of one or more particularly rare and/or regionally declining waterbird species		___ Site does not contain habitat suitable for migration/wintering of any particularly rare and/or regionally declining waterbird species
___ Other factors suggest that migrating/wintering waterbird species or densities at this site are of unusually great importance to food webs or ecological processes located onsite or in the region generally		___ Other factors suggest that migrating/wintering waterbird species or nesting densities at this site are not atypically important to food webs or ecological processes located onsite or in the region generally
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that support migratory or wintering waterbirds to this degree		___ Sites of this subclass and size that support migrating or wintering waterbirds to this degree are relatively abundant both locally and regionally
___ In the past, considerable funds have been expended to restore specifically the suitability of this particular site for migrant/wintering waterbirds		___ In the past, no funds have been expended to restore specifically the suitability of this particular site for migrant/wintering waterbirds
___ Waterbird species that predominate at the site are ones that appear to be beneficial or neutral with regard to crops in surrounding areas, e.g., herons		___ Waterbird species that predominate at the site are ones that are potentially detrimental to crops in surrounding areas, e.g., geese

<u>Your Judgments of **Value** of This Site's Migratory/Wintering Waterbirds</u>:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.12 Value of Songbird Habitat Support

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Site is consistently used by, or is vital to, many wetland-associated birds (other than waterbirds) that are regionally uncommon and/or have declining populations in the Pacific Northwest according to the Breeding Bird Survey; species with special regional status according to Altman (2000); species classified as G1, G2, S1, or S2 by the Oregon Natural Heritage Program (see Appendix G of accompanying *Profiles* report).		___ All songbird species that consistently use this site occur widely in the Willamette Valley ecoregion, and none are known to be declining in the ecoregion
___ Site is one of a very few that contains habitat conditions identified as optimal for one or more particularly rare and/or regionally declining wetland-associated bird species (other than waterbirds)		___ Site does not contain habitat suitable for any particularly rare and/or regionally declining, wetland-associated bird species (excluding waterbird species)
___ Other factors suggest songbird species or densities at this site are of unusually great importance to food webs or ecological processes located onsite or in general region		___ Other factors suggest that songbird species or densities at this site are not atypically important to food webs or ecological processes located onsite or in the region generally
___ In the past, considerable funds have been expended to restore specifically the suitability of this particular site for wetland-associated birds (other than waterbirds)		___ In the past, no funds have been expended to restore specifically the suitability of this particular site for wetland-associated birds (other than waterbirds)
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that support wetland-associated birds (other than waterbirds) to this degree		___ Sites of this subclass and size that support songbirds to this degree are relatively abundant both locally and regionally

<u>Your Judgments of **Value** of This Site's Songbirds</u>:
Value score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

4.13 Value of Characteristic Vegetation

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Site contains many native plant species or associations that are uncommon and/or have declining populations in the Willamette Valley ecoregion. This may include, but is not limited to, species categorized as G1, G2, S1, or S2 by the Oregon Natural Heritage Program		___ All plant species and associations at this site also occur widely in the Willamette Valley ecoregion, and none have been documented to be declining in the ecoregion

Highest Function Value	**Suggested Score:**	**Minimal Function Value**
___ Site is one of a very few that contains habitat conditions identified as optimal for one or more particularly rare and/or regionally declining native plant species or associations. See Christy & Titus (1998)		___ Site does not contain habitat suitable for any particularly rare and/or regionally declining native plant species or association
___ Other factors suggest that native plants at this site are of unusually great importance to food webs or ecological processes located onsite or in the region generally		___ Other factors suggest that native plants at this site are not atypically important to food webs or ecological processes located onsite or in the region generally
___ The site is one of only a few, or is one of the largest ones, of its subclass in this vicinity that support characteristic vegetation to this degree		___ Sites of this subclass and size that support characteristic vegetation to this degree are relatively abundant both locally and regionally
___ In the past, considerable funds have been expended to restore specifically the suitability of this particular site for unusual or characteristic native plant species or associations		___ In the past, no funds have been expended to restore specifically the suitability of this particular site for native plant species

Your Judgments of **Value** of This Site's Characteristic Vegetation:
Final score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

You have now completed the assessment. If you wish, you may transfer scores from preceding pages to the assessment summary form on the following page.

Assessment Summary Form

(page 1 of 2)

Site Name:______________________________ County: ________________________________
Assessed by: ____________________________ Date: _________________________________
Area of Site: ________________________*acres* Mapped Soil Series: ____________________
HGM subclass(es)*: ____
* if site contains multiple subclasses, estimate percent of each

Complete column 2 ("score" – Present Time) of the table below. All other columns are *optional*. Do not mathematically combine scores from different functions, or functions and values.

Functions	**Function Capacity Score** (standardized)				**Value Score** (standardized)
	Present Time		Time 2 (optional)		
	score	acres	score	acres	
Water Storage & Delay	(p.21)				(p. 47)
Sediment Stabilization & Phosphorus Retention	(p. 23)				(p.48)
Nitrogen Removal	(p.**Error! Bookmark not defined.**)				(p.50)
Thermoregulation	(p. 26)				(p.51)
Primary Production	(p.28)				(p.52)
Resident Fish Habitat Support	(p.29)				(p.54)
Anadromous Fish Habitat Support	(p.31)				(p.54)
Invertebrate Habitat Support	(p.33)				(p.53)
Amphibian & Turtle Habitat	(p.36)				(p.55)
Breeding Waterbird Support	(p.38)				(p.55)
Wintering & Migratory Waterbird Support	(p.40)				(p.56)
Songbird Habitat Support	(p.43)				(p.57)
Support of Characteristic Vegetation	(p.46)				(p.57)

Assessment Summary Form

(page 2 of 2)

In the preceding table, were the column-2 scores for Function Capacity from (**check one**):

___ the Reference-based Method, standardized to "highest functioning"?
___ the Reference-based Method, standardized to "least altered"?
___ the Judgmental Method (Appendix B)?

Do you consider the site to historically have been mostly wooded? ___yes ___no

Is the site part of a larger contiguous wetland or riparian area? ___Yes ___No
If yes, describe how it is connected (permanent/ seasonal channel, etc.): ____________________________________

Describe the basis for boundaries you used to define the "site": ____

____

Elaborate, if you wish, on assumptions you made when estimating particular indicators, and additional factors related to this site's importance (see p. 5 of guidebook for listing of these). Use additional pages if necessary.

____

____

The following 3 items are optional, but you are encouraged to complete these in order to provide a fuller context for understanding the assessment scores.

1. Make your best estimate of relative dominance of the direct **sources of water inputs** to this site during each of the two seasonal periods during an average year:

	April 1 – October 31 (dry)	**November 1- March 30 (wet)**
Channel flow (including overbank flooding)	%	%
Overland runoff (not in channels)	%	%
Subsurface flow & groundwater	%	%
Direct precipitation	%	%
Artificial water imports (stormwater pipes, etc.)	%	%
TOTAL	100 %	100 %

2. How much of the site is upland inclusions? __________%

3. Exact coordinates of the site, from GPS reading or digital map:
latitude: _____________N longitude: ______________W

Other Comments: ____

____

____

____

____

Sketch map of site (optional)

Show: Site boundary. High & low water levels. Patches of trees, shrubs, herbs. Upland land cover on perimeter. Inlets & outlets. Dikes, dams, berms, ditches, excavations, pipes. Flow direction.

Indicate map scale: **1 box = ________________ ft. (m)** approximately.

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Appendix A. Procedures and Glossary for Assessing Individual Indicators

Procedures for estimating each indicator are given following its definition. Italicized words are defined elsewhere in this appendix.

Accessible to anadromous fish: Determine this as it exists during *biennial high water*. Disregard the quality of the site for anadromous fish (fish that spend most of their life in salt water but enter fresh water to spawn). During biennial high water, are there any completely impassible barriers between the site and the nearest body of water known to support anadromous fish? Such water bodies are shown, in part, on the maps "Essential Indigenous Anadromous Salmonid Habitat" (available from Oregon Division of State Lands), and additional information is available from Oregon Department of Fish and Wildlife. Barriers that could totally block access include elevated culverts, potentially connecting ditches that never contain more than a few inches of water, and dams without facilities for fish passage.

Acre: A unit of area equal to 43,560 square feet, or about 208 ft. x 208 ft. (if square), or about 90% of the size of a regulation football field excluding the end zones.

Acreage. Measure the area of the site to a precision of about ±1 acre, or to ± 0.1 acre if <10 acres. First locate an existing *topographic map* or other map of the site, or create your own proportionally correct map by enlarging an *airphoto* or (while visiting the site) by using a surveyor's transit, rangefinder, measuring tapes, or visual estimation. Then determine acreage either by a dot-grid method or by digitally scanning the map and measuring area using GIS or CAD software.

Airphoto: an aerial photograph. Black-and-white airphotos of most of the Willamette Valley can be viewed online at www.terraserver.com . Color airphotos of better resolution are available from the US Army Corps of Engineers (Portland District Office), USDA Farm Service Agency (www.fsa.usda.gov/or), University of Oregon library (libweb.uoregon.edu/map), and various commercial sources.

Assessment Site: the wetland or riparian area that is being examined; may include all or part of an entire wetland or riparian zone. See p. 10 for guidance in establishing boundaries.

Assessment Team (A-team): the individuals who collect data from reference sites, in order to calibrate function capacity scoring models.

Bioassessment (Biological Assessment): the process of measuring the biological condition of a site by sampling, identifying, and enumerating species belonging to a subset of its plants and animals, and using prior knowledge of these species' tolerances to human influences to reach conclusions regarding the relative degree of degradation of the site's biological resources.

Biennial: occurring at least once every 2 years, on the average. See also: *High water (biennial), Low water (biennial).*

Buffer zone: as used in this guidebook, an area of specified radius or width surrounding an assessment site; may or may not contain vegetation; may or may not be legally designated.

Calibration: the process of standardizing (scaling) data to a specific numeric range (scale) by dividing by a constant, such as the maximum value in a data set.

Channel: a distinct linear depression with a definable outlet and identifiable bank edges that have been shaped by flowing water; includes manmade ditches and swales that may flow only intermittently

Closed Canopy: as used in this guidebook, places where live trees or shrubs are within one height-distance of each other. Do not count woody plants that were planted within the last 12 months.

Condition: the collective attributes or characteristics of a site. As used most often in wetland regulatory programs, it connotes biological or ecological characteristics, especially as portrayed by indicators, statistical summaries, or indices that are interpreted with regard to designated or "beneficial" uses of or goals for a water body.

Constricted Connection: Assess this as it exists during *biennial high water*. A constricted connection is a defined channel, culvert pipe, or other narrow passageway for surface water that links an assessment site – either permanently or seasonally -- with another wetland or body of water

Contributing Watershed: The catchment area upslope of a site, whose runoff and channels go directly into the site rather than being diverted around it. The contributing watershed may also include areas that contribute water to the site as a result of diversions from other watersheds, e.g., stormwater outfalls. If a contributing watershed divide is encountered before the 200-ft distance while moving upslope, assess and report only the conditions existing between the divide and the site. Also, note that for riverine sites the contributing watershed includes the river that feeds the site, up to 200 ft upriver, even if it feeds the site only during annual floods. To delineate the contributing watershed, use *topographic maps* (coarse-scale versions are viewable online at: topozone.com) and see Roth et al. (1996, p. 164) for description of the delineation procedure. If the site is classified as Slope-Flat and has no perceptible upslope area, with runoff and channels being generally absent, then consider the contributing watershed to be all areas within a radius of 200 ft.

Datum (plural= data). A numeric estimate or measurement.

Diameter of largest trees. Measure this to the nearest inch. As you walk all accessible parts of the site, measure trees that seem to be the largest, noting the species. Measure them at approximately 4.5 ft above the ground. Use a diameter tape, or measure the circumference using a normal measuring tape and then divide by 3.14 to get the diameter. Include trees outside the site if any branches extend into the site. If a tree is forked in the first 4 feet, measure diameter of only the larger of the forks. If no trees are present, leave this blank rather than reporting as "0."

Difference between biennial high & low predominating water levels. From field observations of the site's topography and wetland indicator plants, estimate which of the listed water depth categories most likely *predominates* spatially within the site during *biennial high water* and *biennial low water:*

1) 0 inches
2) 1-2 inches
3) 2-24 inches
4) 2 – 6 ft
5) > 6 ft

Determine the absolute difference, in number of categories. For example, if during low water category #2 predominates but during high water #4 predominates, calculate 4-2 = 2. At sites that are inundated only seasonally, and are visited when water is absent, consider the plant species that are present. For example, the presence of *Ludwigia palustris, Eleocharis acicularis*, and/or *Alisma plantago-aquatica* (among others) indicates the site had deeper, more persistent pools during the winter, whereas the presence of *Carex unilateralis, Eryngium petiolatum*, and/or *Grindelia nana* (among others) indicates shallower, shorter inundation, i.e., fewer depth categories (Lippert & Jameson 1964).

Diffuse Connection: Assess this as it exists during *biennial high water*. A diffuse connection is a broad passageway for surface water, such as an unnotched stream bank, that links an assessment site – either permanently or seasonally -- with another wetland or body of water

Distance to nearest busy road. Measure this to the nearest 300 ft on a topographic map. Update the map if necessary with field observations of new roads. Measure the distance from the approximate center of the site, to the centerline of the nearest busy road. A "busy" road is (a) any road or parking lot in a developed area that contains >4 buildings per acre, (b) any road with a maximum traffic rate of > 6 vehicles per minute, during an average day during the summer.

Ecoregion: A large geographic area delimited by its relative homogeneity of climate, topography, and land cover.

Evenness of wooded & natural grass cover classes within 200 ft of the site. In a zone extending outward 200 ft in all directions from the upland-wetland boundary (or high water line if site is riparian), estimate the percent of the land cover (to within 10%)) occupied by woody land cover and the percent occupied by natural grass cover, i.e., prairie, weedy fields, herbaceous wetlands, pasture – NOT grass lawns, golf courses, row crops. Calculate the ratio of these. For example, if 60% woodland and 15% natural grass, the ratio is 60/15 = 4. If there is no natural grass within 200 ft, the ratio is 60/0 = 0. Land cover percentages may be estimated during a site visit, from airphotos, or from the regional *land cover map* on the CD accompanying this guidebook.

Burned or harvested. Answer "yes" if it appears -- from soil profiles, charred vegetation, vegetation patterns, or interviews with knowledgeable people – that a substantial portion of the site has been burned or its vegetation harvested (hay, timber, or other crops) within the last decade. Do not include such vegetation alteration activities if they are associated with permanent conversion to non-wetland uses, e.g., residential development.

Frequency (score) of humans visiting on foot. This indicator is calculated and expressed as an index, based on the extent of the site that is visited at specified average frequencies during an average year. First, estimate the percent of the site visited at each of the following frequencies:

multiple times a day (i.e., >365 days/yr)	%	x 1	= _____
once daily only (i.e., 84 – 364 days/yr)	%	x 2	= _____
weekly only (i.e., 23 - 83 days/yr)	%	x 3	= _____
monthly only (i.e., 2- 22 days/yr)	%	x 4	= _____
annually or less (i.e., <2 days/yr)	____%	x 5	= _____
	100 %		

Then multiply the % in each row by the number (weighting factor) in the third column, and sum the products. This indicator is fairly coarse and requires judgment: consider the proximity of the site to buildings and roads, ownership (public/private), extent of trails and trash, and likelihood of use for fishing, hunting, farming, and other activities. *Note that "visit" is defined to mean "come within 100 ft of the site."*

Function: what a site does; especially, the hydrologic, geochemical, and biological processes it potentially performs without human assistance, in support of ecosystems and economies.

Function Capacity: an estimate of the rate or magnitude (i.e., effectiveness, *sensu* Adamus 1983) with which an assessment site and its supporting landscape perform a specified function. Termed "Potential functional performance" by Hruby et al. (1999).

HGM Approach: the generic procedure (Smith et al. 1995) for assessing wetlands based on initially grouping a set of wetlands within a region according to their hydrogeomorphic subclass, identifying indicators of function in each of those subclasses, and using the indicators to calibrate scoring models which represent level of function.

HGM Classification: the national classification of wetlands based on geomorphic setting, water source and transport, and hydrodynamics, as proposed by Brinson (1993). For the adaptation developed for the Willamette Valley, see the key beginning on p. 54.

HGM subclass: One of 13 types of wetlands, defined by hydrological and geomorphic characteristics, that occur in Oregon, as described by Adamus (2001).

Herb (abbreviated form of *herbaceous*): a non-woody plant rooted in the soil or sediment and visible to the unaided eye, e.g., grasses, forbs, ferns, mosses, liverworts. Woody plants may be included if shorter than 2 ft.

Herbs as % of parts of the site that are inundated only seasonally. In the part of the site that is covered with surface water during only part of the year, estimate visually the portion of the soil covered with herbs as would occur at the season of peak water level (the herbs may or may not protrude above the water surface then).

Herbs as a % of the parts of the site that are inundated permanently. In the part of the site that remains covered with surface water during time of biennial low water, estimate visually the portion of the water that contains herbs (both emergent species and underwater macrophytes).

High water, biennial: The highest elevation within an assessment site that is reached, even briefly, by surface water during an average 2-year period, i.e., the 2-year flood level. The elevation reached by past flooding may be noted during a site visit by observing highest locations of the following:

Water marks on trees or vegetation
Drift lines of debris on the ground or suspended in trees and shrubs (see photo below)
Scoured areas on the soil surface

Fresh deposits of water-borne sediment
Height of any outlet or berm relative to height of current water level
Water-stained leaves (grayish or blackish in appearance)
Accumulations of algae between grass stems (see photo below)
Areas of aquatic bed plants without any surface water beneath them
Large ant mounds
Level at which moss begins to grow on trees

We acknowledge the difficulty of distinguishing biennial flood marks from those left by annual or larger-than-biennial events. For the precision needed to meet objectives of this guidebook, that distinction is generally of minor consequence. Rarely, airphotos that show high water levels (or conditions close to that peak) may be available for inspection (e.g., December 1999 airphotos of farmlands in a few areas, contracted by Dr. Susan Haig and available from Oregon Watershed Enhancement Board). For current (hourly) flood levels at a few points along the Willamette and Tualatin Rivers, click on the location of the nearest gauge at: water.usgs.gov/cgi-bin/daily_flow?or Discharges associated with biennial high water at the reported sites are approximately: 46,300 cfs (Harrisburg), 51,000 cfs (Albany), 90,500 cfs (Salem), and 6980 cfs (Tualatin River at West Linn). Biennial high water at these sites does not necessarily coincide with occurrence of such an event everywhere in the region (especially in non-riverine wetlands), but provides a rough indication of flood timing so that site visits may coincide.

Dried algae on herbs, indicating approximate high water level during prior wet season.
photo courtesy of Janet Morlan

Note debris suspended in branches by from previous winter's flood, indicating approximate high water level.

Highest Functioning Standard: a site or small group of sites that received the highest score for a specified function, among a much larger group of sites similarly assessed.

Hummock: a dense clump of grasslike herbs – such as Carex, Deschampsia – that protrudes above the wetland surface and characteristically is separated from other hummocks by small depressions (of less than a few square feet) that seasonally contain puddles.

Hydrogeomorphic (HGM): pertaining to water, geology, and/or morphological (landform) features.

Indicator: characteristics that are relatively easy to observe and, in this guidebook, are believed to correlate with (but are not necessarily causally linked with) processes that support specific wetland or riparian functions. Not limited to "field indicators" used to delineate wetlands.

Inundated, Inundation: covered wholly or partly with surface water; the water may come directly from precipitation, subsurface water table rise, runoff, or channel flow.

Judgmental Method: a procedure for estimating *function capacity*, wherein a checklist of indicators pertinent to each function is provided but decisions regarding how to estimate, scale, and combine the indicators into an estimate of function capacity are left up to the user or a team of users.

Land cover in the vicinity of the site in 1800's. If the subclass is Riverine Impounding, automatically assume this to be "wooded." If site is Slope/flats, find the approximate location of your site by loading the CD-ROM that accompanies this report and zooming in on the map, "Land Cover in the Willamette River Basin, Circa 1852." If the vicinity of the site during that period is portrayed as **Prairie, Emergent Wetland, or Herbaceous Upland**, consider it to be "non-wooded."

Least-altered Standard: a site or small group of sites that, by consensus, are the least likely among many in a region to have been exposed to lasting or chronically serious alterations as a result of human activities.

Low water (biennial): The lowest elevation within an assessment site that is reached by surface water during an average 2-year period, i.e., water level during the driest time of year during any 2 years. This may be estimated by observing the surrounding terrain, as well as by noting locations of large areas of open water that lack woody vegetation, especially if dominated by wetland-obligate herbaceous plant species.

Macrophyte: As used herein, a vascular plant visible to the unaided eye that lives at or below the water surface, e.g., waterweed (*Myriophyllum),* duckweed (*Lemna*).

Mapped soil series is hydric. Locate the site on maps in the county soil survey report. Then from the following table, note whether any of the soils mapped as occurring at the site have been designated as hydric.

Soil series of the Willamette Valley that are hydric

Legend: (Ba) or (9) = map symbol for this soil on soil map for this county.
Note: Additional soil series not listed below frequently contain hydric inclusions, but do not include those for this indicator.

Soil Map Unit	Benton	Clack-amas	Lane	Linn	Marion	Mult-nomah	Polk	Yamhill	Wash-ington
Awbrig			5,6	7					
Amity	Am		3	3	Am		3	Am	
Bashaw	Ba,Bc		8,9	8	Ba		6A, 6C, 7		
Brenner	Bp		19				11		
Concord	Co	21		27	Co		20		
Conser	Cs		33	28					
Courtney			34	29	Cu				
Cove		25					21,22	Cv	13,14
Dayton	Da	29	38	33	Da		25	Da,Dc	15
Delena		30C				14C			16C
Faloma						15,16			
Grande Ronde							28	Gr	
Huberly		22							41
humaquepts		42							
Labish					La			Lb	27
Minniece			83B	69B	MyB				
Natroy			85,85,87						
Noti			98						
Panther			102C, 103	75C				PaD	
Pengra			105A	77A					
Rafton						39,40,47 A			
Verboort									42
Waldo	Wa		130	98	98				
Wapato	Wc	43	83, 84	99	99	55	73		
Whiteson				100	100				
Willanch			136						
Wollent						57			

Maximum annual extent of hummocks. This indicator is intended to reflect the vertical variation in topography of the seasonally-inundated and saturated parts of the site. Measure or estimate visually the percentage of the site occupied by hummocks (see photo below), preferably while visiting the site during high water. The uneven microtopography, caused largely by bunchgrasses, makes it noticeably difficult to walk through such areas. This indicator is not assessed in sites belonging to the Riverine Impounding subclass, because in the Willamette Valley such sites seldom have this feature naturally.

Uneven microtopography created by hummocks interspersed with puddles during the wet season.
Photo courtesy of Bob Frenkel.

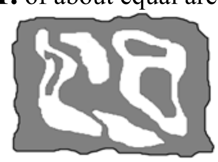
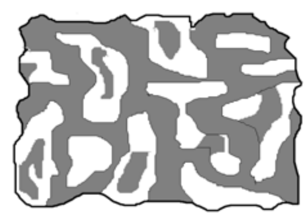
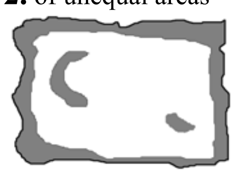
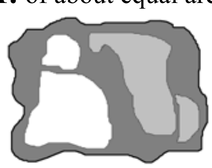
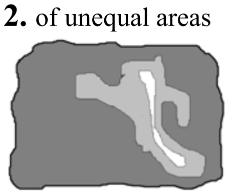
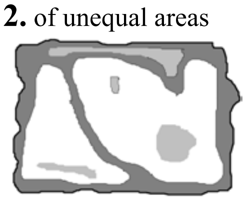
Maximum annual extent of vernal pools, shorebird scrapes, & mudflats. These are areas that meet all of the following criteria:

a) herbs are generally shorter than 4 inches and comprise <80% ground cover during winter or early spring (see photo at right) and
b) topography is basically flat, and
c) inundated to a depth of less than 6 inches for 2 or more continuous weeks, and
d) never shaded by trees, shrubs, or buildings, and
e) not entirely a constructed ditch.

Model, scoring: A mathematical device (formula, equation) for combining numeric estimates of indicators, in a manner thought to represent function or some other attribute of a site.

Non-native: Species not present in the Willamette Valley region during pre-settlement times, but currently occurring as the result of natural or human-aided establishment. Used synonymously with "exotic" or "alien" species. Includes a few species, e.g., Phalaris arundinacea, that were historically present but whose range and regional dominance has expanded tremendously. For a partial listing of non-native herbs in this region, see "Spatial predominance of non-native herbs" in this Glossary.

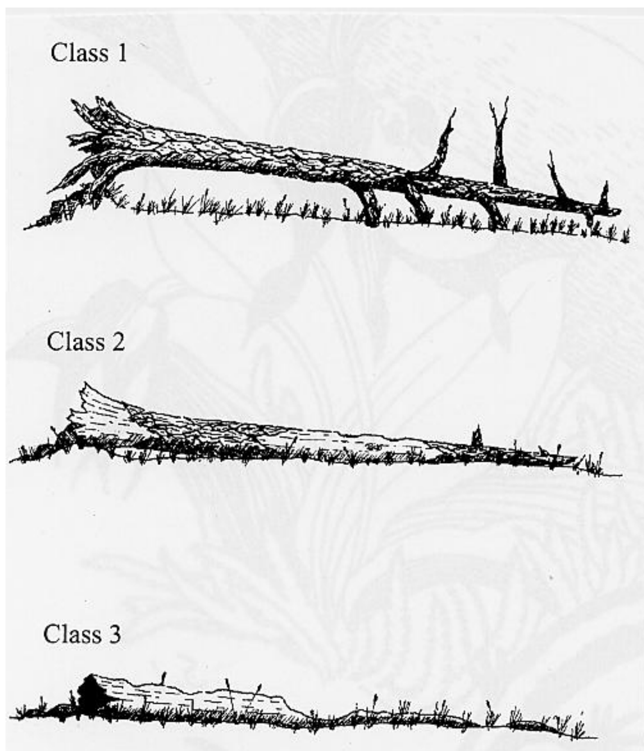
Number & distribution of vegetation forms. Refer to the figure immediately following. The different shades depict distributions of trees, shrubs, and/or herbs. From field observations and (ideally) review of fine-scale airphotos, select whichever condition (letter) best describes the site during the mid-growing season and from an aerial perspective 100 ft above the ground. Shape, depth, and individual size of the vegetation patches is irrelevant here. Do not count woody plants that were planted within the last 12 months. *If the site is >1 acre in size, mentally divide the site into a 1-acre grid and report only the condition that exists within <u>most</u> of the 1-acre grid units.*

Number & distribution of vegetation forms			
	Veg forms are mostly in discrete, quite homogeneous zones or patches:	Zones/patches are recognizable but not homogeneous, and are:	Forms are highly intermixed; zones are mostly not recognizable; no patch >20% of site
Only ONE vegetation form: trees <u>or</u> shrubs/vines <u>or</u> herbs. Do not count forms that occupy < 0.5 acre. **A**			
Two forms … (excluding those occupying <0.5 acre)	**B 1.** of about equal area 	**C 1.** of about equal area 	**D** 
	B 2. of unequal areas 	**C 2.** of unequal areas 	
All three forms … (excluding those occupying <0.5 acre)	**E 1.** of about equal area 	**F 1.** of about equal area 	**G** 
	E 2. of unequal areas 	**F 2.** of unequal areas 	

Number of depth categories. From field observations of the site's topography and wetland indicator plants, estimate how many of the 4 listed depth categories are present during the specified condition (high or low water).

Number of kinds of dead wood. While walking through all wooded parts of the site, refer to the following diagram, and count how many of the following 13 decay classes and diameter classes of woody debris exist within the site. Include wood carried in by floodwaters or currents as well as wood that has fallen directly. All -- except stumps/snags -- *must be >6 ft. long in order to be counted*.

- ___ Class 1 (see diagram below): freshly fallen, have bark & branches and are 4-8"
- ___ Class 1: freshly fallen, have bark & branches and are 8-20"
- ___ Class 1: freshly fallen, have bark & branches and are >20"
- ___ Class 2: mildly rotted and mostly on ground: 4-8"
- ___ Class 2: mildly rotted and mostly on ground: 8-20"
- ___ Class 2: mildly rotted and mostly on ground: >20"
- ___ Class 3: well rotted, losing shape: 4-8"
- ___ Class 3: well rotted, losing shape: 8-20"
- ___ Class 3: well rotted, losing shape: >20"
- ___ Standing stumps/snags: 4-8"
- ___ Standing stumps/snags: 8-20"
- ___ Standing stumps/snags: >20"
- ___ Artificial debris – *check this only if no others present*



Number of native woody species. While walking through the site, identify all woody species taller than 2 ft. and not merely planted within the last 12 months. Refer to column 1 of the Woody/Vine Data Form (Appendix F) to determine which of these are native to the region, and tally this number.

Number of woody species. While walking through the site, identify all woody species taller than 2 ft. and not merely planted within the last 12 months. Record on the Woody/Vine Data Form (Appendix F), and tally this number.

Opportunity: potential given to a site to perform particular functions as a result of its landscape position relative to material inputs

Outlet: the point or channel through which surface water exits from one water body into another that is geomorphically different

Percent cover: The percent of the substrate (soil, water, and dead plant litter) obscured by a plant's foliage when viewed from directly overhead.

Percent of land cover in *contributing watershed* & within 200 ft that is not cropland, lawns, pavement, or buildings. Land cover percentages may be estimated during a site visit, from *airphotos*, or from the regional *land cover map* on the CD accompanying this guidebook. For this indicator, consider only the land cover in the *contributing watershed,* not land cover on all sides of the site, except where the surrounding terrain is totally flat and there are no input channels. The 200-ft distance is estimated from the wetland-upland boundary (or the high water line if site is riparian) and also from the point where an inlet channel (if any) enters the site.

Percent & distribution of pools (during high water, low water). See next page.

Percent of common herb species that are non-native. For this guidebook, "common" herbs are defined as those that cover at least 100 sq. ft. of a site. List these species on the Common Herb Data Form (Appendix F), and mark those that are non-native by referring to the list given in this Glossary under the indicator, "Spatial predominance of non-native herbs." Tally the non-native species, divide by the total number of common herbs you found, and multiply by 100 to express as a percent. Note that the 100 sq. ft. area of each species need not be all in a single patch. Be especially vigilant in large sites for species that are highly dispersed but nonetheless may meet the 100 sq. ft. threshold when all areas occupied by the scattered plants are summed.

Percent of permanent zone containing herbs. Identify parts of the site that contain surface water even during time of biennial low water. Then visually estimate the cumulative percent of that surface water that contains herbs (including both emergent species and underwater macrophytes).

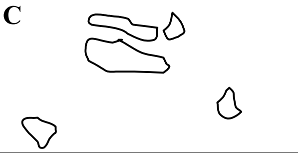
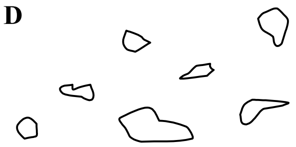
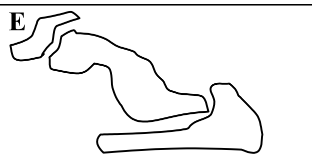
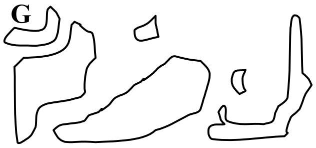
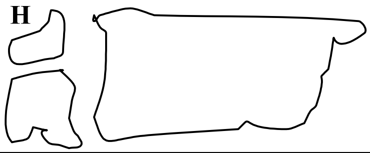
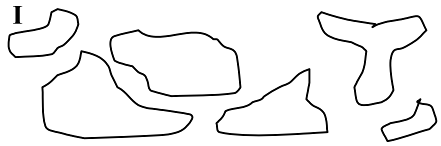
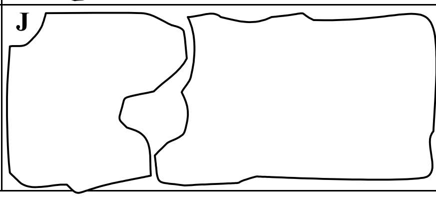
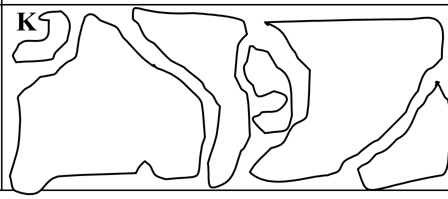
Percent of permanent zone shaded by woody or aquatic plants. Identify parts of the site that contain surface water even during time of biennial low water. Then visually estimate the cumulative percent of the water surface that would be shaded at mid-day during the summer by any vascular plants or topography.

Percent of permanent zone that is open water. Identify parts of the site that contain surface water during time of biennial low water. Then visually estimate the cumulative percent of this zone that is "open water" – it contains no emergent herbs or underwater macrophytes – during such conditions.

Percent of seasonal zone that is bare during the dry season. Within parts of the site that are inundated only seasonally, identify areas that remain mostly devoid of vegetation (other than trees) during most of the time when surface water is absent. These are patches where herbs plus shrubs together comprise less than 50% cover, as viewed from 20 ft above the site. They may remain bare during most of the growing season due to (for example) heavy shade from a tree canopy, severe scouring/ erosion, annual plowing, extreme grazing, especially prolonged springtime flooding, steep sideslope, and/or unfavorable substrate characteristics.

Percent of seasonal zone that contains a *closed canopy.* Within parts of the site that are inundated only seasonally, identify areas where live trees or shrubs are within one height-distance of each other. Estimate the portion of the entire seasonally inundated area that is comprised of such areas. Note this is not quite the same as "canopy closure" or "foliar cover" as measured by some other methods.

Percent and distribution of pools (during high water, low water). *Pools* are areas of standing surface water with little or no vegetation protruding above water surface, and unobscured by tree canopy. Pools do not need to be permanently inundated, and may be separated from each other by strips of erect vegetation or land. To assess this indicator, refer to the figure immediately below and select whichever condition (letter) best fits at the time of year called for. Base this on field observations and (ideally) review of fine-scale airphotos. Each box in this figure represents a wetland, with shapes representing its pools as would be seen from an aerial view about 100 ft above the ground. Shape, depth, and individual size of the pools is irrelevant here *If the site is >1 acre in size, mentally divide the site into a 1-acre grid and report only the condition that exists within the most (largest number of) 1-acre grid units.*

Percent & distribution of pools			
	Pools are few & are mostly clumped together	Pools somewhat scattered, more common	Pools numerous, scattered evenly, & highly intermixed with vegetation
None **A**			
1-30% of site is pools	**B** 	**C** 	**D** 
30-60% of site is pools	**E** 	**F** 	**G** 
60-90% of site is pools	**H** 	**I** 	
>90% of site is pools	**J** 	**K** 	

A freshwater wetland with high interspersion of vegetation and open water, located on the Oregon coast.
Photo courtesy of Bob Frenkel.

Percent of site affected by soil leveling. If this is a slope-flat site, estimate the portion that has been used previously as cropland or appears to have been leveled by equipment in order to improve drainage.

Percent of site affected by soil mixing. While visiting the site look for physical evidence that soils have been plowed, excavations have been dug, or other regrading (except leveling) has occurred. Estimate the extent of alteration. If row crops are present, soil mixing can be assumed. Before the 1930's, most Willamette Valley sites were hayed or grazed, but not plowed (Davis et al. 1995).

Percent of site currently affected by mowing or extreme grazing. While visiting the site look for evidence that the site has been mowed or intensely grazed. Evidence may include presence of exotic grasses that have been reduced to a height of less than about 4 inches, pronounced browse lines on trees, adjoining pastures or barns with livestock, or hay bales. Do not answer affirmatively if mowing or grazing occurred at a distant time and no physical evidence of its impact remains.

Percent of site currently affected by soil compaction. While visiting the site look for physical evidence that soils have been compacted by farm or construction equipment, other vehicles, livestock, constant human traffic, or placement of fill. Evidence can include tire tracks, ruts, abandoned dirt roads, or regularly-used trails. Estimate the extent of compaction that is likely to diminish soil pore space and hinder seed germination.

Percent of site occupied by the most extensive depth category during *biennial low water*. The depth categories are: 0 inches; 1-2 inches; 2-24 inches; 2 – 6 ft; > 6 ft.

Percent of site with closed-canopy woods. Identify areas where live trees or shrubs are within one height-distance of each other. Estimate the portion of the entire site that is comprised of such areas. Note this is not quite the same as "canopy closure" as measured by some other methods.

Percent of site that is inundated only seasonally. While visiting the site, look for water marks or moss lines on trees, debris lines, and other evidence of previous high water level. These comprise the upper boundary of the *seasonal zone.* The lower boundary is defined by the upper boundary of the *permanent zone*, i.e., *biennial low water.* In slope-flat sites, the *seasonal zone* is often dispersed in many patches. These flood during winter but dry up in spring. During summer these seasonally-inundated areas may be defined by a prevalence of obligate or facultative-wet plant species, and by depressions containing vegetation of reduced stature or density. Sites that are large relative to the size of their contributing watershed (e.g., comprise >4% of its area, Reinelt & Taylor 1997) usually have a smaller seasonal zone (less water level fluctuation) than proportionately smaller sites.

Percent of site that was constructed from non-hydric soil. From field observations, comparison with historical airphotos, or from review of permit file information, estimate the percent of the site that currently qualifies as wetland or riparian, but which formerly (within last 100 years) did not, e.g., county soil survey shows it as containing a soil series that is not officially designated as hydric or containing hydric inclusions.

Percent of surface water in the 2-6 ft depth category during low water. From visual estimation, identify the portion of the entire site that is in this depth category during biennial low water. To help judge the depth, consider the surrounding topography. Also, some judgment will be required if the site cannot be visited at approximately the driest time

Percent of surrounding land cover that is water or wetland. Do not include the assessed site itself. For the 3 zones (200, 1000, and 5280 ft), measure these distances from the wetland-upland boundary (or high water line if site is riparian). Estimate the percent of total land cover in each (or just in the 200 ft zone if so specified) that is water or wetland. Sum the 3 percentages and divide by 3 to get the average percent wetland + water. For the 200-ft zone the percentages may be estimated during a site visit, but for the more distant zones they should be estimated from *airphotos*, from local wetland inventory maps, from NWI maps (www.nwi.fws.gov/wetlands_interactive_mapper_tool.htm), from county soils maps, and/or from the regional *land cover map* on the CD accompanying this guidebook. If multiple sources are used, use the source yielding the largest percent of this cover type.

Percent of surrounding land cover that is not cropland, lawn, buildings, or pavement.
Percent of surrounding land cover that is grassland or row crops.
Percent of surrounding land cover that is woodland.
Estimate in a manner generally similar to above.

Permanent pool: a depression within a site that remains inundated with *stagnant* water throughout the year during most years; more correctly termed "perennial."

Permanent water: surface water that remains in a site year-round during most years; more correctly termed "perennial."

Permanent zone (short for permanently-inundated zone): The zone containing surface water that persists year-round during an average year, i.e., perennial.

Percent of woody cover within stratum that is comprised of non-native woody species. Mentally divide the site into three strata*: trees*, *understory shrubs*, and *open shrubs* (at some sites some of these 3 will be absent). Within each stratum that comprises at least 10% of the entire site, visually estimate the percent of the stratum's total area that is comprised of non-native woody species. These are denoted on the Woody Vegetation Form (Appendix F). Do not count woody plants that were planted within the last 12 months. Report the maximum percent occurring among the strata that are present.

Percent of woody species that are native. While walking the site, identify all woody plants to species, report them on the Woody Vegetation Form (Appendix F), and tally the total number of woody species. Then calculate the percent that are natives. Do not count woody plants that were planted within the last 12 months.

Percent shrub & vine cover in parts of the site that are inundated only seasonally. Identify parts of the site that are inundated only biennially. Within these areas, estimate the percent occupied by shrubs and vines, both in the open and beneath tree canopies. Do not count woody plants that were planted within the last 12 months.

Percent understory shrub & vine cover. Identify parts of the site where tree canopies, when viewed from above, obscure features beneath them. In these parts of the site, estimate the percent of the under-canopy (understory) area that is occupied by shrubs and vines, rather than bare ground or herbs. Do not count woody plants that were planted within the last 12 months.

Percent vegetated. Estimate the percent of the site, as viewed from above, that contains trees, shrubs, vines, or herbs (rather than bare or water) as exists during the time of biennial low water.

Percent woody vegetation. Estimate the percent of the site, as viewed from above, that contains trees, shrubs, vines, or other woody vegetation. Do not count woody plants that were planted within the last 12 months.

Pools: areas of standing surface water with little or no vegetation protruding above water surface, and unobscured in aerial view by a tree canopy.

Predominant, Predominating, Predominance: comprising the largest portion of space in the horizontal dimension; need not comprise a majority of the space (i.e., 50% or any other threshold).

Predominant depth category during biennial low water. Identify which of the 5 depth categories comprises the largest portion of the site during the time of biennial low water. To help judge the depth, consider the surrounding topography and the wetland indicator status of the species present. Also, some judgment will be required if the site cannot be visited during the driest time.

Predominant soil texture: From the soil textures listed in the following key, estimate which soil texture occupies the largest volume of the upper 12 inches of the site. See the table below for assistance in determining soil texture. Base your determination on at least 3 widely spaced soil pits, rather than on county soil maps. In large sites, use county soil survey to help identify the range of variation that should be examined further with pits.

Key to Textures of Willamette Valley Soils
1. Soil remains in a ball when squeezed YES… Go to 3 NO … Go to 2 2. More than 50% of the particles (by weight) are larger than 1 mm YES… **Cobble-gravel** NO… **Sand** 3. Squeezed soil* forms an even ribbon YES… Go to 4 NO… **Loamy sand** 4. Soil ribbon can be extended to more than 1 inch length without breaking YES… **Sandy clay loam; silty clay loam; clay loam; sandy clay; silty clay; or clay** NO… Go to 5 5. Soil feels very gritty YES… **Sandy loam** NO… **Loam or silt loam** * To properly assess texture by squeezing, place a moistened ball of soil between thumb and forefinger. Gently push the soil with your thumb and squeeze it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.

Predominant vertical increase in surface water level. While visiting the site, look for water marks or moss lines on trees, debris lines, and other evidence of previous high water level. Identify the highest such mark from the most recent 2 years of flooding, and measure its height in feet above the biennial low water level, i.e., measure the vertical increase in surface water level. Then, taking into account the topography of the wetland and the cross-sectional area of its outlet (if any), estimate the spatially *predominant* vertical increase for the site as a whole.

Presence of hydric soil features. Dig soil pits to a depth of 12 inches in at least 3 widely spaced locations within the site, including at least one pit representative of the seasonally inundated area. Examine the soils for evidence of indicators of hydric conditions, as described in the most recent version of *Field Indicators of Hydric Soils in the United States*, available at: http://www.statlab.iastate.edu/soils/hydric/fieldind/fieldind.html If such evidence is found in any of the pits, indicate "present" regardless of its relative extent and intensity. Among sites addressed by this Guidebook, only riverine sites with very short flooding, and sites constructed very recently from uplands, are likely to completely lack such features.

Gray areas in the soil photo at right are gleying, rusty colors are mottling. (photo courtesy of Janet Morlan).

Presence of logs and/or boulders extending above the surface of permanent water. Note simply if these are present or absent. Indicate present if these features extend above the surface at any season and are capable of providing cover for fish or basking sites for frogs and turtles.

Reference Site: An assessment site that, together with others, is used to calibrate regional scoring models of wetland or riparian function. Such sites are selected to encompass the expected natural and human variability among wetlands of their subclass in the region.

Reference-based Method: a procedure for estimating function capacity, wherein users assess the condition of several *indicators* pertinent to each function, standardize each indicator's data to a common scale that is specific to each indicator and subclass, combine the standardized data into a *function capacity* score using prespecified *scoring models*, and standardize the model output by dividing by the score of the site or sites that have the highest function score and/or are believed to represent the least-altered condition.

Richness: the number of species or other taxonomic units

Riparian: As used in this procedure, an area bordered on one side by a channel and on the other (landward) side by the 2-year floodplain boundary of the channel. May or may not be the same as jurisdictional wetland boundary.

Riverine Impounding (RI): A hydrogeomorphic subclass applied to some wetlands in the Willamette Valley ecoregion. See the key beginning on p. 54 for guidance in recognizing this type.

Saturated zone: The zone that during an average year is never inundated with surface water, but which nonetheless meets wetland criteria due to high water table. To estimate the boundaries, delineate both the maximum water level (using flood marks) and the wetland boundary (using conventional procedures based on hydric soils and predominance of hydrophytic vegetation). The zone that occurs between these boundaries is the saturated zone. If it comprises more than 20% of an RI site, the site should, for assessment purposes, be divided into two sites – one belonging to the RI subclass and the other (the saturated zone) to the SF subclass.

Seasonal water zone: The zone in which surface water is present during only part of the year during most years.

Shrub: A woody plant that is between 6 and 20 ft tall.

Significance: Significance" is the likelihood the function, if performed, will be particularly valued in the locality or region where it occurs (Adamus 1983). Significance is the result or reflection of natural features, economic values (supply and demand for the function), official designations, and strategic location. It includes attributes that are termed "red flags" by some assessment methods.

Site: see Assessment Site

Slope/flats (SF): A subclass representing a "hybrid" of two hydrogeomorphic classes, applied to some wetlands in the Willamette Valley ecoregion. See the key beginning on p. 54 for guidance in recognizing this type.

Spatial predominance of non-native herbs. This indicator is essentially asking:

Is more of the herb cover on the site comprised of non-native than of native herbs?

In the Willamette Valley, non-native herbs most often include the following (do not limit yourself to these species; italics indicate that identification to species is crucial because some wetland-associated members of the genus are native)

Grasslike species: Phalaris spp., Holcus spp., Alopecurus *pratensis*, Festuca *arundinacea*, Agrostis *alba/ tenuis/ gigantea*, Anthoxanthum odoratum, Lolium spp., Elymus *caninus*, Echinochloa crusgalli, Digitaria spp., Aira spp., Agropyron (Elytrigia) *repens*, Bromus *japonicus/ rubens*, Phleum pratense, Trifolium *dubium/ pratense/ repens*, and others.

Emergent Forbs: Lotus *corniculatus*, Mentha *pulegium*, Lysimachia *nummularia*, Ranunculus *repens*, Rumex *crispus/ conglomeratus*, Centaurium *erythraea*, Vicia *sativa/ hirsuta/ tetrasperma*, Parentucellia viscosa, Cirsium *arvense/ vulgare*, Urtica dioica, Hypochaeris radicata, Taraxacum officinale, Prunella vulgaris, Medicago lupulina, Plantago *major*, Lapsana communis, Leucanthemum vulgare, Erodium cicutarium, Dipsacus fullonum (sylvestris), Daucus carota, Geranium sp., Senecio jacobaea, and others.

Aquatic species: Polygonum *persicaria*, Peplis portula, Callitriche *heterophylla*, Jussiaea uruguayensis, Myriophyllum *brasiliense*, and others.

Stagnant: Surface water that is not flowing, or flow, if present, does not visibly disturb the water surface with eddies, ripples, etc.

Stratum: As used in this guidebook, one of three vegetation forms (*tree, understory shrub, open shrub*).

Topographic map: a map showing elevations. Maps at a very coarse scale can be viewed online at: topozone.com

Tree: For purposes of this guidebook, a woody plant taller than 20 ft.

Type of connection to associated channel. From visual observation, categorize the manner in which offsite surface water enters the site.

Upland: as used in this guidebook, any non-aquatic area that neither wetland nor riparian

Values: as used in this guidebook, the economic, ecological, or social importance assigned a function as a result of its *opportunity* to provide functions, goods, and services, and the *significance* of these.

Variable: as used in this guidebook, a factor that determines wetland or riparian function, but may or may not be relatively easy to measure

Vegetation form: As used in this guidebook, a tree, shrub, or herb.

Woody vegetation: Trees plus shrubs and vines (includes Himalayan blackberry).

Appendix B. Assessment of Function Capacity: Judgmental Method

Complete the following "qualitative assessments" of function only if you chose not to complete the reference-based assessments" that began on page 20.

Instructions: In each row, indicate with a checkmark if your site looks more like the "highest capacity" condition or the "minimal capacity" condition. Then circle a number on the scoring line below this table, based on your overall impression of the site's capacity to support this function. Alternatively, instead of checkmarks, you can assign a score to each row by placing a number in the center column of each row, e.g., 0 (minimal capacity) -to- 1.0 (highest capacity), and then combine the row scores in a manner of your choosing, perhaps weighting some rows more than others if you believe those indicators to have greater influence on a function. Whether based on mathematical operations or another way of synthesizing, be sure to circle your final score for the function on either or both of the shaded "Judgment Lines" at the bottom. Definitions of many of the terms are provided in Appendix A.

Function Capacity (Judgmental Assessment of): **Water Storage and Delay**

Highest Functioning	Suggested Score:	Minimal Functioning
___ The proportion of the site that is inundated only seasonally is large. The seasonally-inundated parts are defined by flood marks on trees and shrubs, stunted plants, and/or distinctive assemblages of plant species.		___ None of the site is inundated only seasonally. The site is always comprised only of permanent water or a high water table without surface water.
___ Most of the surface water in the seasonally-inundated zone remains for a few days after each rain event, but not less or more.		___ Water added from rain events empties quickly from all of the site, via outlets or percolation. This often is evidenced by: ___ lack of flood marks on trees and shrubs ___ scarcity of wetland plants (few FAC or wetter) ___ little or no mottling of soils throughout the seasonally-inundated zone. ___ site is located on slope ___ site is flat (few or no puddles, etc.) ___ presence of outlet channels

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Sediment Stabilization and Phosphorus Retention

Highest Functioning	**Suggested Score:**	**Minimal Functioning**
___ High score was assigned to Water Storage & Delay function (inundation is long, frequent, deep, extensive).		___ Low score was assigned to Water Storage & Delay function (water levels barely fluctuate).
___ Texture of the predominant substrate in the upper 12 inches of the seasonal zone is mostly clay, silty clay, sandy clay, clay loam, or native organic. See p. 83 for key to soil textures.		___ Upper 12 inches of the predominant substrate in the seasonal zone is mostly sand or gravel.
___ Herbs, shrubs, and/or vines together always occupy a large percent of the ground cover in the seasonal zone. Very little soil is bare.		___ All or nearly all of the substrate in the seasonal zone is unvegetated.
___ Shallow pools and puddles are present and well-interspersed with herbaceous vegetation		___ Shallow pools are absent at all times of the year
___ Substrates have never been recontoured or otherwise subjected to compaction, excavation, plowing, disking, leveling. No evidence of severe erosion within the site.		___ Substrates throughout the entire site have recently been recontoured or otherwise subjected to compaction, excavation, plowing, disking, leveling. Extensive evidence of severe scour or erosion may be present within the site. No sediment marks on trees or other plants.
___ Most of the site has complex microtopography (hummocks, puddles, etc.)		___ The substrate is uniformly flat, with no noticeable microtopography (no hummocks, etc.)

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Nitrogen Removal

Highest Functioning	**Suggested Score:**	**Minimal Functioning**
Note: Proceed with assessing this function only if mottling and/or other features that indicate oxygen deficits in soils/ sediments are found in at least part of the site.		
___ High score was assigned to Water Storage & Delay function (inundation is long, frequent, extensive)		___ Low score was assigned to Water Storage & Delay function (water levels barely fluctuate)
___ Some surface water or saturation remains year-round or nearly so, and is dispersed around the site such that water flow paths and residence times are long.		___ No surface water or saturation remains year-round. If seasonal flooding occurs, the surface water is concentrated in one part of the site, e.g., channel or pond, and does not remain for long.
___ Soil microbial processes are fairly mature, as possibly suggested by abundance of dead wood, thick and extensive soil organic layer, and many large-diameter trees		___ Soil microbial processes are not well-developed, as possibly suggested by lack of dead wood, thick soil organic layer, and/or large-diameter trees

Highest Functioning	Suggested Score:	Minimal Functioning
___ Substrates have never been recontoured or otherwise subjected to compaction, excavation, or leveling. No evidence of severe erosion within the site. None of the site was constructed from upland.		___ Substrates throughout the entire site have recently been recontoured or otherwise subjected to compaction, excavation, or leveling.
___ Most of the site has complex microtopography (hummocks, puddles, etc.)		___ Most of the site has no noticeable microtopography (no hummocks, puddles, etc.)
___ Site is burned annually or biennially		___ Site has not been burned in recent years

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Primary Production

Highest Functioning	Suggested Score:	Minimal Functioning
___ All of the site has vascular plants and/or water with algae.		___ Much of the site is devoid of vascular plants and/or algae.
___ A variety of plant forms is present in about equal proportions (trees, shrubs, and herbs) and is well-distributed throughout the site		___ Whatever plants are present are mainly of a single form (trees, shrubs, or herbs)
___ Some shallow (<3 ft) surface water remains year-round or nearly so, and in summer is dispersed around the site, e.g., many puddles		___ The site is entirely dry during much of the year.
___ Substrates have never been recontoured or otherwise subjected to compaction, excavation, or leveling. No evidence of severe erosion within the site.		___ Substrates throughout the entire site have recently been recontoured or otherwise subjected to compaction, excavation, or leveling. Severe erosion may be evident within the site.
___ The site's contributing watershed contains no cropland, paved surface, buildings, or lawns – especially in the parts closest to the site.		___ The site's contributing watershed is almost entirely cropland, paved surface, buildings, and lawns – especially the parts closest to the site.

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of): **Thermoregulation**

Highest Functioning	Suggested Score:	Minimal Functioning
Note: This function should be assessed only for riverine sites at which part of the site is permanently inundated and connected by surface water during summer to other water bodies.		
___ Entire water surface in summer is shaded by a closed tree canopy or by topography.		___ None of the water is shaded by vegetation or topography, and all of the water is shallower than 2m during summer.
___ Almost the entire site consists of water deeper than 6 ft.		___ Very little of the site contains permanent water, and it never is deeper than a few inches.

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of): **Resident Fish Habitat Support**

Highest Functioning	Suggested Score:	Minimal Functioning
Note: This function may be assessed only if part of the site is permanently inundated and the subclass is Riverine Impounding.		
___ Permanent water is extensive, and the site is connected only briefly with associated channels		___ Permanent water is very limited
___ Non-native fish species are absent		___ Non-native species dominate the resident fish component, although some natives are present
___ Shallow water area and proportion of the site that is inundated only seasonally is of sufficient extent and quality to support spawning by most species, and supports high densities of aquatic invertebrates		___ If present, shorelines are steep, dropping sharply into water deeper than 6 ft., with little or no seasonal zone being present
___ Cover (aquatic plants, logs, boulders, overhanging trees, deep water spots, etc.) that provides year-round shelter from predation is abundant		___ Where water is present seasonally, cover that could shelter fish from predation is scarce or lacking.
___ Water quality (especially dissolved oxygen) is excellent		___ Water is heavily contaminated with pollutants, and/or experiences severe and prolonged oxygen deficits

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Anadromous Fish Habitat Support

Highest Functioning	Suggested Score:	Minimal Functioning
Note: Proceed with assessing this function only if part of the site is accessible to anadromous fish during seasonal inundation		
___ Floodwaters spill into the site across a broad bank or through a wide (unconstricted) mouth		___ Floodwaters spill into the site across a broad bank or through a wide (unconstricted) mouth
___ Floodwaters remain in the site for more than a few days		___ No surface water remains in the site for more than a few days
___Non-native fish species are generally absent		___ Non-native fish species predominate
___Substrates suitable for spawning or feeding are extensively present		___ Substrates suitable for spawning or feeding are scarce or absent
___Cover (aquatic plants, logs, boulders, overhanging trees, deep water spots, etc.) that provides shelter from currents and predators is abundant, at least in the seasonal zone		___Cover that provides shelter from currents and predators is scarce or lacking from all parts of the site
___Water quality (especially dissolved oxygen) is excellent		___ Water is heavily contaminated with pollutants, and/or experiences severe and prolonged oxygen deficits
___Summertime temperature maxima do not exceed preferred range of anadromous fish		___Summertime temperature maxima exceed limits lethal to anadromous fish

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Invertebrate Habitat Support

Highest Functioning	Suggested Score:	Minimal Functioning
___ Surface water is permanent or nearly permanent, AND all of the water is shallower than 2 feet during May-September*		___ Surface water is present only briefly (RI sites) or not at all (SF sites), OR nearly all of the water remains deeper than 6 ft during May-September
___Cover (especially aquatic plants, woody debris) that supports algae and provides shelter from currents and predators is abundant in both the seasonal and permanent zone		___Cover (aquatic plants, woody debris.) that could support algae and provide shelter from currents and predators is lacking
___Plant forms and species are highly diverse		___Only one plant form is present, and plant species richness is very low
___ Vegetation is well-interspersed with pools		___ Vegetation and pools (if any) are in 2 separate areas or zones
___Water quality (especially dissolved oxygen) is excellent		___ Water is heavily contaminated with pollutants, and/or experiences severe and prolonged oxygen deficits

Highest Functioning	Suggested Score:	Minimal Functioning
___ Substrates have never been recontoured or otherwise subjected to compaction, excavation, or leveling. No evidence of severe erosion within the site.		___ Substrates throughout the entire site have recently been recontoured or otherwise subjected to compaction, excavation, or leveling, or the site was entirely constructed from upland.
___ Surrounding landscape contains large acreage of wetlands, including some with a different water regime than the assessed site.		___ Surrounding landscape contains no wetlands or ponds

* Areas likely to retain water well into the growing season may have many of these characteristics:

___ prevalence of wetland plants (FAC or wetter, and especially OBL)
___ intensive mottling & gleying of soils throughout most of the seasonally-inundated zone.
___ site is located in flatland terrain (not on slopes)
___ site is large relative to its contributing watershed (>4% of total area)
___ extensive microtopographic variation (many hummocks, puddles, etc.)
___ absence of outlet channels, and/or site is managed for water storage.

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of): **Amphibian & Turtle Habitat**

Highest Functioning	Suggested Score:	Minimal Functioning
___ Permanent water is absent, but shallow surface water that contains extensive partly-submerged fine-stemmed herbs[1] is extensive, and recedes very gradually during the months of January – May [2] (i.e., during this period, there are at least 30 days when water levels are stable or have a vertical fluctuation of <2 inches). OR: ___ Permanent water is extensive and contains (a) abundant underwater cover (aquatic plants, logs, boulders, overhanging trees, deep water spots, etc.) that provides shelter from predation, and (b) partly-submerged fine-stemmed herbs[1]		___ Site never contains surface water OR ___ Site is entirely surface water, which either (a) never fluctuates vertically (i.e., no seasonal zone is present), or (b) fluctuates too much – more than 2 inches during all 10-day periods, or (c) is devoid of any emergent herbs that are partly-submerged during the springtime, or (d) flows faster than 4 inches/second during the entire springtime, everywhere in the site, or (e) is mostly deeper than 40 inches and is bordered by a shoreline with a very steep slope
___ Bullfrogs and other non-native predators are absent		___ Bullfrogs and other non-native predators are abundant
___ If surface water everywhere in the site is flowing during springtime, there are at least 30 days when current velocities are slow (<4 inches/second)		___ If surface water everywhere in the site is flowing during springtime, there are never more than 30 days when current velocities are slow (<4 inches/second)
___ There is extensive and varied woody debris in the seasonal zone		___ There is no woody debris in the seasonal zone

Highest Functioning	Suggested Score:	Minimal Functioning
___ Either vegetation and pools are well-interspersed during high water level, or any woody vegetation bordering the larger pools is located mostly on their north end.[3] Microtopography is quite varied.		___ Vegetation and pools are in separate areas of the site during high water level, and any woody vegetation bordering the larger pools is located mostly on their south end. Microtopography is too flat to allow many puddles to form (no hummocks, etc.)
___ Suitable basking sites for turtles and calling sites for frogs are present		___ There are no basking sites for turtles or calling sites for frogs
___ Land cover in adjoining uplands is a mix of natural grassland and woodland; woodlands have extensive and varied woody debris		___ Land cover in adjoining uplands largely contains impervious surface, bare ground, lawns, and row crops
___ Shorelines are gently sloping		___ Shorelines, if present, are mostly steep
___Busy roads are distant from the site		___ Busy roads adjoin the site
___ Many other wetlands (excluding flowing water) are present nearby		___ There are no other wetlands (excluding flowing water) nearby
___ Water quality is excellent		___ Water is heavily contaminated with pollutants, and/or experiences severe and prolonged oxygen deficits
___ Substrates have never been recontoured or otherwise subjected to compaction, excavation, or leveling. No evidence of severe erosion within the site.		___ Substrates throughout the entire site have recently been recontoured or otherwise subjected to compaction, excavation, or leveling, or the entire site was constructed from upland.
___ Soils and submerged sediments contain a moderately thick organic layer (leaf litter, peat, decomposed organics, etc.)		___ Soils and submerged sediments contain no organic layer, and are mostly hard-packed clay; or organic layer is so thick that water is chronically anoxic.

[1] Emergent herbs with stem diameter of <3 mm (measured 2 inches below springtime water surface); this includes nearly all perennial herbs except cattail.

[2] Areas likely to retain water well into the growing season may have many of these characteristics:

- ___ prevalence of wetland plants (FAC or wetter, and especially OBL)
- ___ intensive mottling & gleying of soils throughout most of the seasonally-inundated zone.
- ___ site is located in flatland terrain (not on slopes)
- ___ extensive microtopographic variation (many hummocks, puddles, etc.)
- ___ absence of outlet channels, and/or site is managed for water storage.

During the January-May period, 30 days of stable water levels are required for some aquatic amphibian eggs to mature, and during this time fluctuations of greater than 2 inches are lethal (Richter 1997).

[3] Vegetation located north of pools is less likely to block sunlight important to developing aquatic amphibians (Richter 1997).

Your Judgments:

Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Breeding Waterbird Support

Highest Functioning	Suggested Score:	Minimal Functioning
___ The site contains many acres of permanent or nearly permanent surface water, or a large permanent wetland (excluding streams) is located nearby AND ___ Water depths are predominantly shallow (2 to 24 inches) in April-August*		___ Surface water is present for only a few weeks during April-June, OR ___ Nearly all of the water remains deeper than 6 ft during May-September AND ___ No permanent wetlands are located nearby.
___ Most of the shoreline is not steep		___ Most of the shoreline is steep
___ Larger pools of water are bordered by a wide, dense band of tall herbs and/or shrubs in April-August.		___ Larger pools, if present, are bordered by only a narrow band of sparse vegetation
___ About equal proportions of water and vegetation are present, and are well-interspersed during the April – August period		___ Vegetation and pools (if any) are in 2 separate areas or zones, not interspersed
___ Water levels do not abruptly rise a foot or more during April-June		___ Water levels are prone to quickly rise at least 1 foot during April-June
___ A large variety of herbs is present; the site is actively managed to control the spread of non-native or invasive species		___ Vegetation cover is mostly comprised of one or a few non-native or highly invasive native species
___ Land cover in surrounding buffer zones is mainly a mix of natural grassland, woodland, and water		___ Land cover in surrounding buffer zones largely contains impervious surface, bare ground, lawns, and row crops.
___ Busy roads are distant from the site		___ Busy roads border the site
___Water quality is excellent		___ Water is heavily contaminated with pollutants
___ Substrates have never been recontoured or otherwise subjected to compaction, excavation, or leveling.		___ Substrates have recently been recontoured or otherwise subjected to compaction, excavation, or leveling (unless such activities were done in connection with restoring a site to its historical condition)
___ Surrounding landscape contains large acreage of wetlands, including some with a different water regime than the assessed site.		___ Surrounding landscape contains no wetlands or ponds
___ Nest boxes, nest platforms, and other artificial structures intended to assist waterbird nesting are extensive and are regularly maintained.		___ No nest boxes, nest platforms, or other artificial structures intended to assist waterbird nesting are present, or they aren't well-maintained.
___ Part of the site is visited infrequently in April-June by humans on foot		___ None of the site is visited frequently by humans on foot during April-June

* Areas likely to retain water well into the waterbird breeding season may have many of these characteristics:

- ___ prevalence of wetland plants (FAC or wetter, and especially OBL)
- ___ intensive mottling & gleying of soils throughout most of the seasonally-inundated zone.
- ___ site is located in flatland terrain (not on slopes)
- ___ extensive microtopographic variation (many hummocks, puddles, etc.)
- ___ absence of outlet channels, and/or site is managed for water storage.

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Wintering & Migratory Waterbird Support

Highest Functioning	Suggested Score:	Minimal Functioning
___ The site contains extensive surface water during all or most of the fall-winter-spring period		___ The site contains very little surface water during all or most of the fall-winter-spring period
___ Water depths in most of the site during most of the fall-winter-spring period are shallow (<24 inches)		___ If forested, water depths during the fall-winter-spring period are always shallower than 24 inches in all of the site (shallower depths are permissible then in unforested wetlands).
___ A large portion of the site is inundated only seasonally		___ Of the water that is present, nearly all is present year-round.
___ The acreage of various depth categories is about equal during peak annual inundation		___ A single water depth category predominates.
___ Microtopographic variation (hummocks, puddles, etc.) is extensive		___ The substrate is very flat, essentially prohibiting the formation of puddles.
___ None of the site is visited frequently by humans on foot during September-April.		___ Water is heavily contaminated with pollutants
___ A large variety of herbs is present. The site is actively managed to control the spread of non-native or invasive species		___ Vegetation cover (except in farmed wetlands) is mostly comprised of one or a few non-native or highly invasive native species
___Water quality is excellent		___ Virtually all of the site is visited frequently by humans on foot during April-June
___ Substrates have never been recontoured or otherwise subjected to compaction, excavation, or leveling.		___ Substrates have recently been recontoured or otherwise subjected to compaction, excavation, or leveling (unless such activities were done in connection with restoring a site to its historical condition)
___ Land cover in surrounding buffer zones is mainly a mix of natural grassland, woodland, agricultural lands, and water		___ Land cover in surrounding buffer zones largely contains impervious surface, bare ground, lawns, and row crops.
___ Surrounding landscape contains large acreage of hydric soil, wetlands, and water, including some with a different water regime than the assessed site.		___ Surrounding landscape contains no wetlands, ponds, or hydric soil.

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Songbird Habitat Support

Highest Functioning	Suggested Score:	Minimal Functioning
___ Some part of the site contains surface water during all (or nearly all) of the year.		___ Surface water is never present at any time of the year.
___ The site contains a large acreage of closed-canopy forest, native shrubland, wet prairie, and/or emergent wetland.		___ Acreage of these is very small.
___ If the site is mostly native shrubland and/or forest, then (a) large-diameter trees are numerous, (b) snags of various sizes are abundant, (c) under-canopy shrub cover is extensive, and (d) a large variety of trees, shrubs and vines is present.		___ If the site is mostly shrubland and/or forest, then (a) trees are very small, (b) snags are absent, (c) under-canopy shrub cover is lacking, and (d) the variety of trees, shrubs, and vines is small, and comprised almost entirely of non-native species.
___ If the site is mostly wet prairie and/or emergent wetland, then (a) a large variety of herbs is present, (b) the site is actively managed to control the spread of non-native or invasive herb species, (c) trees and shrubs, if present, are concentrated in one or a few parts of the site.		___ If the site is mostly prairie and/or emergent wetland, then (a) the variety of herbs is small, (b) the site is not actively managed to control the spread of non-native or invasive herb species, (c) trees and shrubs, if present, are scattered widely throughout the site.
___ Land cover in surrounding buffer zones is predominantly a mix of natural grassland, native shrubland, woodland, wetlands, and water		___ Land cover in surrounding buffer zones largely contains impervious surface, bare ground, lawns, and row crops.
___ None of the site is visited frequently by humans on foot		___ Every part of the site is visited frequently by humans on foot
___ Busy roads are distant from the site		___ Busy roads adjoin the site.

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	.8	.6	.4	.2	0
Highest					Lowest

Function Capacity (Judgmental Assessment of):
Support of Characteristic Vegetation

Highest Functioning	Suggested Score:	Minimal Functioning
___Trees, shrubs, and herbs are all present, and are well-interspersed throughout the site		___ Only one plant form (tree, shrub, herb) is present
___ If trees are present, many are very old and large, with abundant evidence of regeneration		___ If trees are present, all are young
___ If shrubs are present, all of the significantly present shrub species are natives		___ If shrubs are present, they are comprised of just one species, and it is non-native
___ If herbs are present, all of the significantly present herb species are natives		___ If herbs are present, they are comprised of just one species, and it is non-native
___ Microtopographic relief is great (hummocks, puddles, etc.)		___ The substrate is very flat, essentially prohibiting the formation of puddles.
___ Springtime surface water levels drop very slowly (< 2 vertical inches per 30 days, average)		___ Springtime water levels fluctuate or drop rapidly (>2 inches per 10 days, average)

Highest Functioning	Suggested Score:	Minimal Functioning
___ None of the site is visited frequently by humans on foot		___ Every part of the site is visited frequently by humans on foot
___ Busy roads are distant from the site		___ Busy roads adjoin the site.
___ Land cover in the contributing watershed is predominantly "natural"		___ Land cover in the contributing watershed largely contains impervious surface, bare ground, lawns, and row crops.
___ Land cover in surrounding buffer zones is predominantly a mix of natural grassland, native shrubland, woodland, wetlands, and water		___ Land cover in surrounding buffer largely contains impervious surface, bare ground, lawns, and row crops.

Your Judgments:
Function Capacity score = ________, or circle one of the following:

1.0	**.8**	**.6**	**.4**	**.2**	**0**
Highest					Lowest

Now, summarize your function capacity assessments by recording them on the Assessment Summary Form (p. 59). Be sure to indicate that you used the Judgmental Method.

Appendix C. Short Form for Characterizing Potential Impacts

This optional form can be used to inventory human activities that might have already caused physical alteration of a site, or which might place the site at risk of unnatural future change, i.e., features often associated with degradation of wetland/ riparian functions and biological condition. The form does not measure degradation (condition) directly, and you're not asked to judge the importance of the features relative to each other, or the likelihood that any single item will cause detectable impacts. Some of the items are also used for assessing functions, and all require some element of judgment. The form is patterned after one developed and used routinely by the Ohio Environmental Protection Agency. We used parts of this form, along with other information, to select the least altered reference sites. The form could similarly be used in future projects when it is important to determine if selected sample sites adequately encompass gradients of usual human influence. The form also is intended as a tool for *preliminary* screening of sites for management designed to alleviate risks or threats to wetlands, and for identifying sites for possible restoration or conservation.

Site Name:________________________ County: ______________________________

Assessed by: _____________________ Date: ________________________________

HGM subclass(es)*: ____

* if site contains multiple subclasses, estimate percent of each

1. Is the site part of a larger contiguous wetland or riparian area? ___Yes ___No

2. How much of the site was <u>non</u>-wetland & non-riparian,
…and physically became wetland within last 5 years? _______% before then? _______%
Year created, if known: __________

3. How much of the site belonged to a different HGM subclass than it does currently (riverine flow-through riverine impounding, depressional, slope/flat),
…and was altered to the current class within last 5 years? ______% before then? ______%
Which subclass did it formerly belong to? ____
Year altered, if known: __________

4. How much of the non-wooded part of the site was once wooded?
…and woody vegetation was removed within last 5 years? ______% before then? _______%
Year(s) cut, if known: __________

5. Do soil profiles suggest previous alteration of the site's soils by humans? ___Yes ___No
Describe:
____

____

For each of the items below, in the second column: Circle "0" if absent or untrue. Circle "1" if <10% of site is physically affected. Circle "2" if >10% of site is physically affected. Circle "3" if all the site is physically affected.		And was altered or constructed within last 5 years?	And was altered or constructed only before last 5 years?
	How much hydrologic/ topographic alteration, attributable to human activities, has occurred within site?		
6.	___flow-impounding – berms, dikes, water control structures	0 1 2 3	0 1 2 3
7.	___flow-impounding – pits, excavations	0 1 2 3	0 1 2 3
8.	___flow-redirecting – straightened channels, berms	0 1 2 3	0 1 2 3
9.	___drainage-inducing – ditches, tile	0 1 2 3	0 1 2 3
	How much physical alteration is there to soil or to natural vegetation within site, as a result of human activities, from:		
10.	___ soil-compacting -- fill, machinery, cows, trails	0 1 2 3	0 1 2 3
11.	___ soil-mixing -- plowing, etc.	0 1 2 3	0 1 2 3
12.	___ soil leveling	0 1 2 3	0 1 2 3
13.	___ mowing or extreme grazing	0 1 2 3	--
	Do flows or water levels onsite differ from unaltered condition due to:		
14.	___ upstream water control structures (human-built)	yes no	
15.	___ discharging pipes (e.g., stormwater)	yes no	
16.	___ ditches located offsite	yes no	
17.	___ drains (e.g., buried tile) located offsite	yes no	
18.	___ surface water pumping (e.g., for irrigation)	yes no	
19.	___ severely downcutting or straightened channels	yes no	
20.	___ other factors (specify: ___________________)	yes no	

In the **contributing watershed** (the lands that supply runoff, groundwater, or channel flow to the site), estimate % occupied by each land cover within the specified distance upslope and upstream. If surrounding topography is completely flat, estimate distances in a circle around the site. The accompanying CD-ROM may be helpful for estimating land cover in 1000 ft. and 1-mile zones. Lump categories if uncertain.

		Within 200 ft.	Within 1000 ft.	Within 1 mile
21.	Wooded (tree/shrub)	%	%	%
22.		%	%	%
23.	Lawns + irrigated crops (e.g., vegetables)	%	%	%
24.	Non-irrigated crops	%	%	%
25.	Wild grass and herbs	%	%	
26.	Paved surfaces + buildings	%	%	%
	Other: ___________________	%	%	
		100 %	100 %	100 %

28.	Does the site receive surface water from a water body listed on Oregon's 303(d) list? Name of water body: ___________________________	yes no
29.	Percent of the site that is visited by humans on foot: (Potential for disturbance of wildlife by human visitation.) multiple times a day? (i.e., >365 days/yr) 1 once daily only? (i.e., 84 – 364 days/yr) 2 weekly only? (i.e., 23 - 83 days/yr) 3 monthly only? (i.e., 2- 22 days/yr) 4 annually or less? (i.e., <2 days/yr) 5 "Visit" means to come within 100 ft. of that part of the site. Assume estimates are for the average annual condition. Now calculate disturbance score as explained on page 72:	 _________% _________% _________% _________% _________% = ________
30.	Potential disturbance by vehicular traffic. Distance to nearest road with approx. >6 vehicles/minute: Distance to nearest road with approx. 1-5 vehicles/minute: Distance to nearest road with approx. <1 vehicles/minute: Measure distances from upland edge of the site. Look no farther than 1 mile. Assume traffic rates are weekly maximum.	 _________ft _________ft _________ft

Describe any other features you noticed impacting the site physically or chemically:

____

____

____

____

____

____

____

Appendix D. Rationales for Function Indicators and Scoring Models

This appendix describes, by function, why particular indicators were (or were not) used. It also describes the logic behind each function model. When available, literature pertaining to the indicator is cited. Citation does not always mean the cited authors unequivocally *proved* the associated statement, but rather that the cited study addressed that topic and in most instances provides some empirical support. Almost all of the cited literature is from the Pacific Northwest. The rationales are kept brief so this volume will be sufficiently compact for field use. Additional justification for these or similar indicators can be found in Adamus et al. (1992) and Adamus (2001).

Water Storage and Delay (indicators and model on p. 21)

The configuration of the scoring model is intended to give equal weight to depth and area because volume of surface water is defined by hydrologists as basically the depth multiplied by area (Dunne and Leopold 1978). Indicator A represents area and indicator B expresses depth of seasonal inundation[1]. Division by the specified coefficients is used to standardize the Function Capacity Score to a 0-to-1 scale. The divisor "1" is the highest score found among all the RI reference sites, among all the least-altered RI sites, and among all the SF sites. The divisor 0.85 is the highest found for this function among the least-altered SF sites. Following are variables and indicators – some quite important to this function -- that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	**Why Excluded from Reference-based Assessment:**
• Duration and frequency of seasonal inundation. • Water retention (residence) time.	Very important but cannot be determined for most sites without regular visits. Although county soil surveys categorize soil series according to duration and frequency of flooding, these are of insufficient accuracy when applied to most individual wetland sites, due to high spatial variability within mapped soil survey polygons.
• Height of water above lowest point of main outlet • Shape (constrictedness) of main outlet • Overall slope of retention basin • Ratio of wetland area to area of its contributing watershed • Landscape position, e.g., headwater vs. mainstem • Extent of channelization and drainage within the site	While meaningful, these indicators are less direct estimators of residence time and live storage than the indicators included. They may be unnecessarily redundant, and their effect is often overridden by water management practices onsite. Nonetheless, they may be used during site visits to help assess the indicators used above.
• Water source	If groundwater is a primary water source, it may keep the site's soils saturated for long periods, during which they are unable to detain additional water from runoff or rainfall. However, for most sites it is impossible to determine during a single visit if groundwater, runoff, or precipitation is the predominant water source.

[1] The letters (e.g., A, B, etc.) correspond to the letters in the first column of the indicator table for this function in Section 3.

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment:
• Texture of soil or sediment	Although texture influences infiltration of surface water and discharge of groundwater (coarser sediments favoring both), the effect on water storage of texture in the upper 12 inches of a site's soils is probably minor when compared with other factors affecting storage, and in any case infiltration is unlikely to vary greatly among the types of hydric soils occurring in this region.
• Evapotranspiration	Sites with large open expanses can dissipate water via evaporation, and sites with vegetation (especially young shrub communities) can dissipate water via transpiration (Snyder & Brownell 1996). However, in Pacific Northwest wetlands, water losses from these processes are relatively minor (Reinelt & Taylor 1997), and are impossible to estimate during a single visit.
• Tree basal area & density • Percent of seasonally-inundated area that contains woody vegetation.	Woody vegetation that intercepts flood currents can delay runoff because it provides frictional resistance (roughness) and transpires water. However, current velocities in the 2 hydrogeomorphic subclasses featured in this Guidebook are negligible, so this role of woody vegetation is minor.
• Percent non-wetland species, or cover dominance of these (as indicator of shorter duration of inundation)	Some sites with few wetland plant species store water only briefly but store a large volume during that time, so it cannot be assumed that sites with few wetland plants store little water. Conversely, some sites with many wetland species (especially obligates) are filled with surface water much of the time so have little room for additional storage. Also, many sites contain a large proportion of species whose affinity for wetlands and tolerance of flooding is unknown.

Sediment Stabilization and Phosphorus Retention

(indicators and models on p. 21)

The score from the previous assessment of Water Storage & Delay function (A) is used to grossly represent water residence time, a crucial determinant of sediment and phosphorus retention (Johnston 1991). Particularly in slope/flats sites, the extent of microtopographic variation as represented by (B) is used both to indicate residence time and to represent the extent of contact between water and vegetation, which also influences sediment retention and phosphorus uptake. The contact between water and vegetation is also represented by indicator C, and the maximum of B or C is taken in order to account for the possibility that B was not estimated (as it would not be in RI sites). Soil clay content, another key factor influencing phosphorus adsorption (Meyerhoff 1976, Simmons 1981, Aumen et al. 1990, Miller 1987) and a reflection of the current or past presence of depositional conditions, is represented by identifying the most prevalent soil texture (D). However, the ability of soil to adsorb phosphorus can be reduced if soil water residence time is reduced, such as by soil compaction (E) or leveling (F), or if wind erosion is promoted by plowing (G). The minimum scaled value is used because this function would likely be limited by whichever of these altering activities is greatest at a site. Bare ground in the seasonal zone (H) reflects a lack of herbs and shrubs that intercept and filter suspended sediments from shallow runoff, and which take up phosphorus seasonally (Geiger et al. 1993, Niswander 1997) and/or which protect deposited sediments from being eroded by wind and water. Although erosion can occur in either the saturated or seasonal zones, plant cover is more often limited within the seasonal zone, and erosive forces are often greater, so bare ground in that zone is used as the indicator.

Division by the specified coefficients is used to standardize the Function Capacity Score to a 0-to-1 scale. The divisor 3.45 is the highest score found among all the RI reference sites, and the divisor 3.75 is the highest found for this function among all SF sites. The divisor 2.7 is the highest found among the least-altered RI, and 2.9 is the highest score found among the least-altered of the SF reference sites. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Land use, slope, soil type, buffer width, and measured sediment/ phosphorus loads in the *contributing watershed* or groundwater. • Primary water source for the site.	These variables address opportunity to perform the function. They play little or no role in determining effectiveness, which is what is measured by the HGM approach.
• Flow path length • Flow path and water source location (surface or subsurface) • Dispersal of any flow throughout the site (i.e., sheet flow rather than channelized) • Current speed, stream power • Average depth of soil litter	Too difficult to estimate objectively or meaningfully during a single site visit.
• Water depth	Shallow water depths usually allow for greater plant-water contact and phosphorus uptake. However, deep water depths also are important because they are typically associated with longer water residence times. Suspended sediments and phosphorus in sites with long water residence times can be effectively removed below the zone of potential wind-mixing by gravity settling.
• Percent of site that is vegetated	Although vegetation is an important seasonal sink for phosphorus and sediment, deep water that lacks vegetation is also important.
• *Predominant* plant species, seral stage, or cover type	Although different plant species, seral stages, and cover types undoubtedly differ in their capacity to take up phosphorus, filter sediment, resist lethal effects of sedimentation, and form hummocks that delay runoff, such data are lacking for most local species, seral stages, and cover types.
• Number of vegetation strata • Plant species richness	Although these should perhaps be positively correlated with sediment stabilization and phosphorus retention, there are no regional data to support this.
• Growing season length	Although important to plant uptake of phosphorus, this variable does not change much geographically within the Willamette Valley ecoregion.
• Tree basal area & density	Although trees (not just herbs & shrubs) help stabilize substrates, capture and retain sediment, and remove phosphorus from the water, they are less effective at doing so. In fact, by shading the understory, trees sometimes preclude the proliferation of herbs & vines, leaving soils exposed to scouring forces.
• Visual evidence of recently deposited sediment	Presence of deposited sediment is influenced at least as much by availability of external sediment sources, which do not affect the effectiveness (capacity) of a site to store or stabilize sediment.

Nitrogen Removal (indicators and models on p. 23)

Denitrification – the microbial process primarily responsible for wetlands removing nitrogen – occurs especially where oxygen-poor sediments or water come in contact with the air or with oxygen-rich water. Such conditions are often most prevalent along the rising and falling edges of inundation. That is because rainwater and floodwaters are more oxygen-rich than groundwater or surface waters that have stood for longer periods within a site. When "fresher" waters come in contact with oxygen-poor "older" waters, denitrification occurs almost instantly and continues until supplies of available nitrate in the source water have been exhausted.

The model requires that the presence of soil mottling or other indicators of periodically oxygen-poor conditions be observed, because without such indicators, it is unlikely denitrification is occurring to any significant degree (Laurent 1979, Gold et al. 2000). The percent of a site that is inundated only seasonally (A) and the difference between high and low *predominating* water depths (B) are used to represent the extent of a moving water edge where oxygen-poor conditions are likely to come in contact with oxygen-rich conditions over extended time periods, especially if water level fluctuations are large. The overall *amount* (not rate) of denitrification that occurs will be greatest if the location of the oxygen poor/rich edge within a site shifts slowly within a season, thus ensuring that a more sustained supply of nitrate is made available to be denitrified. Soil porosity is important to denitrification (Fernald et al. 2000), and activities that have compacted a soil (C) potentially reduce the surface area available to denitrifying bacteria (Myrold 1988). Denitrification also requires adequate supplies of available carbon for direct use by denitrifying bacteria as an energy source (Baumeister 1992). Because organic material in sediments tends to be less in sites that contain a proportionally extensive permanent zone and sites created from upland (D) (Shaffer & Ernst 1999), lower rates of denitrification are expected in most such sites. In the above model for wooded sites, the number of kinds of downed wood (E) and diameter of the largest trees (F) are also used as gross indicators of the maturity of a site and hence, the relative level of available carbon in the soil (e.g., Entry & Emmingham 1998).

Nitrogen also is removed from a site (although temporarily) as plants take up nitrogen to meet their nutritional needs (Brown 2000). Plant uptake is presumably greatest when supplies of waterborne nitrate are regularly replenished, as occurs when a large proportion of a site's surface water is in contact with plants as well as with the algae and microbes associated with them (Dieterich 1993, Gregory 1993, Scherer 1995). The potential for this vegetation-water contact is represented by a site's microtopographic variation, e.g., "puddling" (G) which can be destroyed by soil leveling (H). The potential for vegetation-water contact also is greater at sites with permanent pools that are scattered widely within the site (I)(Geiger et al. 1993). Finally, nitrogen may be removed from a site as particulate material (smoke) by burning its vegetation or by harvesting the vegetation (J), although in the year immediately following, less nitrogen may be removed due to the resulting paucity of plant cover.

Division by the coefficients specified above is used to standardize scores the Function Capacity Score to a 0-to-1 scale. The value 5.2 is the highest score found among all RI reference sites, and 5.0 is the highest among the least-altered RI sites. The value 4.15 is the highest score found among all SF reference sites, and 4.05 is the highest among all SF sites that are both currently and historically not wooded, e.g., prairies. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	**Why Excluded from Reference-based Assessment**
• Percent of site containing soils with mottling or other indicators of anoxia.	Although mottling and similar features are fairly easy to recognize, their spatial extent within a site is difficult to estimate without extensive soil sampling.
• Intensity of soil mottling or other indicators of anoxia.	The vertical extent and intensity of anoxia (e.g., darkness of soil matrix, extent of gleying) does not necessarily equate to greater rates of denitrification. Anoxia can be so severe that denitrification competes with dissimilatory nitrate reduction, a process which is less effective in removing nitrate from the soil.
• Availability of organic carbon to denitrifying bacteria • Sustained supply of nitrate	Not possible to determine in context of a rapid assessment method, although one study suggests greater nitrogen availability in areas dominated by herbs rather than woodland (oak) (Brown 2000).
• Number of vegetation strata • Plant species richness	Although botanically diverse wetlands may take up nitrogen over a longer seasonal period, indicators relating to microtopographic variation address this by implying that greater plant form diversity will be present in more topographically varied sites.
• Land use, slope, soil type, buffer width, and measured nitrate loads in the *contributing watershed* or groundwater. • Primary water source for the site. • Flow path length • Flow path and water source location (surface or subsurface) • Current speed, stream power • Average depth of soil litter • Water depth • Growing season length	See reasons for exclusion under previous functions (p. 102)

Thermoregulation (indicators and models on p. 26)

Summer is when surface waters are most vulnerable to reaching temperatures lethal to some aquatic animals. Thus, site conditions at this season are most important to this function. Where permanent water is present, increasing shade (A) cools or maintains the temperature of the water column (Beschta et al. 1987, Beschta and Taylor 1988, Shaw & Bible 1996, McNamara et al. 2000, Risley 2000), as does increasing water depth (B).

Division by 0.7 is used to standardize the Function Capacity Score to a 0-to-1 scale. The value 0.7 is the highest score found among all partly-shaded RI sites with permanent water. None of the least-altered riverine sites contained both permanent water and shade, so the coefficient for all sites (0.7) is used. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	**Why Excluded from Reference-based Assessment**
• Plant species	Although plant species vary with regard to their light transmissivity and thus ability to shade the water, transmissivity data are lacking for many plants.
• Water source • Presence of springs	Although sites with large groundwater inputs are better able to maintain temperatures and offset solar heat gain, the relative magnitude of groundwater inputs cannot be estimated during a single site visit.

Primary Production (indicators and models on p. 26)

Soil compaction (A) is a well-documented inhibitor of plant production, inasmuch as it can reduce water holding capacity and restrict seed germination. On an annual basis, primary production is presumably greatest in sites that contain trees, shrubs, and herbs (B)– or a diversity of plant species that correlates with this diversity of plant forms (Binkley 1984, Veldhusien 1990, Gregory et al. 1991). The foliage of different plant forms and species "greens up" and dies back according to different seasonal schedules (phenologies). Such a diverse schedule helps ensure that production occurs continually through the growing season. The patchiness of these forms is also important, inasmuch as it implies more widespread penetration of light into the forest understory, and consequently higher production of any forested parts of the site. In many parts of Oregon, soil moisture in late summer probably plays a key role in sustaining primary production of wetland vegetation, even though native species are adapted to some degree to drought (Boss 1983, Otting 1998). The extent of permanent water (E), especially if distributed evenly throughout a site, is used to represent the potential availability of late summer soil moisture. Puddles at other seasons (C,D) also would be expected to support highly productive communities of algae, further diversifying the scheduling of seasonal photosynthetic peaks. Unnatural watershed disturbance (F) is presumed to diminish primary production by stressing individual plants, e.g., altered timing of seasonal moisture availability, increased turbidity that limits depth of solar penetration into the water column, increased mortality due to burial by sediment (Ewing 1996), and increased scouring of young plants. Finally, the percent of the seasonal zone that is bare during most of the dry season (G) is a very direct indicator of diminished primary production.

Division by the specified coefficients is used to standardize scores the Function Capacity Score to a 0-to-1 scale. The value 4.55 is the highest score found among all RI reference sites, and 4.25 is the highest among the least-altered RI sites. The value 3.8 is the highest score found among all SF reference sites, 3.7 is the highest among all SF sites that are both currently and historically not wooded, and 3.65 is the highest score among such sites that also were the least altered. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	**Why Excluded from Reference-based Assessment**
• Fertility and available water capacity of soils	Although important to productivity, these factors cannot be assessed rapidly, nor can they be reliably assumed from standard soil survey maps. Fertilization may stimulate growth of herbs at the expense of woody species (Wilson & Wilson 1995).
• Nutrients from runoff or groundwater	Difficult to assess objectively with a rapid assessment method, and importance relative to onsite cycling of nutrients is uncertain.
• Densities of soil mycorrhizae	Although important to seed germination and production, cannot be assessed by a rapid assessment method.
• Soil texture	Although plant production tends to be greater in clay loam and sandy loam soils than in heavy clay soils, it is uncertain whether this pertains to wetland-associated plants in particular, for which risk of summer drought is also an important factor.
• Plant species richness	Although high richness is sometimes associated with intermediate seral stages that have characteristically high productivity, it is also true that some monotypic plant communities are highly productive, at least in the short term.
• Plant species • Percent non-native species	Although there are genetic differences among species with regard to their capacity for primary production, data are insufficient to rank most species in that manner, or to conclude that non-native plants are more or less productive than natives.

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Shade from trees	Although understory productivity is lower in shaded areas, the trees providing the shade can themselves be very productive.
• Water depth	Although deep water is less productive, depths >2m are unlikely to be extensive in wetlands.
• Diameter of largest trees • Number of types of dead wood	Although they may indicate locations with a high potential for productivity, "mature" sites are not necessarily the most productive sites at the time they are assessed. Intermediate seral stages are typically more productive.
• Seedling density and recruitment rates • Visual signs of reduced plant vigor • Abundance of nutria (Wentz 1971), geese, or other aggressive herbivores	Although sometimes important, these indicators of site productivity cannot be assessed in a rapid, repeatable, statistically-sound manner during a single visit.
• Seral stage • Extent of natural disturbance (patches)	Although early successional stages often produce more aboveground plant material, older successional stages may perhaps be as productive when their belowground production and microbial production are included.

Resident Fish Habitat Support (indicators and models on p. 28)

Predominant depths of 2-6 ft (A, B) are favorable to many native fish because such depths generally have high primary productivity while being too deep for some avian predators, e.g., herons. The presence of a permanent surface connection to other water bodies (C) can be beneficial to most native fish because it expands the potentially inhabitable area (Li et al. 1983, Kruse 1988). Areas that are inundated only seasonally (D) often provide resident fish with rich feeding habitat during the time they are flooded. Logs, boulders, and other underwater cover (E) shelter fish from predators as well as supporting higher densities of aquatic invertebrates upon which fish feed (Baker 1979). Unnatural watershed disturbance (F) potentially diminishes habitat quality for resident fish because it alters timing of runoff (which can impact spawning and recruitment). It also is associated with contamination of waters with excessive nutrients and toxic pollutants (Dimmick & Merrifield 1945, Hughes & Gammon 1987).

Division by 4.4 or 4 is used to standardize the Function Capacity Score to a 0-to-1 scale. The value 4.4 is the highest score found among all RI sites with permanent surface water, and 4 is the highest score found among the least-altered RI sites with permanent surface water. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Observations or reports of native fish. • Fish harvest or stocking data • Water quality data	Data not available for all sites due to non-uniform survey efforts. Selective inclusion of data creates undesirable bias.
• Extent of underwater cover • Densities of predators (e.g., bullfrog, birds, other fish)	Impractical to assess realistically without specialized equipment
• Shoreline shape (irregularity)	Importance to fish not supported by data from sites the size of ones encountered in Willamette Valley

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• upstream water control structures • discharging pipes • surface water pumping	Effect depends on how these features are managed, e.g., volume of water controlled relative to volume of water in wetland and timing of alteration

Anadromous Fish Habitat Support (indicators and models on p. 29)

The scoring model is configured so as to give equal weight to indicators related to type of connection to other surface waters (A), extent of seasonal water (B), cover (C, D, E, F), and water quality (G). Virtually all sites in the riverine impounding subclass contain a connection to other surface waters, at least seasonally. The importance to anadromous fish of various types of surface hydrologic connections is supported by recent research in restored and natural floodplain sites in the Willamette Valley (P. Bayley, Oregon State University, *pers. comm.*). The importance of woody debris (E) as fish cover and a source of invertebrate foods has been frequently documented (Anderson et al. 1978, Sedell et al. 1988, Triska & Cromack 1979, Naiman et al. 1992, Gude 1994), as has the importance of vegetation interspersed with surface water (C,D), although most prior studies are from small high-gradient streams. Indicator F, the number of types of deadwood, is also used to represent the potential availability of woody cover within the floodplain. Watershed land cover (G) has been demonstrated to influence salmonid habitat in the Pacific Northwest (e.g., Richey 1982, Steward 1983, May et al. 1997, May & Horner 2000).

The divisors 5.9 and 5.5 are used to standardize the Function Capacity Score to a 0-to-1 scale. The value 5.9 is the highest score found among all RI sites with fish access, and 5.5 is the highest score found among the least-altered RI sites with fish access. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Observations or reports of anadromous fish. • List of anadromous fish streams • Fish harvest or stocking data • Water quality data	Data not available for all sites due to non-uniform survey efforts. Selective inclusion of data creates undesirable bias.
• Permanent water extent • Number of water depth categories	As long as a connection to another water body exists, these variables are not especially important to salmonids, which use the seasonal zone extensively.
• Timing & duration of flooding • Extent of underwater cover • Salmonid access between ocean and this site • Densities of predators (e.g., bullfrog, birds, other fish)	Impractical to assess realistically without specialized equipment or expertise, and/or without more than a single visit.
• Channel sinuosity • Gravel embededness • Bottom sediment particle size	Relevant primarily to another subclass (Riverine Flow-through), not to Riverine Impounding subclass sites.
• Upstream water control structures • Discharging pipes • Surface water pumping	Effect depends on how these features are managed, e.g., volume of water controlled relative to volume of water in wetland and timing of alteration, and this is generally unknown.
• Extent of acidic *Sphagnum* bogs • Concentrations of tannins	Not an important indicator in these subclasses and ecoregion

Invertebrate Habitat Support (indicators and models on p. 31)

Multiplication (A x B) is used because permanent water (A) is of little value to invertebrates if it does not fluctuate seasonally, and seasonal water level fluctuation (B) is less valuable to invertebrates if the site lacks any permanent surface water. Sites that contain both areas that are inundated only seasonally (B) and areas that contain some permanent water with vegetation (A) are often the most productive for invertebrates, because during inundation the seasonal areas are "inoculated" with invertebrates that have survived the summer in the species-rich permanent pool (Tew 1971, Dieterich 1993, Ludwa & Richter 2000). These invertebrate populations multiply exponentially once additional fertile habitat space becomes available through flooding (DeSzalay et al. 1999).

Sites that lack fish or are visited by fish only briefly tend to have greater invertebrate diversity and abundance, especially if they also contain a permanent pool (Batzer et al. 1999). Indicator C is used to represent this. Areas flooded shallowly (<2 ft) throughout the summer (D) are important because production of algae and macrophytes is greatest in that depth range. Pooled areas are especially important when interspersed with vegetation (E) which provides invertebrates with shelter and feeding sites. Other indicators of microhabitats productive for invertebrates, at least seasonally, include the extent of puddling (F) or the converse, the extent of soil leveling (G). Isolated, seasonally-inundated areas often support high densities of invertebrates due to lack of predatory fish. Compaction of soils (H) is obviously detrimental to the many invertebrates that spend all or part of their lives underground. The indicator, "mapped soil series is hydric" (I), is included to reflect likelihood of there being occasional ponding that extends beyond the assessment site. Sites whose soils are merely a hydric inclusion within a non-hydric map unit are perhaps less likely to have ponding in adjoining soils, and thus would provide less seasonally inhabitable space for invertebrates. Soil organic content is important to supporting a diversity of soil invertebrates, but tends to be less in created wetlands (J) (Shaffer & Ernst 1999). A diversity of vegetation forms (K) probably supports greater diversity of invertebrates because the leaves from various forms (trees, shrubs, herbs) decay at different rates, thus providing detritivorous invertebrates with sustained and varied food sources, especially if these food sources are well-distributed throughout a site. Alteration of natural land cover around wetlands (L) reduces the source of insects that can colonize a site following natural or human-related disturbances (Anderson and Vondracek 1999), and alteration of land cover in the *contributing watershed* (M) often diminishes invertebrate diversity onsite partly as a result of reduced water quality (Fore et al. 1996, Ludwa and Richter 2000).

The divisors are used to standardize the Function Capacity Score to a 0-to-1 scale. The value 4.56 is the highest score found among all RI sites, and 4.53 is the highest score found among the least-altered RI sites. The value 4.11 is the highest score found both among all SF sites and among the least-altered SF sites. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	**Why Excluded from Reference-based Assessment**
• Observations of dragonflies or other aquatic invertebrates/ insects • Water quality	Data not available for all sites due to non-uniform survey efforts. Selective inclusion of data creates undesirable bias.
• Timing & duration of inundation • Extent of underwater cover	Impractical to assess realistically without specialized equipment or expertise, and/or more than a single visit.

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Densities of predators (e.g., bullfrog, birds, other fish)	
• Channel sinuosity • Gravel embededness • Bottom sediment particle size	Relevant primarily to another subclass (Riverine Flow-through), not to Riverine Impounding or Slope-Flat subclass sites.
• upstream water control structures • discharging pipes • surface water pumping	Effect depends on how these features are managed, e.g., volume of water controlled relative to volume of water in wetland and timing of alteration, and this is generally unknown.
• Proximity of site to a wetland of different HGM or hydroperiod class	Wetland maps of adequate resolution are not available, and determinations would be time-consuming. This indicator is approximated by indicators related to % wetlands and water in surrounding landscape
• Extent of acidic *Sphagnum* bogs • Concentrations of tannins	Not an important indicator of invertebrate habitat function in these subclasses and ecoregion

Amphibian and Turtle Habitat Support (indicators and models on p. 34)

These configurations of the scoring model are intended to give approximately equal weight to the contribution of onsite hydrologic factors (indicators A through F), woody cover (G through J), herbaceous cover (L, M), site alterations (K), landscape disturbance (N, O), landscape diversity (P), and water quality influences (Q).

Shallow pools provide essential breeding habitat to amphibians, and their distribution and likelihood of occurrence during critical seasonal periods can be represented grossly by indicators A through C. The indicator, “mapped soil series is hydric” (D), is included to reflect likelihood of there being occasional ponding that extends beyond the assessment site; sites whose soils are merely a hydric inclusion within a non-hydric map unit are perhaps less likely to have ponding in adjoining soils, and thus would be less attractive to some amphibians. Stable water levels during springtime have been demonstrated to be of critical importance to amphibians that attach their eggs to emergent vegetation (Richter and Azous 1995), as well as to western pond turtle (Holte 1998). Indicator E is used as a gross indicator of springtime water level stability. Soil compaction (F) is detrimental to many burrowing salamanders and egg-laying turtles. The importance to basking turtles of logs and boulders that protrude above the surface of permanent water (G) is widely recognized (Holland 1994). At historically wooded sites, the number of kinds of downed wood (H) and diameter of the largest trees (I) are used as gross indicators of the abundance of a diverse, sustained supply of rotting wood and thick soil organic layer important to many salamanders (Butts & McComb 2000). Also, because permanently inundated sites and sites created from upland (K) tend to contain less organic material in their sediments (Shaffer & Ernst 1999), lower suitability for amphibians is expected in most cases. Herbaceous vegetation, especially comprised of flexible thin-stemmed species, is preferred for egg attachment sites by aquatic salamanders and frogs in this region (Richter 1997). If inundated only seasonally, such egg sites may provide some refuge from fish and bullfrogs that otherwise may prey upon the hatchlings (Adams 1997, Adams 1999, Adams 2000, Kiecksecker & Blaustein 1998). Perhaps equally important is the amount of herbaceous vegetation that is partly submerged year-round (L), because such vegetation also provides cover for hatchlings. As salamanders and frogs mature, many disperse into surrounding areas in search of unoccupied habitat. During these dispersal movements they cross roads in large numbers and are vulnerable to being killed by vehicles, as represented by site distance to nearest busy road (M)(Gibbs 1998).

When undeveloped land cover surrounds a site (O) it also provides some measure of protection (e.g., Richter & Azous 1995). In Willamette Valley oak woodlands, amphibian abundance was found to be correlated with riparian acreage within 1 km, and even the abundance of reptiles was correlated with acreage of open water in the vicinity of the oak sites (Vesely et al. 1999). Removal of forest cover as far as 156 m away from breeding ponds can affect amphibian dispersal movements (Raymond & Hardy 1991), which for many species span a distance of at least 300 m. Moreover, unaltered vegetated buffers might intercept airborne or waterborne fertilizer from agricultural fields before it enters wetlands. Amphibians in the Willamette Valley have been shown to be very sensitive to typical levels of nitrate (Marco et al. 1999). Removal of woody cover by clearcuts also can adversely affect amphibian populations (Martin 1998, Cole et al. 1999). In the Oregon Coast Range, riparian buffers of 40 m width have been found to have twice the amphibian richness as buffers of 20 m (Vesely 1997). Nonetheless, a totally wooded buffer zone is not always desirable because interspersion of woodlands with unshaded, warmer microhabitats, whether within the site (M) or immediately surrounding (Q) is important to western pond turtle and some aquatic salamanders (Murphy and Hall 1981, Murphy et al. 1981, Hawkins et al. 1983, Cowie 1997).

As noted above, the stability of water levels and substrate is crucial to many species. Sites with undeveloped watersheds (P), especially where pavement occupies 10% or less of the contributing area (Booth 1990, 1991, Booth & Jackson 1994), tend to have water levels and substrates that are fairly stable. Above this threshold (and especially above 20% coverage by pavement), channel downcutting and associated biological impacts occur much more extensively in the Pacific Northwest, unless water control structures are installed and appropriately managed.

The divisors are used to standardize scores the Function Capacity Score to a 0-to-1 scale. The value 6.44 is the highest score found among all RI reference sites, and 6.3 is the highest among the least-altered RI sites. The value 5.97 is the highest score found among all SF reference sites, as well as among the least-altered ones, that historically were wooded. The value 5.6 is the highest score found among all historically non-wooded SF sites, and 5.58 is the highest among the least altered of the historically non-wooded sites. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Observations or reports of bullfrogs or other amphibians or turtles • Water quality data	Data not available for all sites due to non-uniform survey efforts. Selective inclusion of data creates undesirable bias.
• Number of water depth categories • Channel connection to other water bodies	Implicitly assigns greater importance to sites with permanent water. This is undesirable to native amphibians because permanent water sometimes encourages expansion of non-native bullfrog populations.
• Shoreline slope	Difficult to assess objectively for an entire site, and mostly addressed by the indicator pertaining to distribution of pools
• Timing & duration of inundation • Rate of water level fluctuation • Water velocity in springtime • Extent of underwater cover • Amount of downed wood • Extent and thickness of underwater organic/ detritus layer	Although very important, these variables are impractical to assess without specialized equipment or expertise, and/or require more than a single visit.

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Percent of plant species that are wetland-associated, or cover dominance of these (as indicator of longer duration of inundation)	Some sites contain a large proportion of species whose affinity for wetlands and tolerance of flooding is unknown. A predominance of obligate and facultative-wet plant species may only signal the occurrence of permanent water, which does not benefit all amphibians.
• Water pH (acidity)	Not an important indicator in these subclasses and ecoregion
• Upstream water control structures • Discharging pipes • Surface water pumping	Effect depends on how these features are managed, e.g., volume of water controlled relative to volume of water in wetland and timing of alteration, and this is generally unknown.
• Number of major plant forms within site	Found to be relatively unimportant to amphibians in a study of wetlands in the Seattle area (Richter and Azous 1995).
• Solar exposure (permanent zone is mostly unshaded)	Important to turtles and some frogs, but opposite is true of many adult salamanders
• Corridor dimensions, connectivity, perimeter buffer width	Very scale-dependent and difficult to measure meaningfully (Schuft et al. 1999). Another indicator (Percent of natural land cover within 200 and 1000 ft radii) mostly addresses this.
• Percent of surrounding land cover that is water or wetland	Existing land cover maps do not adequately depict the many small seasonal pools that are important to this function

Breeding Waterbird Support (indicators and models on p. 37)

During the summer nesting period, herbaceous vegetation cover – especially when interspersed with water -- is important to fledglings of most waterbird species, and this is represented by indicators A and F. Gentle shoreline slopes during late spring are important for waterbird nesting and feeding, and are represented indirectly by describing depth category distributions (B) and the number of depth categories (C) as they exist prior to nesting, i.e., during wintertime high water periods. The average of indicator B or C is used because field data for B were not available from all reference sites. Summertime water depths of 2-24 inches (D) attract the most waterbirds because productivity of such waters is often high (Weller 1999). Some nesting waterbird species tolerate little or no water level fluctuation (Richter & Azous 2000), which can be represented partly by the difference between the wet-season and dry-season *predominating* water level (E). Vehicle traffic, represented by indicator G, also poses a hazard to fledglings. Nesting waterbirds – especially the larger species – are sensitive to frequent close approaches by humans on foot (H), although to some degree this can be mitigated by ready availability of nearby water (I, J) to which birds can temporarily escape (Richter and Azous 2000), as well as by the presence of buffer zones of natural (not necessarily wooded) vegetation (K).

The divisors are used to standardize the Function Capacity Score to a 0-to-1 scale. The value 8.2 is the highest score found among all RI sites, and 5.65 is the highest score found among the least-altered RI sites. The value 5 is the highest score found among all SF sites, and 4.6 is the highest among the least-altered SF sites. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Observations or reports of breeding waterbirds (e.g., nests, rookeries) • Water quality data or water body condition ratings	Data not available for all sites due to non-uniform survey efforts. Selective inclusion of data creates undesirable bias.
• Timing & duration of inundation • Rate of water level fluctuation	Although very important, these variables are impractical to assess without specialized equipment or expertise, and/or require more than a single visit.

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Number of snags suitable for cavity-nesting waterfowl	Although important, this variable is impractical to assess accurately during a single visit. Snags are often concealed by other vegetation, and snags located offsite can be used just as much as snags located onsite.
• Upstream water control structures • Discharging pipes • Surface water pumping	Effect depends on how these features are managed, e.g., volume of water controlled relative to volume of water in wetland and timing of alteration, and this is generally unknown.
• Ranking of plant species according to typical seed production and consumption by waterbirds, and suitability for nest support/ concealment	Although important differences exist among plant species, these have not been quantified for most of the wetland plant species in the Willamette Valley ecoregion.
• Nest boxes and nest platforms	Often are concealed, and difficult to tell if they are in working condition
• Percent canopy closure in permanent zone (Barker & Sackinger 2000)	Although many nesting waterbirds shun sites with closed canopies, a few others (e.g., wood duck) prefer these.
• Number and patchiness of plant forms (trees, shrubs, herbs) • Complexity of wetland-upland edge	Of minor importance to most nesting waterbirds in this ecoregion, and very scale-dependent. Characteristics of the water-vegetation edge (not the wetland-upland edge) are more important, but that edge may move constantly and thus is difficult to assess during a single site visit.
• Percent of wetland edge containing "natural" land cover. • Perimeter buffer width	Very scale-dependent (Schuft et al. 1999) and difficult to measure meaningfully. Another indicator (percent of buffer zone natural land cover) mostly addresses this. Also note that wooded buffers are not necessarily beneficial to nesting waterfowl.
• Type of hydrologic connection to other water bodies	Not of demonstrated importance to most nesting waterbirds in this ecoregion.

Wintering and Migrating Waterbird Habitat (indicators and models on p.39)

This configuration of the scoring model is intended to give equal weight to the site's water regimes (A), extent of vernal pools (B), five indicators of water dynamics and distribution (C, D, E, F,G), proximity to other water/wetlands (H, I), and surrounding land cover (J, K). The importance of the first indicator (A) to wintering waterbirds was demonstrated by DeSzalay et al. (1999), who found greater numbers of waterbirds in seasonally-inundated sites, if they had been "inoculated" at the beginning of the annual flood cycle by overflow from permanent ponds that were rich in colonizing invertebrates. Sites with extensive vernal pools (B) are very attractive to migratory and wintering shorebirds in the Willamette Valley (Budeau and Snow 1992). This can be represented less directly by noting the extent of puddling (C) or the interspersion of pools with vegetation (D). These are averaged because of their similarity and the fact that data on the puddle-hummock indicator is not collected from riverine sites. The presence of a variety of depth categories (E) suggests that a site will likely attract a variety of waterbirds because different species feed at different depths. Annual fluctuations in water levels (F), if occurring slowly, can be beneficial to wintering waterbirds because they facilitate germination of wetland plants and cycling of nutrients in soil and sediments, with consequent enhancement of the plant and invertebrate populations upon which many waterbirds feed (Weller 1999). The indicator "mapped soil series is hydric" (G) is included to reflect likelihood of there being occasional ponding that extends beyond the assessment site; sites whose soils are merely a hydric inclusion within a non-hydric map unit are perhaps less likely to have ponding in adjoining soils, and thus would be less attractive to waterbirds. Similarly but at a broader landscape level, the percent of water and wetlands within various buffer distances around a site (H, I) is important because waterbirds are attracted to wetland complexes; birds move among sites within the complex when one site is subjected to natural or human-related disturbance (Haig et al. 1997). The extent of agricultural land cover around a site (J, K) has been shown to predict use of wetland sites by many species of wintering waterbirds – especially geese – in the Pacific Northwest (Lovvorn & Baldwin 1996).

The divisors are used to standardize the Function Capacity Score to a 0-to-1 scale. The value 3.88 is the highest score found among all RI sites, and 2.71 is the highest score found among the least-altered RI sites. The value 3.72 is the highest score found among all SF sites, and 2.76 is the highest among the least-altered SF sites. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	**Why Excluded from Reference-based Assessment**
• Observations or reports of waterbirds • Water quality data or water body condition ratings	Data not available for all sites due to non-uniform survey efforts. Selective inclusion of data creates undesirable bias. Moreover, the seeming absence of migrating and wintering waterbirds is often only the temporary result of the presence of waterfowl hunters.
• Timing & duration of inundation • Rate of water level fluctuation	Although very important, these variables are impractical to assess without specialized equipment or expertise, and/or require more than a single visit.
• Ranking of plant species according to typical seed production and consumption by waterbirds	Although important differences exist among palatability and use of plant species (Crawford 1938, Yocom 1951), these have not been quantified objectively for most of the wetland plant species in the Willamette Valley ecoregion. Moreover, cultivated grains and invertebrates are often used more extensively during winter.
• Percent canopy closure in permanent zone	Although many waterbirds shun sites with closed canopies, a few others (e.g., wood duck) prefer these.
• Number and patchiness of plant forms (trees, shrubs, herbs) • Complexity of wetland-upland edge	Of minor importance to most wintering/migrating waterbirds in this ecoregion, and very scale-dependent. Characteristics of the water-vegetation edge (not the wetland-upland edge) are more important, but that edge may move constantly and thus is difficult to assess during a single site visit.
• Percent of site <u>perimeter</u> that contains "natural" land cover. • Perimeter buffer width	Difficult to measure meaningfully, and another indicator (Percent of natural land cover within 200 and 1000 ft radii) mostly addresses this. Also note that wooded buffers are not necessarily beneficial to wintering/migrating waterbirds.
• Type of hydrologic connection to other water bodies • Proximity to estuary or wildlife refuge • Risk of ice-up	Not of demonstrated importance to most waterbirds in this ecoregion, and/or varies little within the ecoregion..

Songbird Habitat Support (indicators and models on p. 41)

A distinct scoring model is prescribed for sites that historically were prairies or other herbaceous communities, so that indicators pertinent only to wooded sites will not be used to set unrealistic expectations for sites that historically have been non-wooded. The configuration of the scoring models is intended to give equal weight to the overall amount of vegetation (A), the condition of the vegetation onsite and in the surrounding landscape (B through J and K through O), site disturbance (Q, R), and presence of permanent surface water (P). With regard to the condition of vegetation, there is no bias toward heavily wooded sites. A maximizing operation is specified in the scoring model so that historically wooded sites can receive a high score if the condition of either their woody vegetation (indicators B through H) or their herbaceous vegetation (indicators I through K) is attractive to woodland species or to grassland species, respectively.

In wetlands as in other environments, the abundance of birds (especially songbirds) is closely tied to the amount of vegetation (A) because plants provide vertical structure to the environment. In wooded areas (areas defined by a high proportion of woody vegetation, indicator B), patches of closed-canopy woods (C) are important because they attract forest-interior species that avoid more open stands. Layering of vegetation in multiple vertical strata, as represented by the percent of the understory occupied by shrubs (D), is important to thrushes, grosbeaks, and some other species, thus making wooded sites attractive to even more species (Evenden 1949). The variety of woody species (E) is used to represent the likely availability of diverse food sources throughout the seasons, e.g., berries, nuts, seeds (Greenberry 1942, Eddy 1953). The number of types of deadwood (F) and the diameter of the largest trees (G) are used to represent the availability of insects for food, downed wood for cover (Steel et al. 1999), and snags for nesting (McComb and Hagar 1992, Bull et al. 1997, Hagar 1999). The variety of vegetation forms and their evenness of distribution throughout a site (H) increases the diversity of birds at wooded sites (Beck 1962, Perry 1978, Sanders 1995).

Natural vegetation in the vicinity of a site usually supports higher diversity within the site partly because it provides a convenient refuge when rising waters flood habitats within the part of a site usually occupied by some species; when water levels recede these species can easily recolonize the site if they have only a short distance to travel from a nearby vegetation patch. Even during normal weather, some species require (or at least benefit from) resources present mainly in uplands and a complementary set of resources present only in wetlands. Buffers, tracts, or corridors of nearby upland vegetation can augment the food (browse, insects) and cover provided by wetland/ riparian vegetation. Conversely, an absence of buffering upland vegetation often implies increased vulnerability of wetland/ riparian biological communities to contaminated runoff, vehicle and foot traffic, altered hydrologic regimes, and predation or disturbance by domestic animals. Thus, the extent of surrounding woodland (H, I) is used to represent the connectivity of the site with other potentially suitable wooded habitats (Desrochers and Hannon 1996), as well as buffering from human disturbances (Milligan 1985, Ford 1993, Miller et al. 1998). In the Seattle area, Richter and Azous (2000) found avian richness and abundance to correlate positively with vegetative cover within a 1000 m radius of their wetland sites, but not with vegetative cover within 500 m. In a study of Portland-area riparian buffers, Hennings (*pers. comm.,* M.S. in preparation) found conditions within 200 ft of streams to have a greater effect on songbirds than conditions measured farther away. She also found that road network density and road proximity (R) had an especially strong negative effect on the most sensitive riparian songbirds.

Herbaceous sites are assumed to be more suitable for songbirds when herb cover has not recently been plowed (K) or mowed (L). Also, the presence of varied microtopography (M) suggests that the site has not recently been cultivated, and therefore is likely to provide greater vegetation structure. The extent of surrounding grassland (N,O) is used to represent the connectivity of the site with other potentially suitable herbaceous habitats.

The divisors are used to standardize scores the Function Capacity Score to a 0-to-1 scale. The value 3.81 is the highest score found among all RI reference sites, and 3.68 is the highest among the least-altered RI sites. The value 3.72 is the highest score found among all previously wooded

SF reference sites, and 3.47 is the highest among the least-altered of these. The value 4.82 is the highest score found among all historically non-wooded SF sites, and 4.0 is the highest among the least altered of these. Following are some important variables that were not included in the scoring model, and reasons why excluded.

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Observations or reports of songbirds & songbird predators	Data not available for all sites due to non-uniform survey efforts. Selective inclusion of data creates undesirable bias.
• Number of snags • Tree basal area or mean diameter • Size diversity of trees	Not practical to assess accurately in the context of a single visit.
• Ranking of plant species according to typical attractiveness to songbirds	Although important differences exist among plant species, these have not been quantified for most of the wetland plant species in the Willamette Valley ecoregion. Moreover, many songbirds are insectivores.
• Complexity of wetland-upland edge	Probably of minor importance to most songbirds in this ecoregion, and very scale-dependent.
• Percent of wetland perimeter that contains "natural" land cover. • Perimeter buffer width	Very scale-dependent and difficult to measure meaningfully (Schuft et al. 1999). Another indicator (Percent of natural land cover within 200 and 1000 ft radii) mostly addresses this. Also note that woody vegetation can be detrimental to some grassland songbirds.

Support of Characteristic Vegetation (indicators and models on p. 44)

This configuration of the scoring model is intended to give equal weight to indicators that basically indicate vegetation extent, structure, and recolonization potential (indicators A, B, C); those that directly estimate attributes of herb diversity (D, E) and/or directly estimate attributes of woody plant diversity (G, H) and its correlates (I, J); and those that represent actual or potential human-related disturbance (K through R). A separate scoring model is prescribed for sites that historically were prairies or other herbaceous communities, so that indicators pertinent only to wooded sites will not be used to set unrealistic expectations for sites that historically have been non-wooded.

The extent of vegetation on the site (A) is included because vegetation diversity is widely known to correlate with vegetated area. Presence of rare or characteristic species is not necessarily correlated with vegetation form in the Pacific Northwest (Azous & Cooke 2000). Although it might seem preferable to use only the indicators that assess the vegetation *directly* (B, D, E through H), several indirect estimators (i.e., the remaining indicators) are included to help compensate for the coarseness of the direct survey field procedures. The indicator "mapped soil series is hydric" (C) is included to reflect likelihood of there being extensive seed banks of wetland species in the vicinity of a site (Davis et al. 1995); sites whose soils are merely a hydric inclusion within a non-hydric map unit are perhaps less likely to be surrounded by an extensive seed bank of wetland species. Indicators I and J represent the maturity of the site, and thus the likelihood it may contain many species characteristic of less-altered environments (Frenkel & Heintz 1987). Indicator K also represents site maturity; recently-constructed sites are expected to contain fewer native species than well-established natural sites (Magee et al. 1999). Non-native species often invade a site following soil compaction, soil mixing (plowing), or extreme grazing (N). The frequency of humans visiting on foot (O) and distance to nearest busy road (P) are used as indirect indicators of potential for invasion by non-native species (Parendes et al. 2000) and risk of damage from trampling. Natural land cover in the *contributing watershed* (Q) is used to represent likelihood of there being unaltered hydrologic regimes important to maintaining native species, whereas natural land cover in the surrounding buffer zone (R) is used to partly represent likelihood of resistance to invasion by non-native species (McAllister et al. 2000). In a survey of 723 riverine sites in the Pacific Northwest, Hesser and Gangstad (1990) found a predominance of non-native aquatic herbs most often in irrigated (agricultural) landscapes (53% of sites) and urban landscapes (48% of sites). In a survey of 96 small emergent wetlands in the Portland metropolitan area, sites surrounded by agricultural or urban land cover were found to contain more non-native species per site than sites surrounded by undeveloped land (Magee et al. 1999). A similar result was found among 35 wooded riparian sites in the Portland area (O'Neill & Yeakley 2000). A survey of 19 Seattle-area emergent and shrub wetlands found fewer plant species in sites whose watersheds contained greater proportions of impervious surface (Azous & Cooke 2000). Reed canarygrass is an especially pervasive threat (Kilbride & Paveglio 1999).

The divisors are used to standardize scores the Function Capacity Score to a 0-to-1 scale. The value 6.21 is the highest score found among all RI reference sites, including the least-altered RI sites. The value 6.61 is the highest score found among all previously wooded SF reference sites, and 6.38 is the highest among the least-altered of these. The value 5.79 is the highest score found among all historically non-wooded SF sites, and 5.59 is the highest among the least altered of these. Following are some important variables that were not included in the scoring model, and reasons why excluded:

Excluded Variables or Indicators	**Why Excluded from Reference-based Assessment**
• Herb species richness	To achieve statistically valid, unbiased measurement of species richness, a very large number of plots typically is required, even if sampling is first stratified by habitat within sites. For further discussion of sampling issues, see Section 8.2, Volume IB. Also, species-rich sites are often more invasible by non-native species, and often are rich because they contain a large component of non-native species, at least during the early stages of invasion (Planty-Tabacchi et al. 1996).
• Percent of entire site occupied by non-native herb species	In many large and/or diverse sites, overall cover of herb species cannot be "eyeballed" with reasonable precision. To achieve statistically valid measurement of overall percent cover of a species or species group, a very large number of plots typically is required, even if sampling is first stratified by habitat within sites. For further discussion, see Section 8.2, Volume IB.
• Number of plant communities or associations	Recognizing a distinct plant association or community requires considerable experience, and even then experts disagree on the appropriate number and membership of classes that are consistent and recognizable. Considerable gradation exists. There is no generally-accepted, widely validated classification of Willamette Valley wetland or riparian herb "associations" or "communities." Moreover, the diversity of plant species and communities in this ecoregion is often greatest at sites that are have been altered moderately by human or natural disturbance (e.g., O'Neill & Yeakley 2000).
• Species persistence	This indicator is important because in some mitigation projects, many species that are planted enrich diversity only temporarily because they do not compete well and survive. However, the likelihood of a species persisting cannot be assessed accurately during a single visit.
• Size diversity of trees	Not practical to assess accurately in the context of a single visit, and not necessarily related to overall vegetation species diversity.

Excluded Variables or Indicators	Why Excluded from Reference-based Assessment
• Water regime	Although plant species richness in the Pacific Northwest tends be greater at sites exposed to shorter-duration inundation (Boss 1993, Azous & Cooke 2000), the richness is often not comprised of species characteristic of the ecoregion's wetlands. In the Willamette Valley, non-native species can predominate in either drier sites (Finley 1995) or wetter sites (Magee et al. 1999), depending partly on site history.
• Burning	Although controlled burns can benefit many native plants in slope/flats sites (Taylor 1999, Bartels 2000, Maret & Wilson 2000), the exact effects depend on many variables that cannot be estimated during a single visit at an unspecified time after the burn.
• Complexity of wetland-upland edge	Probably of minor importance to vegetation diversity in this ecoregion, and very scale-dependent.
• Percent of site perimeter that contains "natural" land cover. • Perimeter buffer width	Very scale-dependent and difficult to measure meaningfully (Schuft et al. 1999). Another indicator (Percent of natural land cover within 200 and 1000 ft radii) mostly addresses this. Also note that woody vegetation can be detrimental to some plant species.

Appendix E. Rankings of Reference Sites by Function Capacity Scores

Beginning on the next page, the 109 sites from which data were collected in 1999-2000 are ranked from highest to lowest within their subclass, using their Standardized Function Capacity score. In this case, standardization of scores was accomplished by scaling to the site scored as highest-functioning. Note that the rankings would differ if acreage was taken into account.

1. Riverine Impounding Sites

Least-altered (reference standard) sites are in **bold.**

Water Storage & Delay

Bowers Rock slough	1.00
Spongs Landing slough	1.00
Takena Park sloughs	1.00
Willamette Park slough	1.00
Grand Island slough	0.80
Luckiamute floodplain	0.80
Minto-Brown slough 2	0.80
Minto-Brown big slough	0.70
Snagboat Bend slough	0.70
Truax slough	0.70
Calapooia River 2	0.60
Christensen Park slough	0.60
Philomath Park slough	0.60
Truax gravelpit restoration	0.60
Tualatin Hills Lily Pond	0.60
Tualatin NWR Chicken Cr.	0.60
Anderson Park sloughs	0.56
Hileman Park slough	0.56
Minto-Brown slough 1	0.56
Anderson Park alcove	0.42
Tualatin Hills Big Pond	0.42
Wilson Wildlife Area main pond	0.42
Brownsville constructed	0.40
Calapooia River 1	0.40
Cook Park slough	0.40
Mt.View enhanced slough	0.40
Fanno Creek duck donut	0.40
Gibson Creek enhanced slough	0.40
Hileman Park alcove	0.40
Shooting range pond	0.40
Scio pond	0.40
Whitley Landing floodplain	0.40
Willow Creek riverine	0.40
Wilson Wildlife Area north pond	0.40
Stayton Interchange restored	0.28
Oaks Bottom backwater	0.24
Greenberry floodplain	0.20
Buford West slough	0.20
Jasper Park slough	0.20
Coyote floodplain	0.20
Summerlake Park pond	0.20
Finley floodplain	0.14
McDonald Forest ponds	0.14
Willamette Mission slough	0.14
Jackson-Frazier floodplain	0.12
Tualatin NWR beaverdam	0.12
Cascades Gateway slough	0.10
Hedges Creek duck ponds	0.10
Timber-Linn pond	0.10
Adair pond	0.06
Alton Baker Park slough	0.06
Brown's Ferry pond	0.06
Delta Ponds	0.06
Coffin Butte pond	0.04

Sediment Stabilization & Phosphorus Retention

Scio pond	1.00
Minto-Brown big slough	0.99
Minto-Brown slough 2	0.99
Brownsville constructed	0.94
Tualatin NWR Chicken Cr.	0.94
Stayton Interchange restored	0.90
Shooting range pond	0.88
Calapooia River 2	0.88
Cook Park slough	0.88
Whitley Landing floodplain	0.88
Buford West slough	0.87
Coyote floodplain	0.87
Minto-Brown slough 1	0.87
Fanno Creek duck donut	0.83
Timber-Linn pond	0.81
Brown's Ferry pond	0.81
Coffin Butte pond	0.81
Mt.View enhanced slough	0.81
Snagboat Bend slough	0.78
Spongs Landing slough	0.78
Gibson Creek enhanced slough	0.77
Philomath Park slough	0.77
Wilson Wildlife Area north pond	0.77
Tualatin Hills Lily Pond	0.74
Wilson Wildlife Area main pond	0.74
Willamette Park slough	0.72
Bowers Rock slough	0.70
Grand Island slough	0.70
Hileman Park slough	0.70
Summerlake Park pond	0.70
Greenberry floodplain	0.68
Hedges Creek duck ponds	0.68
Finley floodplain	0.67
Luckiamute floodplain	0.67
Christensen Park slough	0.65
Oaks Bottom backwater	0.65
Tualatin Hills Big Pond	0.65
Willow Creek riverine	0.65
Willamette Mission slough	0.64
Anderson Park sloughs	0.61
Jackson-Frazier floodplain	0.59
Jasper Park slough	0.58
Truax gravelpit restoration	0.58
Truax slough	0.58
McDonald Forest ponds	0.57
Takena Park sloughs	0.55
Anderson Park alcove	0.54
Calapooia River 1	0.54
Alton Baker Park slough	0.52
Cascades Gateway slough	0.52
Adair pond	0.52
Hileman Park alcove	0.42
Delta Ponds	0.41
Tualatin NWR beaverdam	0.28

Nitrogen Removal

Grand Island slough	1.00
Anderson Park sloughs	0.99
Minto-Brown slough 1	0.97
Willamette Park slough	0.97
Spongs Landing slough	0.96
Tualatin Hills Big Pond	0.96
Truax slough	0.94
Oaks Bottom backwater	0.93
Anderson Park alcove	0.92
Wilson Wildlife Area north pond	0.91
Bowers Rock slough	0.90
Takena Park sloughs	0.90
Jasper Park slough	0.89
Christensen Park slough	0.88
Snagboat Bend slough	0.88
Hileman Park alcove	0.87
Delta Ponds	0.86
Minto-Brown big slough	0.86
Wilson Wildlife Area main pond	0.86
Philomath Park slough	0.85
Tualatin NWR beaverdam	0.85
Luckiamute floodplain	0.84
McDonald Forest ponds	0.84
Tualatin Hills Lily Pond	0.84
Tualatin NWR Chicken Cr.	0.83
Willamette Mission slough	0.83
Cascades Gateway slough	0.82
Summerlake Park pond	0.82
Minto-Brown slough 2	0.80
Finley floodplain	0.79
Willow Creek riverine	0.79

Adair pond	0.78
Greenberry floodplain	0.78
Brown's Ferry pond	0.76
Calapooia River 1	0.76
Jackson-Frazier floodplain	0.76
Cook Park slough	0.75
Buford West slough	0.74
Coyote floodplain	0.72
Truax gravelpit restoration	0.71
Hileman Park slough	0.68
Mt.View enhanced slough	0.67
Hedges Creek duck ponds	0.67
Gibson Creek enhanced slough	0.66
Fanno Creek duck donut	0.64
Alton Baker Park slough	0.63
Calapooia River 2	0.63
Shooting range pond	0.63
Stayton Interchange restored	0.63
Coffin Butte pond	0.61
Timber-Linn pond	0.61
Brownsville constructed	0.60
Scio pond	0.57
Whitley Landing floodplain	0.34

Thermoregulation

Timber-Linn pond	1.00
Tualatin NWR beaverdam	0.80
Summerlake Park pond	0.51
Adair pond	0.40
Anderson Park alcove	0.00
Greenberry floodplain	0.00
Mt.View enhanced slough	0.00
Gibson Creek enhanced slough	0.00
McDonald Forest ponds	0.00
Minto-Brown big slough	0.00
Snagboat Bend slough	0.00
Truax slough	0.00
Tualatin NWR Chicken Cr.	0.00
Willamette Park slough	0.00
Wilson Wildlife Area north pond	0.00

Primary Production

Tualatin NWR beaverdam	1.00
Hileman Park alcove	0.99
McDonald Forest ponds	0.98
Wilson Wildlife Area north pond	0.98
Anderson Park alcove	0.96
Tualatin Hills Big Pond	0.96
Minto-Brown slough 1	0.95
Wilson Wildlife Area main pond	0.95
Mt.View enhanced slough	0.94
Truax slough	0.94
Willamette Park slough	0.94
Adair pond	0.93
Finley floodplain	0.93
Summerlake Park pond	0.93
Jackson-Frazier floodplain	0.93
Spongs Landing slough	0.92
Christensen Park slough	0.92
Tualatin Hills Lily Pond	0.91
Anderson Park sloughs	0.90
Calapooia River 1	0.90
Jasper Park slough	0.90
Buford West slough	0.88
Snagboat Bend slough	0.88
Tualatin NWR Chicken Cr.	0.88
Willow Creek riverine	0.88
Oaks Bottom backwater	0.87
Delta Ponds	0.82
Gibson Creek enhanced slough	0.80
Truax gravelpit restoration	0.80
Grand Island slough	0.79
Takena Park sloughs	0.79
Alton Baker Park slough	0.79
Brown's Ferry pond	0.79
Bowers Rock slough	0.78
Greenberry floodplain	0.77
Cascades Gateway slough	0.76
Philomath Park slough	0.76
Minto-Brown big slough	0.75
Coyote floodplain	0.75
Hileman Park slough	0.72
Shooting range pond	0.71
Scio pond	0.71
Willamette Mission slough	0.71
Coffin Butte pond	0.69
Timber-Linn pond	0.69
Fanno Creek duck donut	0.65
Stayton Interchange restored	0.64
Cook Park slough	0.63
Luckiamute floodplain	0.62
Minto-Brown slough 2	0.61
Brownsville constructed	0.59
Calapooia River 2	0.57
Hedges Creek duck ponds	0.52
Whitley Landing floodplain	0.32

Resident Fish Habitat

Willamette Park slough	1.00
Truax slough	0.92
Christensen Park slough	0.91
Mt.View enhanced slough	0.91
Willow Creek riverine	0.91
Minto-Brown slough 1	0.90
Summerlake Park pond	0.90
Brown's Ferry pond	0.89
Buford West slough	0.89
Hileman Park slough	0.89
Adair pond	0.88
Timber-Linn pond	0.88
Oaks Bottom backwater	0.86
Tualatin NWR Chicken Cr.	0.85
Tualatin NWR beaverdam	0.85
Alton Baker Park slough	0.84
Delta Ponds	0.84
McDonald Forest ponds	0.84
Wilson Wildlife Area main pond	0.84
Snagboat Bend slough	0.82
Minto-Brown big slough	0.81
Bowers Rock slough	0.80
Tualatin Hills Big Pond	0.78
Gibson Creek enhanced slough	0.74
Stayton Interchange restored	0.73
Willamette Mission slough	0.73
Jackson-Frazier floodplain	0.69
Minto-Brown slough 2	0.69
Coffin Butte pond	0.68
Anderson Park sloughs	0.67
Hileman Park alcove	0.67
Greenberry floodplain	0.66
Grand Island slough	0.51
Wilson Wildlife Area north pond	0.51
Anderson Park alcove	0.50
Cascades Gateway slough	0.49
Jasper Park slough	0.45
Hedges Creek duck ponds	0.35
Brownsville constructed	
Calapooia River 1	
Calapooia River 2	
Cook Park slough	
Fanno Creek duck donut	
Finley floodplain	
Luckiamute floodplain	
Philomath Park slough	
Coyote floodplain	
Shooting range pond	
Spongs Landing slough	

Takena Park sloughs	
Scio pond	
Truax gravelpit restoration	
Tualatin Hills Lily Pond	
Whitley Landing floodplain	

Anadromous Fish Habitat

Truax slough	1.00
Anderson Park sloughs	0.98
Tualatin Hills Big Pond	0.98
Christensen Park slough	0.95
Mt.View enhanced slough	0.95
Minto-Brown big slough	0.95
Willamette Park slough	0.95
Minto-Brown slough 2	0.93
Timber-Linn pond	0.93
Tualatin Hills Lily Pond	0.93
McDonald Forest ponds	0.92
Bowers Rock slough	0.90
Snagboat Bend slough	0.90
Buford West slough	0.88
Calapooia River 1	0.88
Wilson Wildlife Area main pond	0.88
Wilson Wildlife Area north pond	0.88
Cook Park slough	0.85
Finley floodplain	0.85
Luckiamute floodplain	0.85
Minto-Brown slough 1	0.85
Takena Park sloughs	0.85
Willow Creek riverine	0.85
Anderson Park alcove	0.81
Oaks Bottom backwater	0.81
Spongs Landing slough	0.81
Tualatin NWR Chicken Cr.	0.81
Calapooia River 2	0.80
Grand Island slough	0.80
Philomath Park slough	0.80
Jackson-Frazier floodplain	0.76
Stayton Interchange restored	0.75
Scio pond	0.75
Hileman Park slough	0.73
Summerlake Park pond	0.73
Tualatin NWR beaverdam	0.69
Hileman Park alcove	0.68
Willamette Mission slough	0.68
Brownsville constructed	0.66
Greenberry floodplain	0.66
Fanno Creek duck donut	0.66
Whitley Landing floodplain	0.66
Cascades Gateway slough	0.64
Delta Ponds	0.63
Jasper Park slough	0.63
Coyote floodplain	0.63
Shooting range pond	0.63
Truax gravelpit restoration	0.63
Adair pond	0.56
Brown's Ferry pond	0.54
Hedges Creek duck ponds	0.53
Alton Baker Park slough	0.46
Coffin Butte pond	N/A
Gibson Creek enhanced slough	N/A

Invertebrate Habitat Support

Wilson Wildlife Area north pond	1.00
Willow Creek riverine	0.99
Willamette Park slough	0.98
Christensen Park slough	0.93
McDonald Forest ponds	0.91
Anderson Park alcove	0.90
Hileman Park alcove	0.90
Mt.View enhanced slough	0.89
Greenberry floodplain	0.88
Truax slough	0.86
Buford West slough	0.85
Snagboat Bend slough	0.85
Wilson Wildlife Area main pond	0.84
Jackson-Frazier floodplain	0.83
Tualatin Hills Big Pond	0.81
Hileman Park slough	0.79
Anderson Park sloughs	0.78
Finley floodplain	0.78
Spongs Landing slough	0.77
Willamette Mission slough	0.77
Tualatin Hills Lily Pond	0.76
Minto-Brown slough 1	0.75
Tualatin NWR beaverdam	0.75
Minto-Brown big slough	0.72
Scio pond	0.72
Tualatin NWR Chicken Cr.	0.72
Coyote floodplain	0.71
Adair pond	0.70
Brown's Ferry pond	0.66
Gibson Creek enhanced slough	0.66
Shooting range pond	0.65
Timber-Linn pond	0.65
Jasper Park slough	0.64
Oaks Bottom backwater	0.64
Stayton Interchange restored	0.62
Calapooia River 1	0.61
Luckiamute floodplain	0.60
Truax gravelpit restoration	0.59
Minto-Brown slough 2	0.58
Summerlake Park pond	0.58
Philomath Park slough	0.56
Cascades Gateway slough	0.55
Alton Baker Park slough	0.53
Grand Island slough	0.52
Takena Park sloughs	0.51
Brownsville constructed	0.50
Delta Ponds	0.50
Bowers Rock slough	0.49
Cook Park slough	0.46
Calapooia River 2	0.44
Hedges Creek duck ponds	0.44
Fanno Creek duck donut	0.43
Whitley Landing floodplain	0.38
Coffin Butte pond	0.34

Amphibian & Reptile Habitat

Truax slough	1.00
Jackson-Frazier floodplain	**0.98**
Anderson Park alcove	**0.96**
Finley floodplain	**0.89**
Tualatin Hills Lily Pond	**0.87**
Anderson Park sloughs	0.86
Christensen Park slough	0.86
McDonald Forest ponds	**0.86**
Tualatin Hills Big Pond	0.86
Buford West slough	0.85
Calapooia River 1	0.85
Willamette Park slough	0.85
Wilson Wildlife Area main pond	0.83
Wilson Wildlife Area north pond	0.83
Greenberry floodplain	0.82
Shooting range pond	0.82
Tualatin NWR Chicken Cr.	0.82
Snagboat Bend slough	0.81
Tualatin NWR beaverdam	0.81
Adair pond	0.79

Minto-Brown big slough	0.79
Truax gravelpit restoration	0.79
Willow Creek riverine	**0.79**
Bowers Rock slough	0.78
Brown's Ferry pond	0.78
Hileman Park alcove	0.78
Minto-Brown slough 1	0.77
Summerlake Park pond	0.76
Scio pond	0.76
Cook Park slough	0.75
Spongs Landing slough	**0.75**
Hileman Park slough	0.74
Coyote floodplain	0.74
Mt.View enhanced slough	0.73
Luckiamute floodplain	0.72
Oaks Bottom backwater	0.72
Cascades Gateway slough	0.71
Takena Park sloughs	0.71
Whitley Landing floodplain	0.71
Fanno Creek duck donut	0.70
Minto-Brown slough 2	0.70
Philomath Park slough	0.70
Willamette Mission slough	0.69
Calapooia River 2	0.68
Stayton Interchange restored	0.68
Grand Island slough	0.67
Brownsville constructed	0.65
Timber-Linn pond	0.65
Alton Baker Park slough	0.63
Jasper Park slough	0.63
Delta Ponds	0.62
Gibson Creek enhanced slough	0.62
Hedges Creek duck ponds	0.59
Coffin Butte pond	0.46

Breeding Waterbird Habitat (these are the only sites meeting 0.5 acre threshold for permanent water)

Adair pond	1.00
Delta Ponds	0.77
Coffin Butte pond	0.72
Anderson Park sloughs	0.70
Anderson Park alcove	0.69
Brown's Ferry pond	0.67
Summerlake Park pond	0.63
Wilson Wildlife Area main pond	0.63
Timber-Linn pond	0.62
Oaks Bottom backwater	0.61
Buford West slough	0.60
Alton Baker Park slough	0.59
Jackson-Frazier floodplain	0.55
Jasper Park slough	0.53
Willamette Mission slough	0.52
Wilson Wildlife Area north pond	0.52
Minto-Brown slough 1	0.50
Spongs Landing slough	0.49
Cascades Gateway slough	0.46
Truax slough	0.46
Tualatin NWR Chicken Cr.	0.44
Minto-Brown big slough	0.42
Snagboat Bend slough	0.42
Stayton Interchange restored	0.35
Bowers Rock slough	0
Brownsville constructed	0
Calapooia River 1	0
Calapooia River 2	0
Christensen Park slough	0
Cook Park slough	0
Coyote floodplain	0
Mt.View enhanced slough	0
Fanno Creek duck donut	0
Finley floodplain	0
Gibson Creek enhanced slough	0
Grand Island slough	0
Greenberry floodplain	0
Hedges Creek duck ponds	0
Hileman Park alcove	0
Hileman Park slough	0
Luckiamute floodplain	0
McDonald Forest ponds	0
Minto-Brown slough 2	0
Philomath Park slough	0
Scio pond	0
Shooting range pond	0
Takena Park sloughs	0
Truax gravelpit restoration	0
Tualatin Hills Big Pond	0
Tualatin Hills Lily Pond	0
Tualatin NWR beaverdam	0
Whitley Landing floodplain	0
Willamette Park slough	0
Willow Creek riverine	0

Wintering & Migrating Waterbirds

Minto-Brown big slough	1.00
Tualatin NWR Chicken Cr.	0.97
Wilson Wildlife Area north pond	0.93
Greenberry floodplain	0.89
Stayton Interchange restored	0.86
Minto-Brown slough 1	0.83
Willamette Mission slough	0.83
Oaks Bottom backwater	0.81
Wilson Wildlife Area main pond	0.81
Brown's Ferry pond	0.78
Cascades Gateway slough	0.78
Snagboat Bend slough	0.78
Mt.View enhanced slough	0.73
Brownsville constructed	0.72
Gibson Creek enhanced slough	0.72
Bowers Rock slough	0.70
Jackson-Frazier floodplain	0.70
Anderson Park alcove	0.69
Summerlake Park pond	0.68
Timber-Linn pond	0.68
Hileman Park alcove	0.66
Adair pond	0.65
Truax slough	0.65
Grand Island slough	0.61
Christensen Park slough	0.60
Willamette Park slough	0.60
Hileman Park slough	0.58
Minto-Brown slough 2	0.58
Spongs Landing slough	0.57
Anderson Park sloughs	0.56
Willow Creek riverine	0.56
Jasper Park slough	0.53
Buford West slough	0.49
Tualatin Hills Big Pond	0.49
Hedges Creek duck ponds	0.48
Coffin Butte pond	0.46
Truax gravelpit restoration	0.45
Scio pond	0.43
McDonald Forest ponds	0.41
Takena Park sloughs	0.39
Tualatin NWR beaverdam	0.37
Alton Baker Park slough	0.35
Delta Ponds	0.35
Coyote floodplain	0.35
Luckiamute floodplain	0.33

Finley floodplain	0.31
Whitley Landing floodplain	0.31
Cook Park slough	0.30
Fanno Creek duck donut	0.30
Shooting range pond	0.28
Philomath Park slough	0.26
Calapooia River 2	0.24
Tualatin Hills Lily Pond	0.24
Calapooia River 1	0.22

Songbird Habitat

Anderson Park sloughs	1.00
Spongs Landing slough	0.97
Anderson Park alcove	0.96
McDonald Forest ponds	0.93
Jackson-Frazier floodplain	0.88
Greenberry floodplain	0.88
Christensen Park slough	0.86
Minto-Brown slough 2	0.86
Bowers Rock slough	0.85
Truax slough	0.85
Willamette Park slough	0.84
Wilson Wildlife Area north pond	0.84
Wilson Wildlife Area main pond	0.83
Tualatin NWR Chicken Cr.	0.81
Snagboat Bend slough	0.80
Hileman Park alcove	0.80
Grand Island slough	0.80
Gibson Creek enhanced slough	0.79
Tualatin Hills Big Pond	0.78
Willamette Mission slough	0.78
Hileman Park slough	0.78
Finley floodplain	0.75
Willow Creek riverine	0.75
Luckiamute floodplain	0.74
Oaks Bottom backwater	0.72
Mt.View enhanced slough	0.71
Stayton Interchange restored	0.70
Minto-Brown slough 1	0.70
Jasper Park slough	0.70
Calapooia River 2	0.69
Buford West slough	0.68
Timber-Linn pond	0.67
Tualatin NWR beaverdam	0.66
Minto-Brown big slough	0.65
Summerlake Park pond	0.65
Adair pond	0.64
Takena Park sloughs	0.59
Tualatin Hills Lily Pond	0.59
Calapooia River 1	0.58
Cascades Gateway slough	0.58
Shooting range pond	0.58
Philomath Park slough	0.57
Hedges Creek duck ponds	0.54
Truax gravelpit restoration	0.52
Cook Park slough	0.52
Delta Ponds	0.52
Scio pond	0.49
Brownsville constructed	0.48
Alton Baker Park slough	0.47
Brown's Ferry pond	0.46
Coyote floodplain	0.44
Coffin Butte pond	0.42
Whitley Landing floodplain	0.40
Fanno Creek duck donut	0.36

Support of Characteristic Vegetation

Tualatin Hills Lily Pond	1.00
Finley floodplain	0.97
Jackson-Frazier floodplain	0.97
Tualatin Hills Big Pond	0.94
Spongs Landing slough	0.92
Greenberry floodplain	0.91
Buford West slough	0.89
Wilson Wildlife Area north pond	0.88
Wilson Wildlife Area main pond	0.87
Willow Creek riverine	0.86
McDonald Forest ponds	0.81
Minto-Brown slough 2	0.79
Minto-Brown slough 1	0.78
Anderson Park sloughs	0.76
Brownsville constructed	0.76
Christensen Park slough	0.75
Scio pond	0.75
Mt.View enhanced slough	0.74
Calapooia River 2	0.73
Stayton Interchange restored	0.72
Truax slough	0.72
Shooting range pond	0.70
Cook Park slough	0.69
Truax gravelpit restoration	0.69
Cascades Gateway slough	0.68
Willamette Mission slough	0.68
Anderson Park alcove	0.67
Snagboat Bend slough	0.66
Summerlake Park pond	0.66
Willamette Park slough	0.66
Fanno Creek duck donut	0.65
Grand Island slough	0.64
Philomath Park slough	0.64
Tualatin NWR Chicken Cr.	0.64
Coffin Butte pond	0.63
Luckiamute floodplain	0.63
Oaks Bottom backwater	0.63
Adair pond	0.62
Hileman Park slough	0.62
Minto-Brown big slough	0.62
Gibson Creek enhanced slough	0.59
Jasper Park slough	0.59
Timber-Linn pond	0.59
Takena Park sloughs	0.57
Bowers Rock slough	0.55
Calapooia River 1	0.55
Coyote floodplain	0.55
Delta Ponds	0.51
Hedges Creek duck ponds	0.49
Tualatin NWR beaverdam	0.48
Hileman Park alcove	0.47
Brown's Ferry pond	0.44
Whitley Landing floodplain	0.44
Alton Baker Park slough	0.28

2. Slope/flats Sites

Least-altered (reference standard) sites are in **bold.**
No rankings are given for Thermoregulation or Anadromous Fish Support because those functions are mostly not supported by the region's Slope/flats sites.

Water Storage & Delay

Beggars-tick marsh	1.00
Finley slope pond	1.00
Zenger Farm flat	1.00
Champoeg Park flat	0.75
Cook Park restored	0.75
Hunziker Road flat	0.75
Hyland Park pond	0.75
Marion bank pond	0.75
Tualatin NWR Steinborn	0.75
West Waluga seeps	0.75
Bald Hill Park pond	0.50
Coyote Creek woods	0.50
Lebanon ODOT	0.50
Marion bank flat	0.50
Rickreall flat	0.50
Nimbus Drive slope	0.50
Stewart Ponds	0.50
Balboa restored	0.45
Fisher Butte prairie	0.45
Albany powerline	0.40
Ferry Street flat	0.40
Winsor flat	0.40
Cheyenne Way flat	0.30
Aumsville slope	0.25
Champoeg Park woods	0.25
Coyote Creek meadow	0.25
Marys River flat	0.25
Philomath Park meadow	0.25
Sherwood seeps	0.25
Brown's Ferry forest	0.20
Buford East hillslope	0.20
Jefferson pasture	0.15
Adair Park woods	0.15
Coffin Butte flat	0.15
Coffin Butte upslope	0.15
Corvallis Airport flat	0.15
Dimple Hill seep	0.15
Finley prairie	0.15
Frazier-Cogswell woods	0.15
Greenhill Road prairie	0.15
Jackson-Frazier prairie	0.15
Oak Creek restoration	0.15
Philomath Industrial slope	0.15
Tampico forest	0.15
Scio pasture	0.15
Tice Park seeps	0.15
Walnut Park slope	0.15
Willow Cr. prairie & woods	0.15
OSU Pasture forest	0.03
Seavy prairie	0.03
Shooting range woods	0.03
Adair pasture slope	0.00
Finley ash swale	0.00
OSU Pasture slope	0.00
Wilson Wildlife Area prairie	0.00

Sediment Stabilization & Phosphorus Retention

Zenger Farm flat	1.00
Albany powerline	0.95
Champoeg Park flat	0.92
Marion bank flat	0.92
Tualatin NWR Steinborn	0.92
West Waluga seeps	0.92
Bald Hill Park pond	0.92
Philomath Park meadow	0.91
Balboa restored	0.89
Beggars-tick marsh	0.89
Coyote Creek meadow	0.88
Marys River flat	0.88
Coffin Butte flat	0.88
Hunziker Road flat	0.88
Nimbus Drive slope	0.84
Jefferson pasture	0.83
Scio pasture	0.83
Winsor flat	0.83
Marion bank pond	0.79
Ferry Street flat	0.79
Willow Cr. prairie & woods	0.77
Aumsville slope	0.77
Cheyenne Way flat	0.73
Finley slope pond	0.73
Fisher Butte prairie	0.73
Stewart Ponds	0.73
Cook Park restored	0.73
Rickreall flat	0.72
Oak Creek restoration	0.72
Jackson-Frazier prairie	0.72
Seavy prairie	0.72
Corvallis Airport flat	0.68
Hyland Park pond	0.68
Champoeg Park woods	0.67
Lebanon ODOT	0.67
Philomath Industrial slope	0.67
Greenhill Road prairie	0.67
OSU Pasture forest	0.65
Buford East hillslope	0.61
Coyote Creek woods	0.61
Finley prairie	0.61
Tice Park seeps	0.59
Sherwood seeps	0.55
Dimple Hill seep	0.51
Coffin Butte upslope	0.51
Frazier-Cogswell woods	0.51
Wilson Wildlife Area prairie	0.51
Shooting range woods	0.49
Brown's Ferry forest	0.49
Adair Park woods	0.45
Finley ash swale	0.40
OSU Pasture slope	0.40
Walnut Park slope	0.40
Adair pasture slope	0.35
Tampico forest	0.35

Nitrogen Removal

Adair Park woods	1.00
Buford East hillslope	1.00
Tampico forest	1.00
Fisher Butte prairie	0.98
Sherwood seeps	0.98
Tice Park seeps	0.98
Finley slope pond	0.96
Hunziker Road flat	0.95
Cook Park restored	0.90
Coyote Creek woods	0.90
Frazier-Cogswell woods	0.90
Champoeg Park flat	0.89
Greenhill Road prairie	0.89
Stewart Ponds	0.88
Brown's Ferry forest	0.86
Finley ash swale	0.86
Finley prairie	0.86
Philomath Industrial slope	0.85

Coyote Creek meadow	0.83
Champoeg Park woods	0.82
Hyland Park pond	0.82
Jackson-Frazier prairie	0.82
Coffin Butte upslope	0.81
West Waluga seeps	0.80
Winsor flat	0.80
Dimple Hill seep	0.79
Ferry Street flat	0.78
Marion bank pond	0.78
Marys River flat	0.78
Walnut Park slope	0.78
Rickreall flat	0.77
Tualatin NWR Steinborn	0.77
Aumsville slope	0.72
Seavy prairie	0.72
Shooting range woods	0.71
Beggars-tick marsh	0.69
Coffin Butte flat	0.67
Philomath Park meadow	0.67
Albany powerline	0.65
Balboa restored	0.65
OSU Pasture slope	0.65
Nimbus Drive slope	0.63
Adair pasture slope	0.62
Oak Creek restoration	0.62
Wilson Wildlife Area prairie	0.59
Zenger Farm flat	0.59
Marion bank flat	0.57
Bald Hill Park pond	0.55
Lebanon ODOT	0.53
Corvallis Airport flat	0.51
OSU Pasture forest	0.51
Scio pasture	0.48
Jefferson pasture	0.43
Cheyenne Way flat	0.37

Primary Production

Buford East hillslope	1.00
Rickreall flat	1.00
Finley prairie	0.98
Fisher Butte prairie	0.98
Hunziker Road flat	0.96
Greenhill Road prairie	0.95
Adair Park woods	0.94
Champoeg Park woods	0.93
Stewart Ponds	0.93
Finley slope pond	0.92
Hyland Park pond	0.91
Coyote Creek meadow	0.90
Jackson-Frazier prairie	0.90
Philomath Industrial slope	0.90
Finley ash swale	0.90
Tampico forest	0.88
Champoeg Park flat	0.88
Dimple Hill seep	0.85
Marion bank pond	0.85
Adair pasture slope	0.85
Marys River flat	0.85
OSU Pasture slope	0.85
Sherwood seeps	0.84
Wilson Wildlife Area prairie	0.83
Tice Park seeps	0.82
Winsor flat	0.81
Walnut Park slope	0.80
Aumsville slope	0.79
Ferry Street flat	0.78
Seavy prairie	0.78
Frazier-Cogswell woods	0.76
Coffin Butte flat	0.76
Coyote Creek woods	0.76
Lebanon ODOT	0.76
Shooting range woods	0.76
Tualatin NWR Steinborn	0.76
Coffin Butte upslope	0.73
Cook Park restored	0.72
Willow Cr. prairie & woods	0.71
Philomath Park meadow	0.71
Brown's Ferry forest	0.67
Bald Hill Park pond	0.65
Balboa restored	0.63
West Waluga seeps	0.61
Oak Creek restoration	0.61
Scio pasture	0.61
Cheyenne Way flat	0.56
Marion bank flat	0.56
Albany powerline	0.56
Nimbus Drive slope	0.54
Jefferson pasture	0.52
Zenger Farm flat	0.52
OSU Pasture forest	0.51
Beggars-tick marsh	0.49
Corvallis Airport flat	0.35

Invertebrate Habitat Support

Buford East hillslope	1.00
Bald Hill Park pond	0.99
Finley slope pond	0.99
Hunziker Road flat	0.89
Coyote Creek woods	0.81
Finley prairie	0.81
Fisher Butte prairie	0.81
Champoeg Park flat	0.80
Champoeg Park woods	0.80
Coffin Butte upslope	0.80
Greenhill Road prairie	0.80
Adair Park woods	0.79
Tampico forest	0.79
Shooting range woods	0.78
Stewart Ponds	0.78
Aumsville slope	0.77
Rickreall flat	0.76
Willow Cr. prairie & woods	0.76
Jackson-Frazier prairie	0.75
Adair pasture slope	0.74
Finley ash swale	0.74
Marion bank pond	0.73
Marys River flat	0.73
Tualatin NWR Steinborn	0.72
Dimple Hill seep	0.71
Marion bank flat	0.71
Scio pasture	0.71
Coyote Creek meadow	0.69
Oak Creek restoration	0.68
Philomath Industrial slope	0.68
Lebanon ODOT	0.67
Sherwood seeps	0.66
Coffin Butte flat	0.64
OSU Pasture slope	0.64
Hyland Park pond	0.63
Seavy prairie	0.63
Balboa restored	0.61
Jefferson pasture	0.59
Beggars-tick marsh	0.58
Philomath Park meadow	0.57
Tice Park seeps	0.57
Wilson Wildlife Area prairie	0.57
Ferry Street flat	0.56
Frazier-Cogswell woods	0.56
Walnut Park slope	0.56
OSU Pasture forest	0.55
Corvallis Airport flat	0.52
West Waluga seeps	0.52
Brown's Ferry forest	0.45
Winsor flat	0.45
Cheyenne Way flat	0.41
Cook Park restored	0.35
Albany powerline	0.33
Nimbus Drive slope	0.30
Zenger Farm flat	0.26

Amphibian & Turtle Habitat

Adair Park woods	1.00
Buford East hillslope	1.00
Champoeg Park woods	0.97
Finley slope pond	0.97
Marion bank pond	0.95
Tualatin NWR Steinborn	0.94
Finley ash swale	0.93
Willow Cr. prairie & woods	0.92
Champoeg Park flat	0.91
Marys River flat	0.90
Hunziker Road flat	0.89
Aumsville slope	0.88
Stewart Ponds	0.88
Dimple Hill seep	0.86
Walnut Park slope	0.86
Bald Hill Park pond	0.84
Coyote Creek meadow	0.84
Frazier-Cogswell woods	0.83
Finley prairie	0.82
Fisher Butte prairie	0.81
Marion bank flat	0.81
Philomath Industrial slope	0.80
Greenhill Road prairie	0.79
Jackson-Frazier prairie	0.79
Tice Park seeps	0.79
Wilson Wildlife Area prairie	0.79
Tampico forest	0.77
Shooting range woods	0.76
Scio pasture	0.75
Adair pasture slope	0.73
Coffin Butte flat	0.73
Coyote Creek woods	0.73
OSU Pasture slope	0.73
Oak Creek restoration	0.73
Sherwood seeps	0.73
Cook Park restored	0.71
Jefferson pasture	0.70
Ferry Street flat	0.70
West Waluga seeps	0.70
Rickreall flat	0.69
Winsor flat	0.69
Hyland Park pond	0.68
Brown's Ferry forest	0.67
Seavy prairie	0.67
Balboa restored	0.66
Coffin Butte upslope	0.66
Philomath Park meadow	0.63
Zenger Farm flat	0.62
Albany powerline	0.60
Beggars-tick marsh	0.60
Lebanon ODOT	0.57
Nimbus Drive slope	0.56
OSU Pasture forest	0.54
Cheyenne Way flat	0.47
Corvallis Airport flat	0.47

Breeding Waterfowl Support (these are the only sites meeting 0.5 acre threshold for permanent water)

Rickreall flat	1.00
Cook Park restored	0.81
Beggars-tick marsh	0.76

Wintering & Migratory Bird Support

Rickreall flat	1.00
Corvallis Airport flat	0.74
Fisher Butte prairie	0.73
Finley prairie	0.71
Tualatin NWR Steinborn	0.70
Champoeg Park flat	0.66
Marion bank flat	0.66
Greenhill Road prairie	0.63
Lebanon ODOT	0.60
Coffin Butte flat	0.58
Oak Creek restoration	0.57
Bald Hill Park pond	0.56
Coffin Butte upslope	0.56
Cook Park restored	0.54
Hunziker Road flat	0.52
Adair Park woods	0.51
Beggars-tick marsh	0.51
Finley slope pond	0.51
Buford East hillslope	0.49
Zenger Farm flat	0.48
Cheyenne Way flat	0.46
Nimbus Drive slope	0.46
Willow Cr. prairie & woods	0.45
Jackson-Frazier prairie	0.44
Balboa restored	0.43
Coyote Creek meadow	0.43
Albany powerline	0.42
Marys River flat	0.39
Hyland Park pond	0.38
Seavy prairie	0.38
Aumsville slope	0.34
Marion bank pond	0.34
Adair pasture slope	0.33
Sherwood seeps	0.33
Stewart Ponds	0.30
Brown's Ferry forest	0.29
Shooting range woods	0.27
Jefferson pasture	0.26
Champoeg Park woods	0.26
Frazier-Cogswell woods	0.26
Wilson Wildlife Area prairie	0.26
Tampico forest	0.25
Tice Park seeps	0.25
Philomath Industrial slope	0.24
Coyote Creek woods	0.23
OSU Pasture forest	0.23
Scio pasture	0.23
Walnut Park slope	0.23
Ferry Street flat	0.21
OSU Pasture slope	0.21
West Waluga seeps	0.21
Philomath Park meadow	0.16
Finley ash swale	0.13
Winsor flat	0.12
Dimple Hill seep	0.04

Songbird Habitat

Rickreall flat	1.00
Adair Park woods	1.00
Buford East hillslope	0.93
Coffin Butte upslope	0.87
Hunziker Road flat	0.83
Cook Park restored	0.83
Finley slope pond	0.83
Corvallis Airport flat	0.82
Tice Park seeps	0.81
Finley prairie	0.77
Beggars-tick marsh	0.77
Sherwood seeps	0.75
Dimple Hill seep	0.74
Finley ash swale	0.72
Zenger Farm flat	0.70
Fisher Butte prairie	0.70
Jackson-Frazier prairie	0.70
Champoeg Park woods	0.69
Hyland Park pond	0.69
Aumsville slope	0.68
Bald Hill Park pond	0.67
Greenhill Road prairie	0.65
Marion bank flat	0.65
Marion bank pond	0.64
Frazier-Cogswell woods	0.64
Philomath Industrial slope	0.64
Tualatin NWR Steinborn	0.64
Willow Cr. prairie & woods	0.63

Oak Creek restoration	0.61
Wilson Wildlife Area prairie	0.61
Shooting range woods	0.60
OSU Pasture forest	0.60
OSU Pasture slope	0.60
Coyote Creek meadow	0.60
Coyote Creek woods	0.59
Tampico forest	0.58
Balboa restored	0.58
Lebanon ODOT	0.56
Winsor flat	0.55
Cheyenne Way flat	0.55
Coffin Butte flat	0.54
Marys River flat	0.54
Adair pasture slope	0.53
Walnut Park slope	0.52
Champoeg Park flat	0.52
West Waluga seeps	0.51
Ferry Street flat	0.51
Brown's Ferry forest	0.51
Scio pasture	0.50
Jefferson pasture	0.49
Stewart Ponds	0.49
Seavy prairie	0.47
Albany powerline	0.47
Philomath Park meadow	0.46
Nimbus Drive slope	0.41

Support of Characteristic Vegetation

Shooting range woods	1.00
Finley prairie	0.98
Tampico forest	0.97
Philomath Industrial slope	0.96
Frazier-Cogswell woods	0.95
Fisher Butte prairie	0.92
Willow Cr. prairie & woods	0.91
Buford East hillslope	0.90
Balboa restored	0.89
Coyote Creek woods	0.87
Finley ash swale	0.86
Greenhill Road prairie	0.85
Adair Park woods	0.84
Hyland Park pond	0.84
Jackson-Frazier prairie	0.83
Wilson Wildlife Area prairie	0.83
Stewart Ponds	0.81
Hunziker Road flat	0.80
Seavy prairie	0.79
Champoeg Park woods	0.78
Scio pasture	0.78

Champoeg Park flat	0.75
Coffin Butte upslope	0.74
Finley slope pond	0.74
Rickreall flat	0.73
Beggars-tick marsh	0.71
Brown's Ferry forest	0.71
Tice Park seeps	0.71
West Waluga seeps	0.71
Coyote Creek meadow	0.70
Marys River flat	0.70
Tualatin NWR Steinborn	0.70
Aumsville slope	0.69
Bald Hill Park pond	0.69
Oak Creek restoration	0.69
Lebanon ODOT	0.68
OSU Pasture forest	0.68
Albany powerline	0.67
Coffin Butte flat	0.67
Dimple Hill seep	0.67
Walnut Park slope	0.65
Winsor flat	0.65
Ferry Street flat	0.63
Adair pasture slope	0.61
Marion bank pond	0.61
Cook Park restored	0.59
Philomath Park meadow	0.59
Sherwood seeps	0.59
Nimbus Drive slope	0.57
Corvallis Airport flat	0.54
Zenger Farm flat	0.50
Marion bank flat	0.44
Cheyenne Way flat	0.41
OSU Pasture slope	0.32
Jefferson pasture	0.28

Appendix F. Forms for Collecting Plant Data

Non-native	**Woody/Vine Data Form** *In each column, estimate cover of each species as a percent of all species in that column that are found at the site. Base your estimate on observations while walking through the site (no plots needed). Include upland trees if any branches extend into the site. Exclude plantings if planted within last12 months. If species cover is <10% of total, mark "T" (trace). On extra sheets, add any woody/vine species not listed*		**SHRUBS & VINES** (2 - 20 ft.)		**TREES** (>20 ft.)
			in open	**in understory**	
	Acer circinatum	vine maple			
	Acer macrophyllum	bigleaf maple			
	Alnus rubra	red alder			
	Amelanchier alnifolia	serviceberry			
	Berberis (Mahonia) unident. sp.1	Oregon-grape sp.			
*	*Convolvulus* spp.	morning glory, bindweed			
	Cornus sericea	creek dogwood			
	Corylus cornuta	hazelnut			
	Crataegus douglasii	hawthorn			
*	*Crataegus monogyna*	English hawthorn			
	Fraxinus latifolia	Oregon ash			
*	*Hedera helix*	English ivy			
	Lonicera involucrata	black twinberry			
	Oemleria cerasiformis	Indian-plum			
	Physocarpus capitatus	Pacific ninebark			
	Populus balsamifera ssp. trichocarpa	black cottonwood			
	Prunus unidentified sp.1	wild plum			
	Pseudotsuga menziesii	Douglas-fir			
	Pyrus fusca	crabapple			
*	*Pyrus* unidentified sp.1	wild pear; wild apple			
	Quercus garryana	white oak			
	Rhamnus purshiana	cascara, buckthorn			
	Rhus diversiloba	poison oak			
	Rosa nutkana	Nootka rose			
*	*Rosa eglanteria*	sweetbrier			
	Rosa pisocarpa	clustered wild rose			
	Rosa unidentified sp. 1	rose unidentified species			
*	*Rubus discolor*	Himalayan blackberry			
*	*Rubus lacinatus*	evergreen blackberry			
	Rubus parviflorus	thimbleberry			
	Rubus spectabilis	salmonberry			
	Rubus ursinus	trailing blackberry			
	Salix fluviatilis	river willow			
	Salix geyeriana	Geyer willow			
	Salix hookeriana	Hooker willow			
	Salix lucida ssp. lasiandra	Pacific willow			
	Salix sitchensis	Sitka willow			
	Salix unidentified sp. 1	willow unidentified sp.			
	Sambucus racemosa	red elderberry			
*	*Solanum dulcamara*	nightshade			
*	*Solanum niger*	black nightshade			
	Spiraea douglasii	Douglas spiraea			
	Symphoricarpos albus	common snowberry			
	Thuja plicata	red cedar			
	Tsuga heterophylla	western hemlock			
	Vaccinium caespitosum	dwarf blueberry			
	Check:		100%	100%	100%

Common Herb Data Form. List only the species **that occupy more than 100 ft^2** of the area of the site (not necessarily in one patch). Include vines and woody species if they are shorter than 2 ft and meet this spatial threshold and were planted more than 12 months ago. If common plants are noted that are recognizable as a different species but you are unsure of identification, record as "Herb sp. 1," "Herb sp. 2," etc.	**Check if NON-native**
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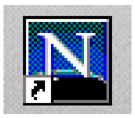
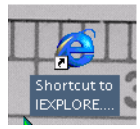
How to Use the Appendices on the Accompanying CD-ROM

Put the CD in your CD drive, then follow instructions below, depending on which appendices you want to view. Note: If you do not already have Adobe Acrobat Reader on your computer, you must first download and install it if you want to view Appendix G or H. See instructions in Table A-1 below.

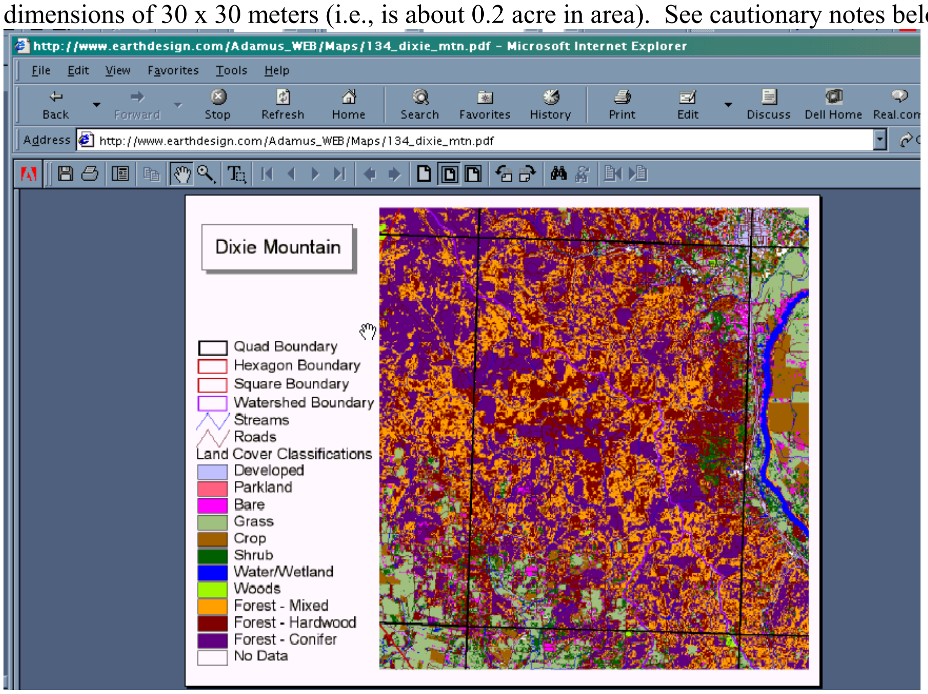
Appendix G. Map: Land Cover of the Willamette Valley, Circa 1992

Assuming you have Adobe Acrobat Reader, click on Netscape or IE Explorer browser icon on your desktop, but don't connect to the internet (i.e., Work Offline).





Once the browser opens, on its toolbar click File, then Open File, and in the address bar type in D: (or whichever drive your CD is on) and press Enter. Click on the folder **Adamus_CD,** then on the file **INDEX.HTM** (this is the one that simply says "Index" under the Netscape icon). To view land cover in a particular area, click on the appropriate rectangle (= quad map) in this index map. A full-screen version (like below) of that rectangle will appear. In order to zoom to (enlarge) a particular area within the rectangle, first locate it using the major roads shown (and with an Oregon road atlas at your side), then click repeatedly on the magnifier icon in the Adobe Acrobat menu. Each small square (pixel) has dimensions of 30 x 30 meters (i.e., is about 0.2 acre in area). See cautionary notes below before using.



Appendix H. Map: Land Cover of the Willamette Valley, Circa 1850 (includes study site locations)

Assuming you have Adobe Acrobat, click on the file **HISTMAP.PDF.** To view land cover in a particular area, first locate the area using the major roads shown (and with an Oregon road atlas at your side), then click repeatedly on the magnifier icon in the Adobe Acrobat menu to zoom in. Locations of the 109 sites assessed by OWRA field teams during 1999-2000 are marked with red stars. See cautionary notes below before using.

Appendix I. Maps: Locations of Study Sites (individual maps)

These files contain detailed color maps of the area immediately surrounding all 109 of the reference sites, usually one site per file. Click on the **SITEMAPS** folder. The file names inside this folder correspond to the site ID numbers; see Table I-1 below for list. For viewing the maps, import them using any of several image-viewing software programs, for example, in MS Word2000, open a new document, click Insert-Picture-From File, and type in the file name and location, e.g., D:\sitemap\SITE64.BMP).

Appendix J. Descriptions of Willamette Valley Hydric Soil Series

Open **HYDSOILS.RTF** in MS Word or another word processing programs. This file contains narrative information on all soil series officially designated as "hydric" in the Willamette Valley, plus some additional soils that often contain hydric inclusions. These descriptions were extracted verbatim from NRCS documents, and provide information on characteristics of a typical pedon, range in characteristics, similar soil series, geographic setting, geographically associated soil series, and diagnostic features.

Appendix K. Function Indicator Data from 109 Reference Sites

Open file **HGMDATA.TXT** using any database or spreadsheet software, e.g., MS Excel, MS Access. The file is in ASCII format, with data fields (columns) delimited by commas. Rows contain the site names. The columns (containing the indicator data) are not labeled (do not have headers), but are mostly in alphabetical order from right to left, in the sequence described in Table K-1 below. See cautionary notes below before using.

Appendix L. Biological Data from 109 Reference Sites

Click on folder **BIOTA**. Then open one of these files using any database or spreadsheet software, e.g., MS Excel, MS Access, and specify "comma-delimited fields" if asked.

HERBDB.TXT -- our herbaceous plant species data. The unlabeled columns are in the sequence shown in Table L-1 below. See cautionary notes below before using.

WOODYDB.TXT -- our woody plant species data. The unlabeled columns are in the sequence shown in Table L-2 below. See cautionary notes below before using.

BIRD0600.TXT -- our bird data (5 sites only). From left to right, the unlabeled columns are Site Name, Identifier for point within the site, Date of survey, Species found, Observation type (X = out of range, >50 m away), Latitude of site, Longitude of site

GPSPLOTS.TXT -- geographic coordinates of most of the herb plots. From right to left, the columns are: Site Name, Plot ID#, Latitude (N), Longitude (W).

Appendix M. Bibliography of Wetland/Riparian Literature for the Pacific Northwest

Click on folder **DOCS**. Open **BIBOREG.RTF** in MS Word or another word processing program.

Appendix N. Photographs of Selected Reference Sites

Click on folder **PICS**. The file names inside this folder correspond to the site ID numbers; see Table I-1 below for list. For viewing the photos, import them using any of several image-viewing software programs, for example, in MS Word2000, open a new document, click Insert-Picture-From File, and type in the file name and location, e.g., D:\PICS\PIC13.BMP).

Appendix O. Copies of the Guidebook Volumes

Click on folder **DOCS**. Using Adobe Acrobat, open whichever file you want:

VOL_1A.PDF: The assessment methods
VOL_1B.PDF: The technical report
STATEPRO.PDF: The statewide classification and profile

Appendix P. Condensed Version of Data Form for Function Assessment

Using Adobe Acrobat Reader, open the file SHORTFRM.PDF.

Cautionary & Explanatory Notes

If you intend to publish reports or articles based on further statistical analysis any of the data sets, we would appreciate being contacted to discuss opportunities for collaboration and shared authorship

Notes about Appendix G. The original digital coverage, from which this map was derived, *was provided by the Forest Sciences Laboratory at Oregon State University*. They prepared the land cover maps largely by applying computer image processing techniques to 1992 satellite imagery (LANDSAT Thematic Mapper). This was done by Douglas Oetter and others at the Forest Sciences Laboratory (FSL), with funding from the U.S. Environmental Protection Agency (USEPA). Each pixel was labeled only according to the land cover class that predominated within its 30 x 30 m area. Very little ground-checking was done. For full details, see: http://www.fsl.orst.edu/larse/wrb/wrb.html
Watershed boundaries, and locations of roads, streams, and cities were provided by the State Service Center for GIS. Hexagon boundaries were provided by the USEPA, and boundaries of 5 x 5 km squares used by the Oregon Breeding Bird Atlas Project were provided by that project.

Appendix H. The original digital coverage, from which this map was derived, *was provided by the Oregon Natural Heritage Program.* The map is based on anecdotal written notes of surveyors who worked for the General Land Office (GLO) between 1851 and 1909, as they surveyed township and section lines. Those notes were recently interpreted by John Christy and others at the Oregon Natural Heritage Program, with partial funding from the U.S. Environmental Protection Agency, Oregon Division of State Lands, U.S. Bureau of Land Management, Army Corps of Engineers, Bonneville Power Administration, the Oregon Community Foundation, The Nature Conservancy, and the City of Portland. In most cases, land cover present at the time of the GLO survey is believed to be a close approximation of vegetation prior to widespread changes wrought by Euroamerican settlement. The accuracy and precision of the information is unknown and unknowable. For full details of this "Version 2.0" coverage, see: http://www.fsl.orst.edu/pnwerc/wrb/toc_frames_x.html
The road and stream coverage was provided by the Forest Sciences Laboratory (FSL), Oregon State University. Locations of cities were provided by the State Service Center for Geographic Information Systems.

Notes about Appendix I. These files contain detailed color maps of the area immediately surrounding all 109 of the reference sites, usually one site per file. The maps are at scales of 1:24,000 (larger sites) or 1:12,000 (smaller sites). These maps are from the USGS 1:24,000 quad map series. For determining the larger context of these locations, see the maps in Appendix H (/HISTMAP.PDF), or use the coordinates given in Volume IA of the guidebook. NOTE: The thick blue lines drawn on these maps are NOT the precise jurisdictional boundaries of wetlands. The lines are only the approximate boundaries of the assessment site, and they may encompass some (generally <20% of total area) upland inclusions and other HGM subclasses.

Notes about Appendix K. Data were entered into the database only for indicators that were used in the scoring models, even though data on many additional indicators were collected at all sites.

Notes about Appendix L. BIOTA

HERBDB.TXT: This contains all data on herb species from the 109 reference sites, including both observations from 1-square meter non-random plots, and casual observations (coded separately). *These data do not represent a comprehensive botanical inventory of these sites, and identifications have not be thoroughly checked.* Before using the data, be sure you understand the protocols that were used to collect these data, as described in Section 8.2 (and especially Table 10) of Volume IB.

WOODYDB.TXT: This contains all data on woody plant species from the 109 reference sites, including both observations of woody plants <2 ft tall from 1-square meter non-random plots, and (mostly) the casual observations from outside the plots. *These data do not represent a* *comprehensive botanical inventory of woody vegetation at these sites, and identifications have not be thoroughly checked.* Before using the data, be sure you understand the protocols that were used to collect these data, as described in Section 8.2 (and especially Table 10) of Volume IB.

BIRD0600.TXT: This file contains species presence/ absence information based on a single visit to 5 mostly wooded reference sites during June 2000. The sites were visited during early morning during good weather. At each site, birds recognized visually and/or auditorily during a 5-minute count period at a fixed point were noted. Most sites contained more than one point, and points were spaced approximately 150 m apart.

Table A-1. Obtaining, installing, and viewing maps with Adobe Acrobat

(prepared by Ralph Garono, EarthDesign, Corvallis, OR)

1. Visit the Adobe web site and download the free Acrobat Reader. The address is: http://www.adobe.com /products/ acrobat/readermain.html

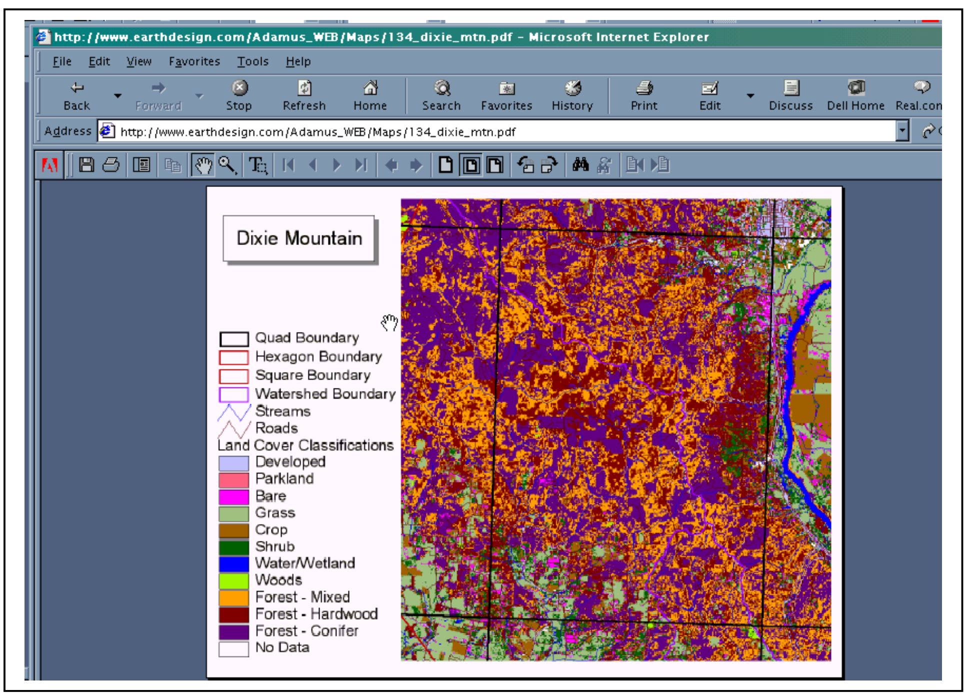
2. On the Adobe web page you'll have to answer a few questions to select the correct version for your computer and language. You'll also need to give your name & email address.

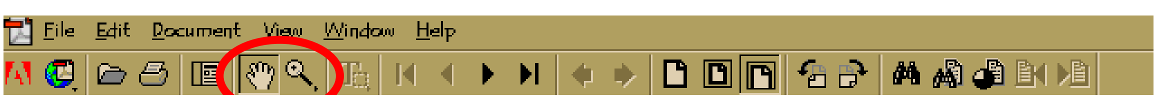
3. Indicate where you want the file to be saved to your local machine (generally c:/temp). Make sure that you remember where you saved the file! The file can be as large as 5 MB and may take a while to download, depending on your connection speed.

4. When the download of the file (an EXE file) is completed, open your file explorer (e.g., Windows Explorer) and navigate to the directory where you saved the file from the Adobe web site. Find the file (named something like AR405ENG.EXE) and double click on the file with your file explorer to run the installation program. You'll see a message box that describes all the files that are being 'unpacked' to your hard drive. Next, you'll be asked to answer several questions. For example, *Where should the program be installed?* You should type in "C:/Program Files/Adobe" (without the quotation marks). When the software is done being installed, you will see a message that thanks you for installing it.

5. After loading the map (see Appendix G and H descriptions above), use the left mouse key and click on the quad in the index image. ***Hint***: if you let the cursor hover over the quad, a popup window will identify the quad name before you click on it. Once you find the quad that you are interested in, you can click the mouse key and you should see the Adobe Acrobat Reader load. The quad map will appear in the web browser window. To move back to the index map, click on the BACK button on your web browser.

6. Look for the following tool bar:





There are two tools that will be particularly useful: the **Magnifying** tool will let you zoom in on a particular area and the **Hand** tool will let you move the page around

To use the Magnifying tool. First, select the tool from the tool bar. The cursor will change to a magnifying glass. Move the cursor to the area you want to zoom in on. Left click your mouse and hold the mouse key down while dragging the mouse. You should see a box outline on the screen that delineates the area that you'll zoom in on. To return the map/text to normal size, click on the left most icon of a page (five icons to the left of the binoculars).

To use the Hand tool: First, select the tool from the tool bar. Then while holding down the left mouse key, drag the mouse to move the text.

Table I-1. Site Identification Numbers:
(* = photographed)

Site	ID#
Adair Park woods 1999	2
Adair Park woods 2000	3*
Adair pasture slope	4
Adair pond	5
Albany powerline	6
Alton Baker Park slough	7*
Anderson Park alcove	8
Anderson Park sloughs	9
Aumsville slope	10
Balboa restored	11
Bald Hill Park pond	12
Beggars-tick marsh	13*
Bowers Rock slough	14*
Brown's Ferry forest	16
Brown's Ferry pond	17
Brownsville constructed	18
Buford East hillslope	20*
Buford West slough	21*
Calapooia River 1	22
Calapooia River 2	23
Cascades Gateway slough	24*
Champoeg Park flat	25
Champoeg Park woods	26
Cheyenne Way flat	27
Christensen Park slough	28*
Coffin Butte flat 1999	29
Coffin Butte flat 2000	30*
Coffin Butte pond	31
Coffin Butte upslope	32
Cook Park restored	33*
Cook Park slough	34
Corvallis Airport flat - DF	35
Corvallis Airport flat - PA	36
Coyote Creek meadow	37
Coyote Creek woods	38
Coyote floodplain	91
Delta Ponds	39
Dimple Hill seep	40
Mt.View enhanced slough	41
Fanno Creek duck donut	42
Ferry Street flat	43
Finley ash swale	44
Finley floodplain	45*
Finley prairie	46*
Finley slope pond	47
Fisher Butte prairie	48*
Frazier-Cogswell forest	49*
Furnburg Park	50
Gibson Creek enhanced slough	51
Grand Island slough	52*
Greenberry floodplain	19
Greenhill Road prairie	53
Hedges Creek duck ponds	54*
Hileman Park alcove	55
Hileman Park slough	56*
Hunziker Road flat - DF	57
Hunziker Road flat - PA	58
Hunziker Road flat - YV	59
Hyland Park pond	61
Jackson-Frazier floodplain	62
Jackson-Frazier prairie	63*
Jasper Park slough	64*
Jefferson pasture	1
Kingston Prairie slope	65
Lebanon ODOT	68
Luckiamute floodplain	69
Marion bank flat	70
Marion bank pond	71
Marys River flat 1999	72
Marys River flat 2000	73*
McDonald Forest ponds	74
Minto-Brown big slough	75
Minto-Brown slough 1	76*
Minto-Brown slough 2	77
Nimbus Drive slope	80
OSU Pasture forest	81
OSU Pasture slope	82
Oak Creek restoration	83*
Oaks Bottom backwater	84
Philomath Industrial slope 1999	85*
Philomath Industrial slope 2000	86
Philomath Park meadow	87*
Philomath Park slough	88
Rickreall flat	79
Scio pasture	101
Scio pond	102
Seavy prairie	89*
Sherwood seeps	90*
Shooting range pond	92
Shooting range woods	93
Snagboat Bend slough	94
Spongs Landing slough	95*
Stayton Interchange restored	96
Stewart Ponds	97
Summerlake Park pond	98
Takena Park sloughs	99*
Tampico forest	100*
Tice Park seeps	103*
Timber-Linn pond	104
Truax gravelpit restoration	105
Truax slough - DF	106
Truax slough - PA	107*
Tualatin Hills Big Pond	108
Tualatin Hills Lily Pond	109
Tualatin NWR Chicken Cr.	110
Tualatin NWR Steinborn	111
Tualatin NWR beaverdam	112
Walnut Park slope	113
West Waluga seeps	115
Whitley Landing floodplain	116*
Willamette Mission slough	117
Willamette Park slough	118
Willow Cr. prairie & woods	119*
Willow Creek riverine	120*
Wilson Wildlife Area main pond	121
Wilson Wildlife Area north pond	122
Wilson Wildlife Area prairie	123
Winsor flat	124
Zenger Farm flat	125

Table K-1. Data field headings for HGMDATA.TXT

Column	Code	Indicator (full name)
1	HGM	HGM subclass
2	ID	Site ID#
3	SiteName	Site Name
4	RFS	Least-altered (LA) Site? 1= LA RI site, 2= other RI site 3= LA SF site, 4= other SF site
5	Area	Area of entire site (acres)
6	AcPerm	Acreage of permanent water
7	AnadAcc	Accessible to anadromous fish 0= no anadromous fish passage, 1= accessible
8	BareSeas%	Percent of seasonal zone that is *bare* during most of the dry season
9	BuffCropG	Percent of land cover in 200 ft buffer zone that is grassland or cropland
10	BufCropGabc	Mean percent of land cover in 200, 1000, & 5280 ft buffer zones that is grassland or cropland
11	BuffGrass	Percent of land cover in 200-ft buffer zone that is grassland or wetland/water
12	BufGrassAB	Mean percent of land cover in 200 & 1000 ft buffer zones that is grassland or wetland/water
13	BuffMix	Ratio of natural grass % to woodland % in 200-ft buffer zone
14	BuffNat	Percent of land cover in 200-ft buffer zone that is “natural” (wooded or grass or wetland/water)
15	BufNatAB	Mean percent of land cover in 200 & 1000 ft buffer zones that is “natural” (wooded or grass or wetland/water)
16	BuffWet	Percent of land cover in 200 ft buffer zone that is “water” or “wetland”
17	BufWetABC	Mean percent of land cover in 200, 1000, & 5280 ft buffer zones that is “water” or “wetland”
18	BuffWood	Percent of land cover in 200-ft buffer zone that is woodland (forested or shrubland or parkland)
19	BufWoodAB	Mean percent of land cover in 200 & 1000 ft buffer zones that is woodland (forested or shrubland or parkland)
20	Burned	Fire or harvest 0= no evidence, 1= evidence
21	ConnType	Type of connection to other water bodies 0= none, 1= seasonal constricted, 2= seasonal diffuse, 3= permanent constricted, 4= permanent diffuse
22	Create%	Percent of site created from upland
23	Deadwd	Number of kinds of dead wood
24	DeepL	Percent in the 2-6 ft depth class during low water
25	Depth#class	Number of depth categories during high water
26	DepPre%L	Percent of site occupied by the most extensive depth category during biennial low water.
27	FCC%	Percent of site with closed-canopy woods (wooded sites only)
28	FCC%Seas	Percent of seasonal zone with closed canopy
29	FluxMost	Difference between annual high & low predominating water levels
30	H%Perm	Percent of permanent zone containing herbs
31	H%Seas	Herbs as % of seasonal zone
32	HcvNN	Relative spatial prevalence of non-native herbs 1= Non-natives predominate, 2= Cannot determine (about equal), 3= Natives predominate
33	Hsp%NN	Percent of common herb species that are non-native
34	LevMaxL	Maximum water depth during low water 1= 0”, 2= 1-2”, 3= 2-24”, 4= 2-6 ft, 5= >6 ft
35	LevMostL	Predominant depth class during low water 1= 0”, 2= 1-2”, 3= 2-24”, 4= 2-6 ft, 5= >6 ft
36	LiveStor	Predominant vertical increase in surface water level (ft.)

Column	Code	Indicator (full name)
37	Logs	Apparent presence of partly submerged logs & boulders 0= absent, 1= present
38	Mow	Rating for mowing or extreme grazing (% of site) 0= none, 1= 1-10%, 2= 10-90%, 3= >90%
39	Perm	Presence of permanent surface water 0= absent, 1= present
40	PermOpen%	Percent of permanent zone that lacks herbs
41	Poolmix%H	Percent & distribution of pools during high water (see figure in Glossary of Volume IA): condition A= 0, B=1, C= 2, D= 3, E= 4, F= 5, G= 6, H= 7, I= 8, J= 9, K= 10
42	Poolmix%L	Percent & distribution of pools during low water (coded same as above)
43	Puddle	Extent of puddles/ hummocks (% of site) 0= none, 1= 1-10%, 2= 10-90%, 3= >90%
44	Redox	Presence of mottling &/or other features that indicate oxygen deficits in soils/ sediments 0= absent, 1= present
45	RoadDis	Distance to nearest busy road (ft)
46	Seas&P	Seasonal zone as percent of site in sites that also contain a permanent zone
47	Shade%P	Percent of permanent zone shaded by woody or aquatic plants
48	ShallowL	Percent in the 2-24 inch depth class during low water
49	ShedNat%	Percent "natural" land cover in the contributing watershed within 200 ft. of the site
50	SoilComp	Percent of site currently affected by soil compaction 0 = none, 1 = >5 years ago, 1-10% of site, 2 = >5 years ago, 10-90% of site 3 = >5 years ago, >90% of site 4 = recent, at 1-10% of site 5 = recent, at 10-90% of site 6 = recent, at >90% of site
51	SoilHy	Mapped soil series is hydric (not simply a hydric inclusion) 0= no, 1= yes
52	SoilLev	Rating for soil leveling (% of site) 0= none, 1= 1-10%, 2= 10-90%, 3= >90%
53	SoilPlow	Rating for soil mixing from plowing or other earth-moving (same scale as SoilComp, see above)
54	SoilTex	Predominant texture of upper soil layer (particle size) 1= clay, 2= loam, 3= sand, 4= cobble/gravel
55	SU%Seas	Understory shrub & vine cover as percent of seasonal zone (wooded sites only)
56	SUcvsum	Percent understory shrub cover
57	TreeMaxD	Diameter of largest trees (wooded sites only, in inches)
58	VegMixL	Number of vegetation forms & their distribution during low water (see figure in Glossary of Volume IA): condition A= 1, B2=2, C2= 3, B1= 4, C1= 5, D= 6, E2= 7, F2= 8, F1= 9, F2= 10, G= 11
59	VegPct	Percent vegetated (as viewed from above)
60	VegPre	Land cover in the vicinity of the site in 1800's: 1= mostly non-wooded, 2= mostly wooded
61	Vernal	Extent of vernal pools, mudflats or shorebird scrapes in shallow depressions (sq. ft.) 0= none 1= 1-100 2= 100-1000, 3= 1000-10,000 4= >10,000
62	Visits	Frequency of humans visiting on foot -- score on scale of 100 (most) to 500 (least)
63	WdCv%NN	Percent of woody cover within stratum that is comprised of non-native species (greater of tree; understory shrub; or open shrub stratum)

Column	Code	Indicator (full name)
64	WdSp%Ntv	Percent of woody species that are native
65	WdPct	Percent of site containing woody vegetation (as viewed from above)
66	WdNtvsp	Number of native woody plant species
67	WdSpp	Number of woody plant species
68	WSfuncRI	Standardized score from assessment of Water Storage & Delay function in Riverine Impounding sites
69	WSfuncSF	Standardized score from assessment of Water Storage & Delay function in Slope/Flat sites
70	ZoneP%	Percent of site in permanent zone
71	ZoneSeas%	Seasonal zone as percent of total site

Table L-1. Data field headings for HERBDB.TXT

Column 1: HGM subclass:
RI= riverine impounding; SF= slope/flats
Column 2: Site ID
Column 3: Site Name
Column 4: Special Site?
R= Assessed by same person during the following year. Plot ID#'s between years do not correspond. Only the data not marked "R" were used in the final calibration of indicators.
D= assessed independently by more than one person (only the data not marked "D" were used in the final calibration of indicators)
Column 5: Reference Standard Site
X= considered to be a least-altered (reference standard) site for its subclass
Column 6: Plot ID#.
99= casual observation from outside the plots
Note: Within sites, data were originally recorded by "zone", e.g., Plot 1 from "seasonally inundated understory", Plot 1 from "seasonally inundated open", Plot 1 from "saturated-only open." The zone descriptors were subsequently dropped and plots were renumbered, so that different plots never shared the same plot number.
Column 7: Scientific Name
Column 8: 6-letter code for scientific name.
usually, the first three letters of the genus and species
Column 9: Full Species?
2= a full species
1= a form almost certain to be unique for this site and/or plot
0= a form that might be the same as others at the site and/or plot
Column 10: Wetland Indicator Status, according to USFWS indicator list for Oregon:
OBL= obligate, FACW= facultative wetland, FAC= facultative, FACU= facultative upland, UPL= obligate upland, UNK= absent from indicator list, or a non-indicator. Furthermore, "+" indicates more frequently found in wetlands, "-" indicates less.
Column 11: Origin (Native to the Willamette Valley?)
1= yes, 0= no, blank= unknown
A few highly invasive natives were classified as non-native.
Column 12: Relative percent cover estimate

Based on observations in each plot. "1" indicates percent cover was "trace" (median cover of <10% in plot). "0" indicates species was not found within any plots, but was encountered casually. Totals of <100% indicate that the remainder was bare, water, and/or species with a median cover of <5%.

Table L-2 . Data field headings for WOODYDB.TXT

Column 1: HGM subclass:
RI= riverine impounding; SF= slope/flat
Column 2: Site ID
Column 3: Site Name
Column 4: Stratum:
SO= open shrub, SU= closed shrub, T= tree
Column 5: Scientific Name
Column 6: 6-letter code for scientific name.
usually, the first three letters of the genus and species
Column 7: Full Species? (same as HERBDB.TXT described above)
Column 8: Wetland Indicator Status, according to USFWS indicator list for Oregon
(same as HERBDB.TXT described above)
Column 9: Origin (Native to the Willamette Valley?)
(same as HERBDB.TXT described above)
Column 10: Relative percent cover estimate within stratum

Based on observations within the stratum across the entire site. "1" indicates percent cover within that stratum was "trace" (median cover of <10% in plot). If a woody species was found in the herb plots but not during casual searching, it was recorded in this file as a "trace." Numbers should sum to about 100% *within strata.*