

# Manual for the Oregon Rapid Wetland Assessment Protocol (ORWAP)



Version 3.1

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Oregon Rapid Wetland Assessment Protocol  
(ORWAP)**

**Version 3.1**

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**The supporting website should be cited as:**

Rempel, M., P. Adamus, and J. Kagan. 2015. Oregon Explorer - Oregon Rapid Wetland Assessment Protocol (ORWAP) Map Viewer: an internet tool for ORWAP wetland assessment support and data archiving. Oregon State University Library and Institute for Natural Resources, Oregon State University, Corvallis, OR. Internet:

[http://tools.oregonexplorer.info/oe\\_map\\_viewer\\_2\\_0/Viewer.html?Viewer=orwap](http://tools.oregonexplorer.info/oe_map_viewer_2_0/Viewer.html?Viewer=orwap)

This manual, the calculator spreadsheet, supporting data files, data forms and other wetland assessment guidebooks may be downloaded from the Oregon Department of State Lands' Technical Resource web page (under construction at time of printing) or [www.oregonstate.edu/~adamusp/](http://www.oregonstate.edu/~adamusp/).

Updates also will be posted periodically at these locations.

For more information about this protocol and opportunities to be trained in its use, please contact:

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## SUMMARY

The Oregon Rapid Wetland Assessment Protocol (ORWAP) is a standardized protocol for rapidly assessing the functions and values of wetlands. The Department of State Lands (DSL) has led its development with funding from the U.S. Environmental Protection Agency and oversight by an advisory committee of state and federal agencies and private consultants. ORWAP is designed to be used for multiple purposes by multiple agencies. The purposes may include assessing all wetlands within a city for land use planning; assessing wetlands within a watershed; assessing individual wetlands or portions of wetlands for purposes of state and federal permitting and compensatory wetland mitigation; and evaluating success of voluntary wetland restoration or enhancement projects. An accompanying document *Guidance for Using the Oregon Rapid Wetland Assessment Protocol (ORWAP) in State and Federal Permit Programs* (Oregon Department of State Lands, November 2016) is available from DSL.

ORWAP is applicable to wetlands of any type anywhere in Oregon. Unlike Oregon's previous hydrogeomorphic (HGM) wetland assessment methods, ORWAP can be used to compare wetlands of very different types. ORWAP does not require the user to fill out different data forms for different wetland types (except for tidal wetlands) or regions of the state. A single three-part data form can be used for all Oregon wetlands. The procedure for using ORWAP involves six basic steps (see section 3.1.1). After data from the three-part form are entered into an Excel spreadsheet, ORWAP automatically generates scores intended to reflect a wetland's ability to support the following functions: Water Storage and Delay, Sediment Retention and Stabilization, Phosphorus Retention, Nitrate Removal and Retention, Anadromous Fish Habitat, Resident Fish Habitat, Amphibian & Reptile Habitat, Waterbird Nesting Habitat, Waterbird Feeding Habitat, Aquatic Invertebrate Habitat, Songbird, Raptor and Mammal Habitat, Water Cooling, Native Plant Diversity, Pollinator Habitat, Organic Nutrient Export and Carbon Sequestration. For all but two of these functions, scores are given for both components of an ecosystem service: function and value. The functions are also condensed into thematic groups, called "grouped services." In addition, wetland Ecological Condition (Integrity), Public Use and Recognition, Sensitivity, and Stressors are scored. Testing showed that a typical application of ORWAP V.3.1 requires fewer than 4 hours to complete. Among independent users, repeatability of the scores for most functions was found to be within  $\pm 0.6$  point or less on a 0-to-10 scoring scale.

ORWAP's scoring is based on logic models programmed into the Excel spreadsheet. Although this has the potential to create a "black box" wherein underlying assumptions and calculations are not transparent to the user, transparency has been assured by detailed explanations of the assumptions and mathematics of each scoring model (both in the spreadsheet and Appendix B). Collectively, the models use information for 77 (non-tidal) or 52 (tidal) indicators that are assessed onsite, as well as information for 43 indicators gathered mainly from one website and from aerial imagery. Although most indicators are applied to estimate several wetland functions, values, and other attributes, the data for each indicator need be entered in only one place on the data forms. When not pertinent to the particular type of wetland being assessed, indicators are automatically dropped from a model's calculations rather than being scored as a "0."

A website created collaboratively with this project provides an online support tool for locating a site and then viewing and overlaying existing maps of Oregon wetlands, hydric soils, floodplains, watersheds, and related themes, as well as broadly noting the known locations of rare wetland plants and animals:

[http://tools.oregonexplorer.info/oe\\_map\\_viewer\\_2\\_0/viewer.html?Viewer=ORWAP](http://tools.oregonexplorer.info/oe_map_viewer_2_0/viewer.html?Viewer=ORWAP). Note: if this link is not supported by your browser, copy and paste the link into Internet Explorer. The ORWAP Map Viewer tool also allows ORWAP users to archive their completed assessments (see section 3.4.4).

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This protocol would not have been possible without the participation and help of supporters. Numerous individuals contributed to the development of the original ORWAP (2006 – 2009), many of them over a period of several years. Several of these same individuals plus additional participants assisted with development of this current version (2011-2016). The list of participants can be found in Appendix D. The authors and the Department of State Lands (DSL) are deeply grateful for everyone's contribution and commitment to the development of this much-needed tool for assessing Oregon's wetlands. We wish to acknowledge their efforts and to thank everyone for their assistance.

# 1.0 Introduction

## 1.1 Background and Purpose

National and state goals for “no net loss” of wetlands pertain not only to wetland acreage but also to the ecosystem services (functions and values) that wetlands provide naturally. By providing these services, well-functioning wetlands can reduce the need for humans to construct alternative infrastructure necessary to provide those services, often at much higher cost (Costanza et al. 1997, Finlayson et al. 2005, Euliss et al. 2008). In addition, Oregon’s Removal-Fill Law and the federal Clean Water Act both require that when compensating for permitted impacts to wetlands through compensatory mitigation, wetland functions and values must be considered and replaced. Nonetheless, most agencies responsible for wetlands have focused only on measuring net change of wetland acreage, with little attention to assessing changes that result from the degradation of the many remaining wetlands. However, the increasing availability of standardized, regionally-tailored, rapid procedures for estimating the functions and values of wetlands has highlighted the importance and improved the feasibility of measuring and regulating losses of functions and values, over and beyond the simple loss of acreage.

The primary driver for developing ORWAP was the need for a rapid wetland assessment method that could be used for all kinds of wetlands in all regions of Oregon for state and federal wetland regulatory programs. However, ORWAP is designed to be used for multiple purposes by multiple agencies, including:

- Assessing individual wetlands or portions of wetlands for purposes of state and federal permitting and compensatory wetland mitigation (e.g., impact assessment, compensatory mitigation)
- Evaluating success of voluntary wetland restoration or enhancement projects
- Assessing all wetlands within a community or watershed (e.g., for characterizing watershed health, prioritizing restoration opportunities, or developing a wetland protection program)
- Assessing wetland impacts for activities subject to “Swampbuster” provisions of the 1985 Farm Bill

In addition, under Section 401 of the federal Clean Water Act, states and tribes are just as responsible for maintaining the quality and beneficial uses of jurisdictional wetlands as they are for maintaining the quality and designated uses of streams, rivers, lakes, and estuaries. The need to assess wetland *functions and values* —not just wetland condition or integrity—is mentioned explicitly in numerous laws and policies of state and federal agencies, e.g., December 2002 Regulatory Guidance Letter pertaining to Section 404 of the Federal Clean Water Act, Oregon Removal-Fill Law, and Oregon Watershed Assessment Manual. The requirement to assess functions and values is viewed as generally compatible with the requirement for assessing “aquatic life uses” in waters for which that is the officially designated “use.”

In order to be used for these purposes, ORWAP needed to be rapid (take less than a full day to complete an assessment) and require only a single site visit in any season. ORWAP is intended to provide consistent and accurate numeric estimates of the relative ability of a wetland to support a wide variety of functions and values important to society. To do so, ORWAP uses

standardized data forms, procedures, and data processing models. Its authors have attempted to incorporate current scientific knowledge of wetlands through peer-reviewed technical literature and the shared knowledge of dozens of local experts who participated in field-testing early versions of ORWAP.

## 1.2 Conceptual Basis

Functions and values are independent of one another. For example, a wetland that is extremely effective for removing whatever nitrate enters it is not considered to be of high *value* for that *function* unless it is exposed to significant loads of nitrate and/or its watershed has been designated as “Water Quality Limited” as a result of ongoing problems with nitrate pollution. A high level of function does not alone make a wetland valuable. Likewise, even if a wetland’s effectiveness for storing water is low, the *value* of that function may be considered potentially high if the wetland is situated above homes that are periodically flooded by heavy runoff. Similarly, if a wetland occurs within a designated “Priority Area” for conservation, it potentially may have great *value*, but if the designation was based mainly on presence of rare plants or salmon, whereas the function under consideration is nitrate removal or waterbird habitat, then it cannot be assumed to be valuable for those functions, especially if the structural characteristics necessary to support those functions are lacking. Analyses of ORWAP assessment data from a statistical sample of Oregon wetlands found no statistically significant relationship between their levels of most functions and their priority designations or perceived ecological condition. A survey of European wetlands reached a similar conclusion, finding little correlation between levels of functions and perceived ecological condition (Hansson et al. 2005). In concept, wetland *services* are the combination of *functions* and the *values* of those functions, judged individually. Thus, for a wetland to be considered as providing a high level of services, *both* its functions and the values of those functions should be high.

Fundamentally, the levels and types of *functions* that wetlands individually and collectively provide are determined by the processes and disturbances that affect the movement and other characteristics of water, soil/sediment, plants, and animals (Zedler & Kercher 2005, Euliss et al. 2008). In particular, the frequency, duration, magnitude and timing of these processes and disturbances shape a given wetland’s functions (Smith et al. 2008). Climate, geology, topographic position, and land use strongly influence all of these. The levels and types of *values* that wetlands provide, individually and collectively, are largely determined by the *opportunity* to provide a particular function and the local *significance* of that function (Adamus 1983). For many hydrologic and water quality values, opportunity is determined by what’s upslope of a wetland (e.g., land use and buffers in the wetland’s contributing area) and significance is predicted partly by what’s downslope (e.g., floodplains, water-quality limited water bodies).

To estimate services, variables that determine or at least correlate with each function or value must first be identified. These are commonly termed *indicators*. The number of variables that potentially indicate wetland functions is enormous, but the number of meaningful indicators that can be assessed rapidly and consistently during a single visit is small. To convert indicator estimates to estimates of functions, values, and services, specific *aggregation procedures* must next be constructed and applied. Depending on user needs, the aggregation procedures may

include scoring models (Smith et al. 1995), narrative criteria (e.g., Rocchio 2005), or simply best professional judgment (“BPJ”).

For regulatory and management applications (e.g., wetland functional enhancement), it’s often helpful to assign the indicators of functions to one of four categories:

1. *Onsite modifiable*. These features may be either natural or human-associated and are relatively practical to manage. Examples are water depth, flood frequency and duration, amount of large woody debris, and presence of invasive species. More important than the simple presence of these are their rates of formation and resupply, but those often are more difficult to control.
2. *Onsite intrinsic*. These are natural features that occur within the wetland and are not easily changed or managed. Examples are soil type and groundwater inflow rates. Thus they are poor candidates for manipulation when the goal is to enhance a particular wetland function.
3. *Offsite modifiable*. These are human or natural features whose ability to be manipulated in order to benefit a particular wetland function depends largely on property boundaries, water rights, local regulations, and cooperation among landowners. Examples are watershed land use, stream flow in wetland tributaries, lake levels, and wetland buffer zone conditions.
4. *Offsite intrinsic*. These are natural features such as a wetland’s topographic setting (contributing area size, elevation) and regional climate that in most cases cannot be manipulated. Still, they must be included in a wetland assessment method because of their sometimes-pivotal influence on wetland functions and values.

*Stressors* are factors or features that diminish the levels of specific wetland functions. These typically include only human-associated features, but some assessment methods (such as ORWAP) include natural disturbances as well when they have the potential to cause long-term changes in the delivery of some ecosystem services, especially changes that are far outside the historical precedent. Stressors occur either onsite or offsite (more often the latter). Their indicators can be direct (e.g., existing data showing water quality degradation) or indirect (e.g., presence of potentially polluting land use practices near the wetland). Stressor indicators that are indirect are more correctly termed *risk* indicators until their presumed negative influence on a specific wetland is proven. The functions of some wetland types are more *sensitive* to the influence of stressors. For that reason, ORWAP includes a model whose purpose is to estimate the relative sensitivity of a wetland.

The impact of potential stressors on a wetland depends partly on their proximity to the wetland, their proportional extent, and spatial arrangement. There are many ways to measure these, and nearly limitless combinations (e.g., Mita et al. 2007). For example, assuming that intensively cropped areas are a potential wetland stressor, that stressor could be expressed as a proportion of the surrounding landscape at any particular distance from the center or edge of a wetland. In addition or instead, that land use could be measured as a percent of the wetland-upland edge (wetland perimeter). The measurement could be limited to just the areas upslope of the wetland being assessed, or include all areas within a specified radius. Alternatively, for some functions the size of the largest patch of a land use within some specified distance may be more important than its distance and the presence of connecting corridors. Some research data suggest land use practices many miles from an isolated wetland can impact its functions (Houlahan & Findlay

2003, DeLuca et al. 2004), but the relationship of function to distance cannot be assumed to always be linear, and there are limits to what can be estimated both accurately and rapidly from aerial imagery and field inspection. The array of potential choices for defining and measuring “landscape” or “connectivity” indicators is befuddling, and there is no compelling research data from replicate studies that support particular proximities, proportions, and configurations that are especially pivotal (Baker et al. 2006). ORWAP somewhat arbitrarily estimates most of the important landscape features at distances of 100 ft., 0.5 mile, and/or 2 miles. For adequately assessing stressor effects on wetland functions, field evaluation of stressors is at least as important as the analysis of aerial imagery using GIS (Wardrop et al. 2007)

### 1.3 User Advisories

ORWAP is not intended to answer all questions about wetlands. Users should understand the following important considerations and limitations:

1. **ORWAP does not change any current procedures for determining wetland jurisdictional status, delineating wetland boundaries, or requirements for monitoring mitigation banks or other wetland projects.** When using ORWAP for regulatory applications, it is important to be familiar with other regulatory requirements related to wetland assessment. Contact the pertinent agencies as necessary.
2. **The intended users are wetland specialists for government agencies, natural resource organizations, and consulting companies.** ORWAP training is encouraged. For ORWAP training information, contact the Department of State Lands. Prior training and experience in delineating wetlands accurately will be helpful. Specifically, users should be able to (a) recognize most wetland plants, (b) determine soil texture (c) understand wetland hydrology, (d) delineate wetland contributing area boundaries from a topographic map, (e) access and acquire information from the internet, and (f) enter data in Microsoft Excel® (1997 or later version). For field application of ORWAP, a multidisciplinary team is encouraged but not required.
3. **Some of the information ORWAP requires may not be accurately determinable during a single visit to a wetland, particularly if that visit occurs outside the early growing season.** Some wetland conditions vary dramatically from year to year and even within a growing season. Thus, the accuracy of results will be greater if users are familiar with the changes in wetland conditions that typically occur locally, or consult landowners or others who are familiar with local conditions and variability.
4. **ORWAP scores only indicate a wetland’s functions relative to other wetlands in Oregon.** Intensive or long-term field measurements might subsequently determine that even the wetlands scored lowest by ORWAP are, in fact, performing a particular function at a very high absolute level, or some wetlands that score very high are found to barely provide the function (see Appendix B for more on model validation). Thus, the numeric estimate that ORWAP provides of wetland functions are *not actual measures* of those attributes, nor does ORWAP combine the data using deterministic models of ecosystem processes. Rather, the scores, like those of most rapid assessment methods (Hruby 1999), are estimates arrived at by

using standardized criteria (models). The models systematically combine well-accepted indicators in a logically sophisticated manner that attempts to recognize context-specific, functionally contingent relationships among indicators, such as wetland type.

ORWAP output includes both raw and "normalized" scores. Because natural functions of wetlands are not evenly distributed across the 0-10 scale, the normalized scores require careful interpretation. For example, if 90% of the wetlands in Oregon had raw scores of 0 for the Fish Habitat function and among the remainder the maximum score was 4, after ORWAP normalizes those raw scores (i.e., mathematically spreads them out into a scale of 0 to 10), a wetland with a score of 3 would have a normalized score of 9 (because 3 is close to the statewide maximum score of 4 for this function). The high normalized score implies the wetland is functioning very well for Fish Habitat, when in fact it's very low raw score of 3 (out of a theoretically possible score of 10) suggests it probably is not, in an absolute sense.

5. **ORWAP scoring models have not been validated in the sense of comparing their outputs with those from long-term direct measurement of wetland processes.** This is true of all other rapid assessment methods because the time and cost of making the measurements necessary to fully determine model accuracy would be exorbitant. Nonetheless, the lack of validation is not, by itself, sufficient reason to avoid use of any standardized rapid method, because the only practical alternative—relying entirely on non-systematic judgments (best professional judgment)—is not demonstrably better overall. When properly applied, ORWAP's scoring models and their indicators are believed in most cases to adequately describe the *relative* effectiveness of a wetland for performing particular functions.

There is an inherent conflict in attempting to develop a rapid assessment method based on science without over-simplifying complex natural systems to the point of disconnect. Oregon DSL is fully aware of this conflict and its implications. While it has been necessary for ORWAP to employ some untested assumptions, those assumptions are based on scientific principles and many were peer-reviewed.

6. **It is possible that two ORWAP users, viewing the same wetland, will interpret some indicator questions differently.** Potentially, this could result in different scores for one or more of the wetland functions. This is true regardless of whether they use ORWAP, another tool, or their professional judgment. However, Oregon DSL independently tested the repeatability of the current version and determined that the statistical confidence intervals around the scores, depending on the particular function, averaged  $\pm 0.6$  of the score mean on a scale of 0 to 10. For example, allowing for differing user perceptions of a wetland, a score of 6.00 could be interpreted as actually being between 5.4 (6.0 - 0.6) and 6.6 (6.00 + 0.6). Thus, user variability would seem to be of relatively little concern, despite some subjectivity inherent in some of the indicator questions. The relative narrowness of the score variance among users stems partly from the fact that some ORWAP indicators are intentionally redundant, and averaging is often used to combine indicators in the ORWAP models.
7. **ORWAP outputs should always be screened by the user to see if they "make sense."** ORWAP outputs, like those of other rapid methods, are not necessarily more accurate than judgments of a subject expert, partly because ORWAP spreadsheet models lack the

intuitiveness and integrative skills of an actual person knowledgeable of a particular function. Also, a model cannot anticipate every situation that may occur in nature. Nonetheless, ORWAP scoring models provide a degree of standardization, balance, and comprehensiveness that seldom is obtainable from a single expert or limited set of measurements. The protocol may be used to augment the data or interpretations of a subject professional (e.g., a fisheries biologist, plant ecologist, ornithologist, hydrologist, biogeochemist) when such expertise or finer-resolution data are available.

8. **ORWAP does not assess all natural functions that a wetland might support.** Those which it addresses are ones ascribed to wetlands most commonly in this region, and which also are capable of being estimated using indicators (metrics) that can be observed during a single visit to a wetland, analysis of existing spatial data, and manual interpretation of aerial images. Groundwater recharge, for example, is an important wetland function that is not scored because it has no reliable indicators that can be estimated rapidly in this region.
9. **ORWAP does not assess the suitability of a wetland as habitat for any individual wildlife or plant species.** Models of greater accuracy, using the same spreadsheet calculator and heuristic modeling framework that ORWAP uses, could easily be created for individual species, for more specific biological guilds (e.g., diving ducks vs. surface-feeding ducks instead of Waterbird Habitat) and functions (export of dissolved vs. particulate carbon instead of Organic Nutrient Export). However, as functions are split into finer categories, the amount of output information increases, perhaps gaining accuracy and specificity but losing simplicity in the interpreting and applying of results.
10. **ORWAP's logic-based process for combining indicators has attempted to reflect currently-understood paradigms of wetland hydrology, biogeochemistry, and ecology.** Still, the scientific understanding of wetlands is far less than optimal to support, as confidently as some might desire, the models ORWAP and other rapid methods use to score wetland functions. Moreover, science is constantly evolving as new studies refine, refute, or support what currently is known. It is incumbent that planning tools keep pace with new findings and their models be revised at regular intervals, perhaps every 5-10 years, to reflect that.
11. **ORWAP is not intended to predict changes to a wetland** – only to estimate the likely direction and relative magnitude shifts in various functions if specific wetland characteristics are altered. If proposed changes to a wetland are projected to cause little or no change in a particular function score, it cannot be assumed automatically that no impacts will occur. That is because ORWAP is a fairly coarse tool and no method or model is capable of anticipating all possible changes.
12. **The relationship between wetland size and the total level of a service delivered is not necessarily linear.** Even if two wetlands have similar effectiveness scores for a function and its value, the larger wetland is usually more likely to provide a greater total level of the associated ecosystem service. For example, if its characteristics make a particular wetland ineffective for storing or purifying water, or for supporting particular plants and animals, then simply increasing its size by adding more wetland having the same characteristics will

usually not increase the total amount of water stored or purified, or plants and animals supported. The threshold below which a wetland's characteristics make it completely ineffective is unknown in many cases. Where scientific evidence has suggested that wetland size may benefit a function in a greater-than-linear manner, ORWAP has included wetland size as an indicator for that function. Those functions are Waterbird Feeding Habitat, Waterbird Nesting Habitat, Songbird, Raptor, & Mammal Habitat, and Pollinator Habitat.

13. **The scores that ORWAP's models generate in some wetlands may not be sufficiently sensitive to detect, in the short term, mild changes in some functions.** For example, ORWAP is not intended to measure small year-to-year changes in a slowly-recovering restored wetland, or minor changes in specific functions, as potentially associated with limited "enhancement" activities such as weed control. Nonetheless, in such situations, ORWAP can use information about a project to predict the likely *direction* of the change for a wide array of functions. Quantifying the actual change will often require more intensive (not rapid) measurement protocols that are complementary.
14. **Outputs are not intended to address the important question, "Is a proposed or previous wetland creation or enhancement project in a geomorphically appropriate location?"** That is, is the wetland in a location where key processes can be expected to adaptively sustain the wetland and the particular functions which those of its type usually support, e.g., its "site potential?" Although ORWAP uses many landscape-scale indicators to estimate functions and values of a wetland, ORWAP is less practical for identifying the relative influence of multiple processes that support a single wetland. See the *Guidance for Using the Oregon Rapid Wetland Assessment Protocol (ORWAP) in State and Federal Permit Programs* (Oregon Department of State Lands, May 2009) for additional information on site selection.
15. **For the portion of ORWAP that incorporates existing digital data from the Oregon Explorer website,** it is understood that those data were originally created at scales much coarser than represented by the region's typically small wetlands. Consequently, when those data are interpolated to the scale of an individual wetland, some of the data are likely to be inaccurate. Also, some of the conditions described by the spatial data, such as for land cover, may have changed since the layer was created or last updated. Nonetheless, DSL believes that the advantages of judiciously using the existing spatial data as a component of each wetland's ORWAP scores outweighed the disadvantages.

Other important cautions on ORWAP use and interpretation are provided throughout section 3.0, as well as in the ORWAP regulatory use guidance document available from DSL.

## 2.0 Changes in Version 3.1

Since the release of ORWAP in 2009, users have identified the need for three primary revisions: (1) adjust field indicators as needed to improve understanding and efficiency; (2) minimize complexity of the assessment's "office" component; and (3) normalize the scores for functions and values so they all potentially span a range of 0 to 10 in order to make the output scores easier to understand and apply. The specific manner in which these needs have been addressed and



other improvements made is described in the accompanying Technical Supplement. Below is an abbreviated list of changes:

- Revisions to clarify and simplify problematic indicators (questions).
- Separation of field forms (spreadsheets) for freshwater and tidal wetlands.
  - 72 freshwater indicators and 47 tidal indicators
- Reduced number of indicators on the office Form OF and Form S.
  - 43 office indicators and 5 stressor indicators
- Normalization of function and value scores to a 0 – 10 range, which allows for straightforward comparison of any function score with any other function score from the same or a different wetland.
- Improvements to the Oregon Explorer’s ORWAP Map Viewer (old ORWAP Reporter) to reduce the number of websites that users need to access.

## 3.0 Guidance for Completing an Assessment

### 3.1 Overview of the process

Completing an assessment consists of filling in four Excel forms. The cover page (**CoverPg**) asks general information about the wetland location and characteristics, and information on comprehensiveness of the site visit. The office **Form OF** contains a series of questions (indicators) that are answered remotely with data from the ORWAP Map Viewer prior to conducting a site visit. **Form F** for non-tidal wetlands or **Form T** for tidal wetlands and **Form S** (stressors) have a series of questions to be answered during a comprehensive site visit. This chapter provides a guide through the assessment process.

To answer some of ORWAP’s questions, you will need a map showing the *entire* wetland (or wetland plus contiguous pond, lake, or river if a fringe wetland) that is associated with your Assessment Area (AA) - the area that ORWAP will be applied to, comprising all or part of a single wetland (see section 3.2.2). The best wetland map to use is a wetland delineation map that includes the entire wetland, not just a portion of the wetland (the AA). If a wetland delineation of the entire wetland that includes the AA has not been completed, search for any existing mapping in the ORWAP Map Viewer (see section 3.1.2). The Map Viewer has incorporated wetland maps from the National Wetlands Inventory (NWI), Oregon’s Local Wetlands Inventories (LWI’s) and other sources. In addition, the LWI maps and supporting information that has been completed for more than 80 cities in Oregon and can be viewed at the Department of State Lands’ Wetland Inventories website.

If no wetland maps are available for your location, or if existing wetland maps show no wetlands at that location, then assume (until you visit the site and can attempt to delimit boundaries with more certainty) that the wetland boundary coincides with that of visible surface water or saturated soil signatures in aerial images or with mapped hydric soils (not those mapped as partially hydric) as shown in the ORWAP Map Viewer.

The instructions in section 3.2 direct you on how to find specific information that you will use to answer questions on the CoverPg form and office Form OF. The electronic version of those and

the other data forms (worksheets), which you'll eventually need, are in the file *ORWAP\_Calculator.xls*.

### 3.1.1 Basic Steps

- Download the most recent version of the two Excel spreadsheet files: *ORWAP\_Calculator* and *ORWAP\_SuppInfo*<sup>1</sup>.
- Use the ORWAP Map Viewer website and complete the “office” component, which involves filling out the CoverPg and Form OF worksheets in the *ORWAP\_Calculator* file (see section 3.2).
- Download and print (from the same sites) the PDF files of the data forms to be completed in the field (Form F for non-tidal wetlands or Form T for tidal wetland, and Form S).
- Conduct a site visit and complete the “field” component by filling out Form F or Form T and Form S. You may need to refine some answers to questions on Form OF (section 3.3). For each question on the data forms, it is critical that you read through the question in its entirety before marking a response. Also read column E of the *ORWAP\_Calculator*, which provides additional guidance for interpreting some of the questions. Note that questions marked “W” must be answered for the entire wetland.
- Once back in the office, refer to the web resources and other information (see below and tables in the *ORWAP\_SuppInfo* file) to adjust, where appropriate, the answers to any of the field questions. Complete the remainder of the CoverPg form and data entry of the field forms.
- Process and interpret the results (section 3.4).

### 3.1.2 Navigating the ORWAP Map Viewer on the Oregon Explorer

Using the updated ORWAP Map Viewer (formerly ORWAP Reporter) is required in order to complete an ORWAP assessment. The tool is located at [http://tools.oregonexplorer.info/oe\\_map\\_viewer\\_2\\_0/viewer.html?Viewer=ORWAP](http://tools.oregonexplorer.info/oe_map_viewer_2_0/viewer.html?Viewer=ORWAP). Note: if this link is not supported by your browser, copy and paste the link into Internet Explorer. The recent update reduces the number of websites and tables users need to access for information. The Google Chrome browser does not support the Silverlight based Map Viewer, so download and use Internet Explorer, Mozilla Firefox, or another browser that supports Silverlight.

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<sup>1</sup> The *ORWAP\_Calculator* file contains the following worksheets: CoverPg, Form OF, Form F, Form T, Form S, Scores; individual worksheets for each function or attribute containing the indicators, their scores, rationales, and scoring models; Sens, EC, STR, and FuncDeficit. The *ORWAP\_SuppInfo* file contains the following worksheets (data tables): AllSites\_Fscores, AllSites\_Vscores, P\_Salt, P\_LowTidal, P\_Invas, P\_Exo, P\_UnCom, NFIX, IBAs, HUCbest, HUC4, HUC5, HUC6, WetVerts, WetInverts, InvertsExo, and InvertsRare.

Here are some tips for navigating the map layers on the ORWAP Map Viewer:

1. **Tabs and tools:** there are four tabs at the top of the map viewer – Explore Map, Layers, Create & Share, and Help (Figure 3-1). Each tab has a tool bar with various tools that will be utilized to answer the office Form OF indicators (Figure 3-2).

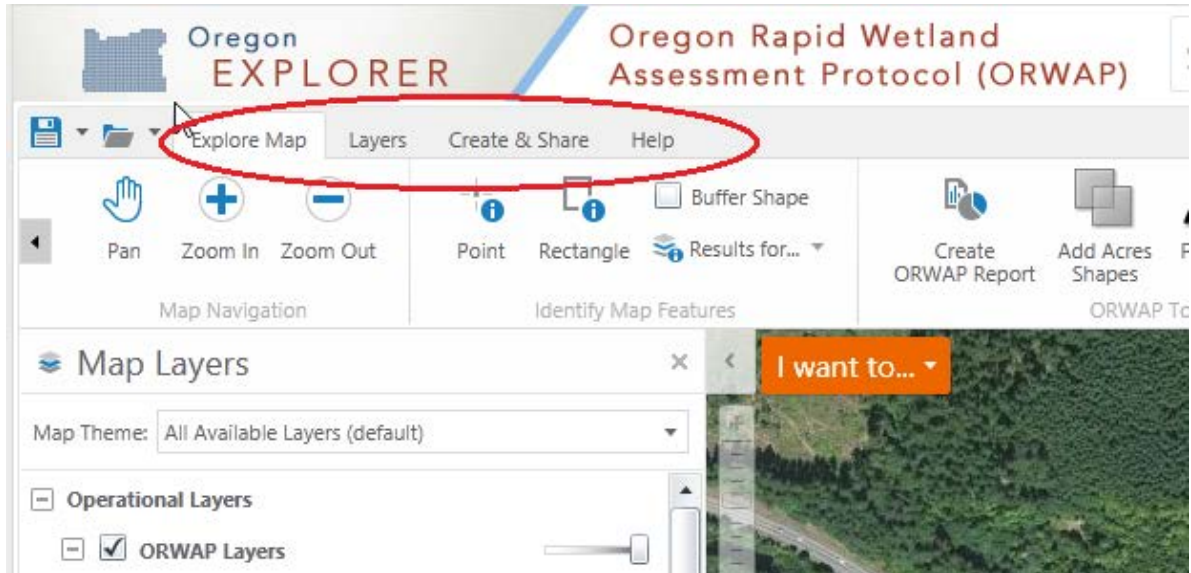


Figure 3-1. Four tabs: Explore Map, Layers, Create & Share, Help.

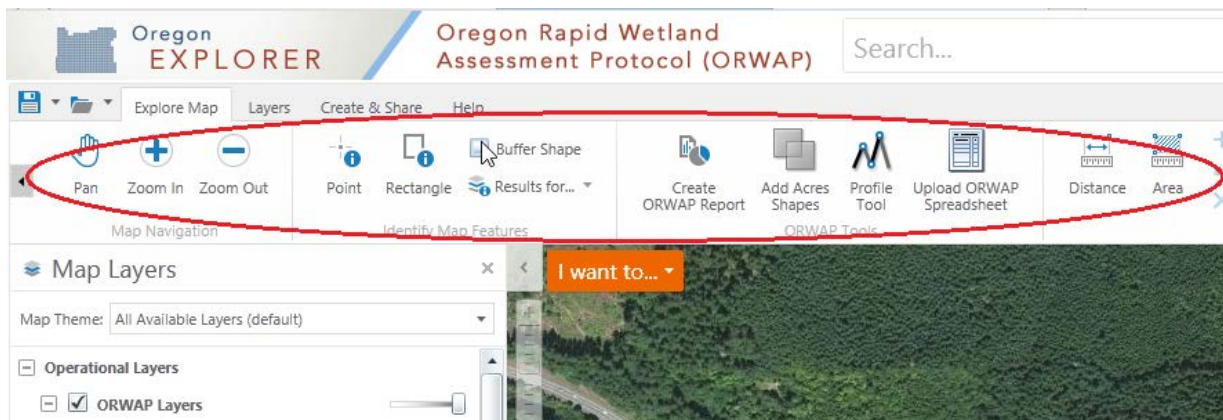


Figure 3-2. Each tab has a set of tools.

2. **Map Layers:** are located on the left side of the map screen (Figure 3-3):
  - Map layers can be turned on and off by clicking the check box/square at the left of the layer name.

- Map layers are grouped to simplify use. Groupings can be expanded and collapsed with the + and – symbols to the left of the grouping. (Layers can still be turned on and off individually when in groups.)
- The transparency of a layer can be adjusted by moving the slider bar located to the right of the layer name.

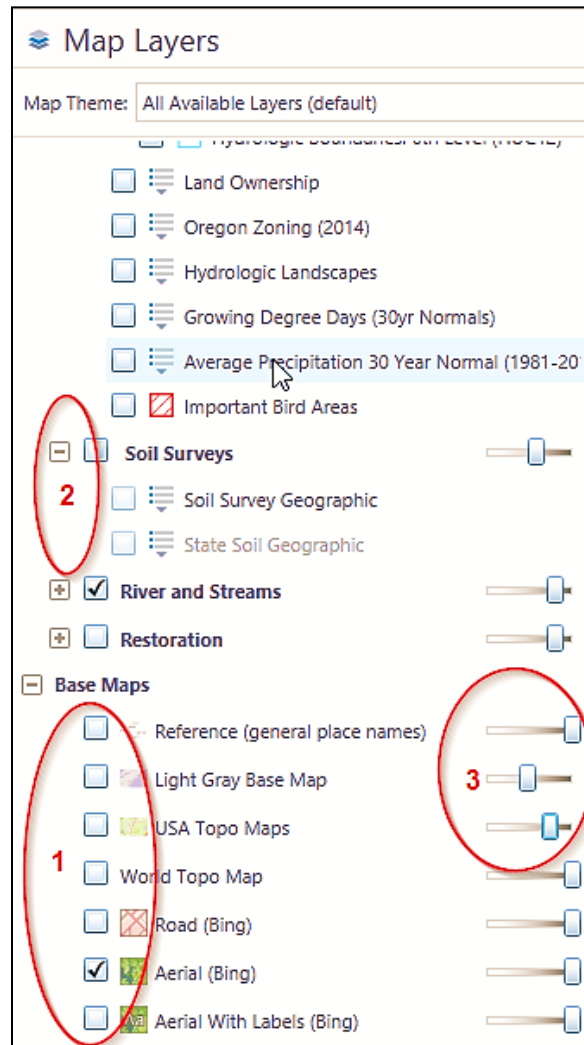


Figure 3-3. Map Layers (1) can be turned off and on, layer groupings (2) can be expanded or collapsed; and the slider bar (3) can be used to adjust the transparency of a layer.

3. **Mapped Wetlands:** The Wetlands map layer may provide an estimate of wetland location and extent of your wetland site. This coverage is a compilation of polygon data from numerous sources, and represents the most comprehensive dataset available for the location, type, and extent of the state's wetlands. It uses as a base all available digital data from the National Wetlands Inventory (U.S. Fish and Wildlife Service), to which has been added draft NWI mapping (Oregon Biodiversity Information Center and The Wetlands Conservancy), Local Wetlands Inventories (approved by DSL), wetlands along state highways (Oregon Department of Transportation), Wetland Reserve Program sites (NRCS), wetland mitigation

banks (DSL), and mapping of individual sites by a variety of federal, state, academic, and nonprofit sources. Despite the contributions from many sources, many wetlands are not shown in this coverage.

Additional navigating instructions are provided in the instructions for conducting the office assessment in section 3.2. Additional information about the map layers and data in the Map Viewer is in Appendix C.

### 3.1.3 Supplemental Resources

Whenever possible, the current or previous landowner should be asked about indicators that are difficult to assess during just a single visit to a wetland. The most important of these include the extent and depth of surface water in the wetland at different times of the year and among years, the presence of artificial surface water inlets and outlets which may be difficult to see, and the duration of outflow annually. Less critically, ask about present and past land use, management practices, soils, contaminants, groundwater, plants, and wildlife. Some of this information may be known to persons working for local, state, or federal agencies (particularly public works, planning, and natural resource agencies), or may be found in wetland delineation reports for adjacent project areas, in Local Wetlands Inventory reports, or in watershed plans and similar documents. When available, also review imagery from other years and seasons, as can sometimes be found by clicking on the clock icon in the center of the Google Earth toolbar. An internet search of the name of a nearby feature can sometimes be productive as well.

In addition to the ORWAP Map Viewer, websites that may provide additional imagery or information about a wetland include the following:

- Latitude/Longitude can be obtained from the Google Earth website: [http://earth.google.com/downloadearth.html](http://earth.google.com/downloadeearth.html).
- Google Earth Pro is now free and allows users to import ESRI shapefiles as well as use a "measure" tool to draw a buffer circle of any size and measure polygon areas. Or you can go to <http://dev.bt23.org/keyhole/circlegen/> and input your coordinates and the circle radius you want. It will draw that circle on the Google Earth image and adjust it appropriately as you zoom in and out.
- In the Portland metro area, useful site-specific natural resource data may be found by inputting an address at: <http://www.oregonmetro.gov/tools-partners/data-resource-center> or [www.portlandmaps.com](http://www.portlandmaps.com).
- Microsoft Imagery website: <http://maps.live.com/>. In more populated parts of the state, there will also be a tab (right side of the tool bar) called "Birds Eye" that provides remarkable side-views of the specified site.
- Natural Resource Conservation Service (NRCS) Web Soil Survey (WSS) website: <http://websoilsurvey.nrcs.usda.gov>. Provides not only soil unit mapping overlaid on an aerial, but also detailed information about the soil units.

- Published NRCS Soils Surveys at <http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=OR>.
- Oregon Explorer Imagery website: <http://imagery.oregonexplorer.info/>. The finest-resolution imagery (0.5 m) available to the public for all of Oregon will be found here, but must be downloaded into a GIS and the transfer is not rapid.
- Topographic maps:
  - <https://viewer.nationalmap.gov/viewer/>
  - <http://www.mytopo.com/maps/>
  - The topographic maps which are easiest to read are usually the hard copy versions (1:24,000 or finer scale) purchased from USGS or an outdoor supply store, or those from software containing these maps for Oregon (e.g., can be purchased from <http://www.richardsoncharts.com/>, <http://www.terraserver.com/>, or other sources).
- LiDAR imagery:
  - In areas where it is available and can be viewed at little or no cost, LiDAR imagery (topographic maps with extremely fine vertical resolution) is strongly recommended as a means for improving the accuracy of an ORWAP assessment, especially when all or part of a wetland cannot be physically or legally accessed.
  - <http://www.oregongeology.org/sub/LiDARdataviewer/index.htm>

## 3.2 Instructions for the Office Component

Review this entire section before proceeding to follow the instructions and completing the forms. As you fill out Form OF, you may find it helpful to flag questions that you particularly want to evaluate in the field, as well, because of inadequate resolution in the aerial imagery or the topo map.

Download the *ORWAP\_Calculator.xls* and the *ORWAP\_SuppInfo* from the Department of State Lands' Technical Resource web page (under construction at time of printing). When you open the *Calculator* file, you may get a message asking if you want to enable "macros." Mark yes; the macros in this file will not harm your computer and they are necessary to automate all the calculations.

### 3.2.1 Locating the Site on ORWAP Map Viewer

Navigate to the Oregon Explorer's ORWAP Map Viewer at [http://tools.oregonexplorer.info/oe\\_map\\_viewer\\_2\\_0/viewer.html?Viewer=ORWAP](http://tools.oregonexplorer.info/oe_map_viewer_2_0/viewer.html?Viewer=ORWAP). Note that the Google Chrome browser does not support the Silverlight based Map Viewer, so download and use Internet Explorer, Mozilla Firefox, or another browser that supports Silverlight.

There are two ways to locate the site on the Map Viewer:

- a. Use the Zoom In navigation tool on the Explore Map tab until the site is located, or

- b. Enter the Lat/Long coordinates of the center of the assessment area (AA) or the approximate geographic coordinates of the wetland area.
  - In the Explore Map tab, click on the Create ORWAP Report tool and enter the geographic coordinates. Do not be concerned if the Lat/long is not entirely the correct location; the point location can be corrected later after the assessment area is drawn.
  - Click on Get Report at the bottom of the screen. You will see that the Lat/Long point is shown on the map along with buffer circles around the point.
  - Close the report. Turn off all the current ORWAP Layers, Base Map layers, and Graphic Layers (except “Selected Lat/Long”) to declutter the map. Turn on one of the Base Maps’ aerial layers. Locate and zoom into the wetland area using the Zoom In tool.

### 3.2.2 Defining the Assessment Area (AA)

#### General guidelines

The Assessment Area (AA) is the area to be evaluated with ORWAP. The AA is either the entire wetland or some portion of it as described below. The approximate AA boundaries will need to be delimited. The AA boundaries may need to be adjusted during the field component, but for ORWAP’s purposes you don’t need to delineate the AA boundary with the high level of precision customary for jurisdictional delineations. Nonetheless, *where* you draw the boundaries of the AA can dramatically influence the resulting scores. If a wetland delineation has been submitted and approved by the responsible agencies, it should be used as the basis for delimiting the AA’s upland edge.

The AA preferably will consist of the entire wetland plus, in some cases, some or all of the adjoining unvegetated water (see specific guidelines below). However, ORWAP may be applied to an area comprising less than the entire wetland if any of three situations occur:

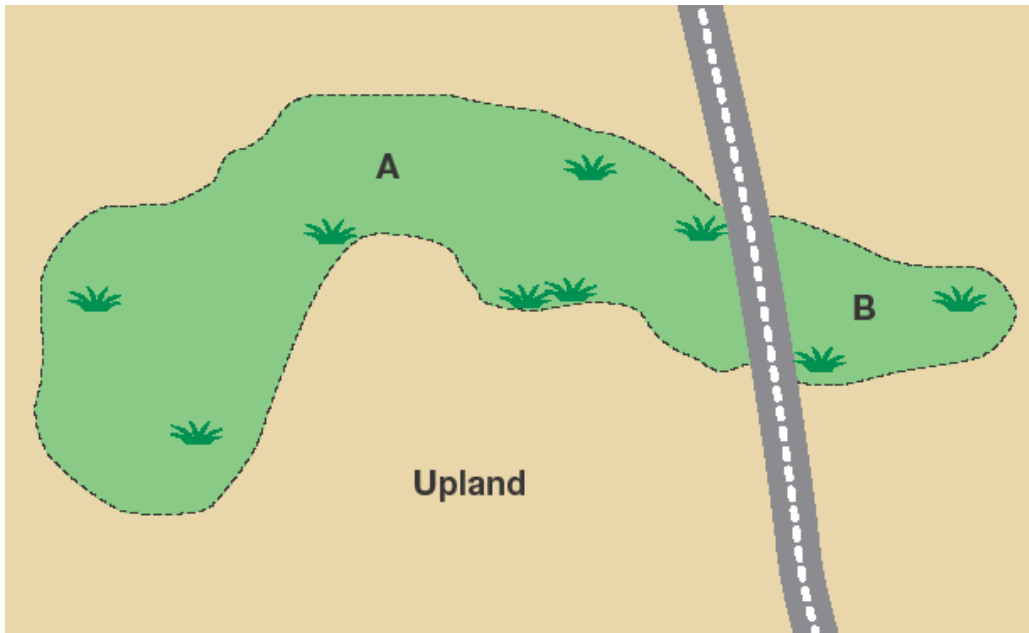
- The wetland extends across property lines and access permission to part of the wetland was not granted.
- The wetland is so large (e.g., >50 acres) and internally varied that an accurate assessment cannot be completed in a day.
- A project or activity will occur in only part of a wetland and the effect on functions of just that project or activity needs to be determined. For use in state and/or federal regulatory programs, see additional guidance in section 4.0.

*Boundaries of the AA should be based mainly on **hydrologic connectivity**.* They normally should not be based *solely* on property lines, fence lines, mapped soil series, vegetation associations, elevation zones, and land use or land use designations.

#### Specific Guidelines

- a. **Dissected Wetland.** If a wetland that once was a contiguous unit is now divided or separated from its formerly contiguous part by a road or dike (Figure 3-4), assess the two

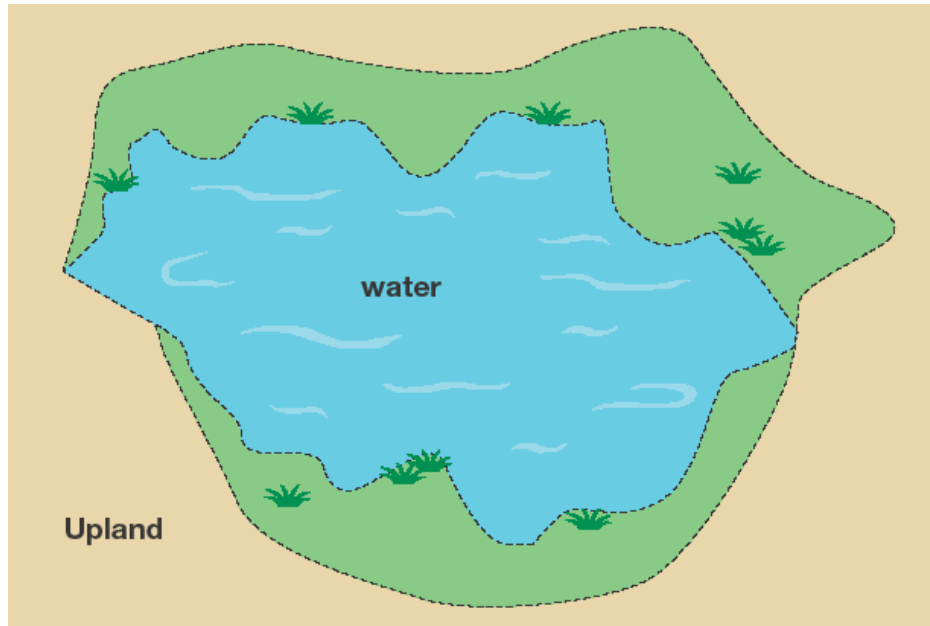
units separately unless a functioning culvert, water control structure, or other opening connects them, and their water levels usually are simultaneously at about the same level.



*Figure 3-4. Dissected Wetland. A wetland is crossed by a road or filled area. Separate the wetland into two AA's and assess separately, if A and B have different water levels and circulation between them is significantly impeded.*

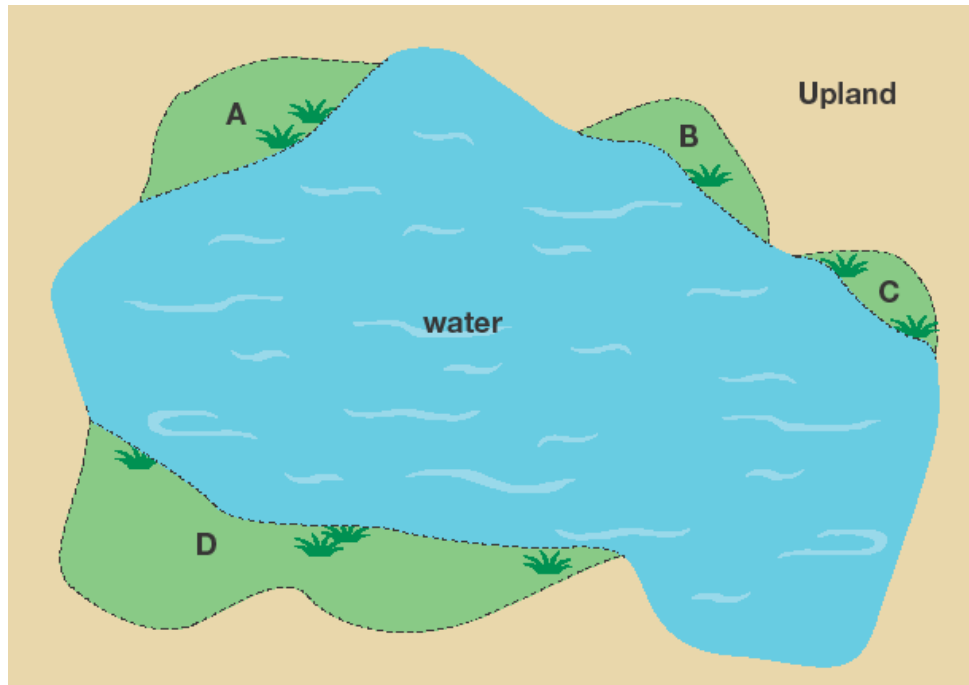
- b. **Fringe Wetland** (type 1). If a wetland is a fringe wetland (that is, it borders a bay, estuary, pond, or river in which the contiguous stretch of open water is  $>3x$  wider than the wetland), the AA should include just the vegetated wetland, not the adjoining water (unless the method specifically directs you to answer a question about that). An exception is if the contiguous water body including the wetland is smaller than 20 acres, e.g., a pond. In that case, the water body itself (regardless of depth) should be included as well as the wetland (Figure 3-5).





*Figure 3-5. Fringe Wetland Type 1. The average width of the open water area is more than three times wider than the average width of the wetland, making this a fringe wetland. If the entire polygon is smaller than 20 acres, the AA should include the open water. If larger, the AA should include only the wetland.*

- c. **Fringe Wetland** (type 2). If patches of fringe wetlands share the same margin of a river, lake, or estuary and are separated from each other by non-vegetated shore (mud, sand, gravel, algae, pavement, upland) over a distance of greater than 100 ft., they should be assessed as separate AA's (Figure 3-6) unless they appear to be the same in nearly every aspect (dominant vegetation, soil texture, hydrology, landscape position, Cowardin classification, adjoining land use, etc.) and are within 1000 ft. of each other.



*Figure 3-6. Fringe Wetland Type 2 (fringe wetland patches). Wetland patches B and C would be included in the same AA if separated by no more than 100 ft. by water, bare substrate, algal flats, or upland. Wetland patches A and D would be in the same AA if separated by 100 ft. or less, or if they are within 1000 ft. of each other and their vegetation, soil texture, water regime, Cowardin classification and adjoining land use is the same.*

- d. **Lacustrine Wetland with Tributary.** If a lacustrine wetland is intersected by an inflowing stream, the wetland should be considered lacustrine except for the part that is more subject to seasonal overflow from the stream than from fluctuations in lake levels. That part should be assessed separately.
- e. **Wetland Mosaic.** If the wetland is a patch in a mosaic of wetlands within uplands or other non-wetland waters (Figure 3-7) and none of the above rules apply, the entire mosaic should be considered and delimited as one AA if:
  - Each patch of wetland is smaller than 1 acre, and
  - Each patch is less than 100 ft. from its nearest neighboring wetland and is not separated from them by impervious surface, and
  - The areas of vegetated wetland are more than 50% of the total area. The total area is the wetlands plus other areas that are between the wetlands (such as uplands, open water, and mudflats).

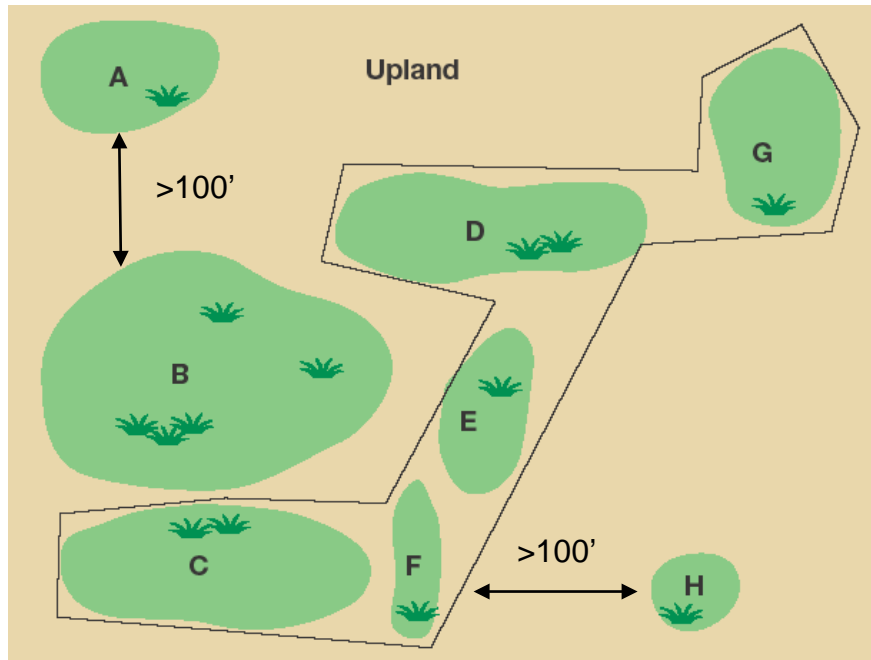


Figure 3-7. Wetland Mosaic Assessment Area (AA). In this diagram the dark line defines the mosaic. The circles are wetlands and the areas between them are upland. Wetlands C, D, E, F, and G comprise a mosaic because they occupy more than 50% of the total area bounded by the dark line. Wetland B is excluded because it is larger than 1 acre. Wetlands A and H are excluded because each is >100 ft. from its closest neighbor.

- f. **Tidal/Non-Tidal Wetland.** If any vegetated part of the AA is tidal (experiences fluctuating water levels as a result of tides) on any day during an average year, assess that part separately from the non-tidal part.

### 3.2.3 Drawing the AA and Measuring Its Area

Using the ORWAP Map Viewer, zoom in to an appropriate scale. Click on the Create & Share tab at the top. Click on the polygon drawing tool and use the adjustments to the right (border color, thickness, fill) to define the polygon. Delimit the assessment area (AA) on an Aerial layer. Place your cursor in the center of the AA and right click. The Lat/Long point will relocate to the new location. The Map Viewer will rerun the ORWAP Report. Click on View report in the legend. Save and print the ORWAP Report as it provides information needed to answer some of the office and field questions. Close the report.

**Warning: From this time on, do not right click on the map. The Lat/Long point will relocate and issue a new report.**

Zoom into the AA overlaid on the aerial image layer and print for use in the field as a base map. The image should be of adequate resolution, viewed at (zoomed to) and printed at a scale such that the entire AA nearly fills a printed page. Click on the Print Map tool. If you want to see the area that will be printed, click on the “Preview Extent” button.

Next, for the CoverPg worksheet (to be completed in section 3.2.5), determine the size of the AA. If the AA does not occupy all of a wetland, you must estimate and report the approximate percent of the wetland it occupies. Click on the Explore Map tab at the top. Use the Area tool to redraw the AA. Change the Measurement Info's Area to acres.

If the AA was only part of a larger wetland, determine the size of the entire wetland using the Area tool again to delineate the entire wetland. Enter the AA's area on the CoverPg and its percent of the entire wetland. To keep the entire wetland boundary on the map, click on the Add as Drawing tool. Print the entire wetland area overlaid on the aerial image layer for use in the field to answer applicable questions relating to the entire wetland. This delineated feature layer can be turned off by going to the legend Graphics Layers and uncheck "Measurements."

*Note: On both Form OF and Form F, a few questions **must** be answered in terms of the **entire** wetland, not the more limited portion defined by just the AA. Those questions are indicated by a large **W** in column D of the data forms.*

### 3.2.4 Obtaining a Soils Map

A soil map and soil map unit name(s) will be needed to complete the CoverPg and for field work. This is a good point to obtain a map from the Map Viewer. Note that the ORWAP Report has a Soil Information section; however, this information is only for the location of the Lat/Long point. Click on the Soils layer and turn on the Oregon Soils layer. Note: This layer is only visible at a scale of 1:125,000. Print the map using the Print tool. To determine the name of the map units, click on the Explore Map tab and then the Point identify tool. Left click on a soil unit to identify the unit's name. Make a note of the dominant soil unit's complete name. Additional information can be obtained by clicking on "Table View." When done, turn off the bottom informational box by clicking on the X in the upper right corner of the box.

### 3.2.5 Completing the CoverPg Form

Open the *ORWAP\_Calculator* and go to the first worksheet tab called "CoverPg." Complete lines 2-18 and 22-24. Location Information can be obtained from resources listed below.

- Township, Range, and Section:
  - County assessors' websites.
  - Google Earth: This application puts a TRS overlay on the Google Earth map. <http://www.metzgerwillard.us/plss/plss.html>. Works well and is easy to use. Just click on "download PLSGE" and it comes up with directions. NOTE: You need to click on the "Township" option under "Layers" for the TRS lines to show up, and have "automatic" selected under "Refresh Mode" for them to be regenerated when you move the map top a new location.
  - GeoCommunicator is the publication site for the Bureau of Land Management's National Integrated Land System. This is an interactive map. <http://www.geocommunicator.gov/blmMap/Map.jsp?MAP=OG>.
- Tax lot: Go to ORMAP <http://www.ormap.net/flexviewer/index.html>.

Information for the remaining questions on the CoverPg will be obtained during field work.

### 3.2.6 Completing the Office Data Form

Open the ORWAP\_ Calculator's OF spreadsheet. *It is recommended that you read through the entire question, possible answers and additional guidance in column E of ORWAP worksheet before answering the question. Note that questions marked "W" must be answered for the entire wetland.*

Color highlighting in columns A and B denote questions with somewhat similar themes, or allowed "skips" in a block of questions. Cell names in column F are only for purposes of documenting parts of the Excel formulas that the calculator uses.

You will be using the various Map Viewer layers, especially the Graphics Layers' buffer circles. The transparency of the buffer circles can be adjusted by moving the slider bar that is located to the right of the layer name. The buffers are centered on the Lat/Long point, not the wetland polygon. Therefore, the 100 ft. and 300 ft. buffers can only be used for reference and not the actual area.

*Warning: right clicking your curser in the Map Viewer at any time will reset the Lat/Long point.*

#### Indicator questions OF1 through OF13

Aerial images at various scales will be used to answer these indicator questions. While viewing the images you will need to roughly estimate broad categories of land cover that are *not mutually exclusive*. The different land cover types are measured in different ways and at varied scales because of differing effects they have on different functions. The estimates should be made prior to the site visit, recorded on Form OF, printed and taken with you during the site visit. Upon visiting the site, your estimates should be modified, if appropriate, based on your observations of the site.

The land cover types will be assessed in the following zones. Note that not all of the land cover types will be assessed in *every* zone:

- Within a circle of radius 2 miles (10,560 ft. or 3219 m)
- Within a circle of radius 0.5 mile (2640 ft. or 805 m)

*Note that some distances are measured from the center of the AA, and others from the wetland-upland edge.*

To estimate the *percentages* of a given land cover, imagine all the patches specified type that fall within the circle being "squeezed together" and determine the approximate fraction of the circle they would occupy. In addition to assessing percentages of these land cover types, two other estimates will be needed:

- Proximity (feet or miles) to the nearest land cover of the specified type and minimum size
- Tract size (acres) of the nearest land cover of the specified type

Acreages can be determined by using the Area tool in the Explore Map tab to draw and measure.

OF1 In the Explore Map tab, use a Base Maps Aerial layer and the Add Acres Shapes tool to add the 100 acres shape (Figure 3-8). The square shape can be moved around by left clicking and holding while moving the mouse around the screen.

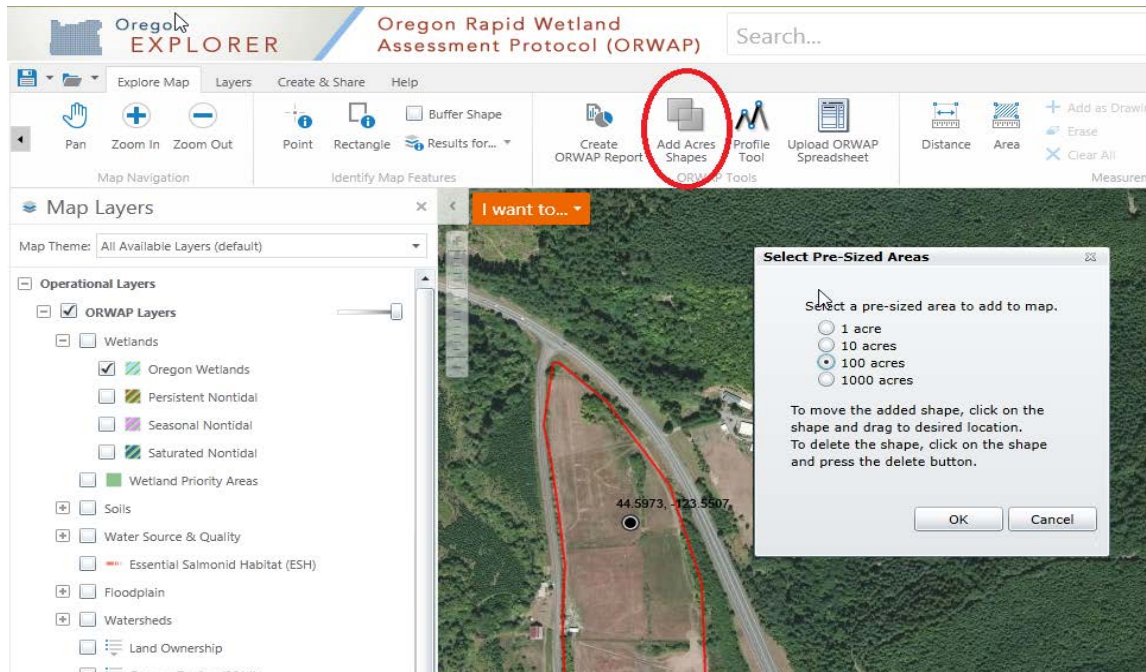


Figure 3-8. “Add Acres Shapes” tool gives you the option of four squares of set size (1, 10, 100, and 1,000 acres). The squares can be dragged around the map by clicking and dragging your mouse. To delete, left click on the shape and click delete.

Along with the Graphics Layers’ buffer circles or the Distance tool, determine the distance of the closest patch or corridor of perennial cover larger than 100 acres (excluding lawns and other shortgrass areas) from the AA edge.

- **Perennial cover:** vegetation that includes wooded areas, native prairies, sagebrush, vegetated wetlands, as well as relatively unmanaged commercial lands in which the ground is disturbed less than annually, such as hayfields, lightly grazed pastures, timber harvest areas, and rangeland. It does not include water, row crops (e.g., vegetable, orchards, and Christmas tree farms), lawns, residential areas, golf courses, recreational fields, pavement, bare soil, rock, bare sand, or gravel or dirt roads.
- **Corridor:** an elongated patch of perennial cover that is not narrower than 150 ft. at any point.

OF2 If applicable, use the Headtide map layer (expand Water Source & Quality) and the Distance tool to determine the distance of the closest body of tidal water from the AA edge.

- OF3 Use the Persistent Nontidal layer (expand Wetlands) to locate the closest non-tidal fresh water body (wetland, pond, or lake) that is separated from the AA and is ponded all or most of the year. Use the Graphics Layers' buffer circles or Distance tool to determine the distance of the closest fresh waterbody from the AA edge.
- OF4 Use the Persistent Nontidal layer (expand Wetlands) to locate the closest non-tidal fresh water body that is separated from the AA, is ponded all or most of the year, and is larger than 20 acres. Use the Graphics Layers' buffer circles or Distance tool to determine the distance from the AA edge.
- OF5 Use the Add Acres Shapes tool and select the 10 acre shape. Along with the Graphics Layers' buffer circles or Distance tool, determine the distance to the closest patch of herbaceous open land, larger than 10 acres and in flat terrain, from the AA edge.
- **Herbaceous open land:** Can include both perennial and non-perennial cover. This includes unwooded areas that typically occur on flat ground, such as most herbaceous wetlands, grassy parts of airports, golf courses, recreational fields, irrigated and row crops, and other agricultural lands (e.g., hayfield, pasture, ryegrass, fallow fields) if they are known with certainty to be situated on flat (<5% slope) land. It does not include open water of lakes, ponds, or rivers; unvegetated surfaces; developed areas; shrub land; orchards; or woodland.
- OF6 Use the Graphics Layers' buffer circles or Distance tool to estimate distance to nearest busy road (with an average daytime traffic rate of at least 1 vehicle/minute) from the AA center. Verify this in the field.
- OF7 Use the Add Acres Shapes tool or the Area tool to aid in determining the largest patch or corridor of perennial cover (including the AA's vegetated area) that is contiguous with the vegetation in the AA (i.e., not separated by roads or channels that create gaps wider than 150 ft.). The Distance tool can be used to measure for 150 ft. gaps.
- OF8 First, determine if any of the listed vegetation classes comprises more than 10% of the AA. If none, answer "none of the above." For any vegetation classes that do comprise >10% of the AA, use the half mile buffer circle and the Area tool to determine if that vegetation class also comprises less than 10% of the 0.5 mile buffer circle (~50 acres). Remember that the transparency of the buffer circle can be adjusted with the slider bar.

Questions OF9 – OF11 refer to a percentage of the 2-mile buffer circle of the AA. The following may be helpful:

- 5% of a 2 mile circle is ~400 acres
- 20% of a 2 mile circle is ~1,600 acres
- 60% of a 2 mile circle is ~4,800 acres
- 90% of a 2 mile circle is ~7,200 acres

- OF9 Use the 2 Mile Buffer circle to estimate percentage of land with perennial cover within 2 miles of the AA center.
- **Perennial:** see OF1

- OF10 Use the 2 Mile Buffer circle to estimate the cumulative amount of forest (regardless of forest patch size and including any forest in the AA) within 2 miles of the AA center.
- **Forested patch:** a land cover patch that currently has >70% cover of woody plants taller than 20 ft. May be in a plantation.
- OF11 Use the 2 Mile Buffer circle to estimate the amount of herbaceous open land in flat terrain that is within 2 miles of the AA center. The USA Topo Maps Base Map layer may be needed to identify flat terrain. Increasing the transparency of the topo layer (with the slider bar) allows the aerial to be seen along with the topo.
- **Herbaceous open land:** can include both perennial and non-perennial cover. This includes unwooded areas that typically occur on flat ground, such as most herbaceous wetlands, grassy parts of airports, golf courses, recreational fields, irrigated and row crops, and other agricultural lands (e.g., hayfield, pasture, ryegrass, fallow fields) if they are known with certainty to be situated on flat land. It does not include open water of lakes, ponds, or rivers; unvegetated surfaces; developed areas; shrub land; orchards; or woodland.
  - See illustrations in Appendix A
- OF12 Use the 2 Mile Buffer circle, and the Oregon Wetlands layer to determine wetland connectivity within 2 miles of the AA center. Use the Distance tool to confirm a corridor of perennial vegetation is at least 150 ft. wide.
- To confirm no other wetlands, also use knowledge of the area and consider unmapped wetland features. The Oregon Wetlands layer is predominately based on the National Wetlands Inventory that was done in the early 1980's in Oregon, which did not include agricultural wetlands and did not capture many seasonal wetlands.
  - **Perennial:** see OF1
  - **Regular traffic:** at least 1 vehicle per hour during the daytime throughout most of the growing season. Assess this based on local knowledge, type of road, and proximity to developed areas.
  - **Distinct wetlands:** are wetlands that the map shows as being separate (not connected). Consider them separate and distinct even when connected to the AA by a stream.
- OF13 Use the Half Mile Buffer layer, and the Oregon Wetlands layer to determine local wetland connectivity within 0.5 miles of the AA center.
- See OF12 instructions.

#### Indicator questions OF14 - OF16

Answer the following questions with information in the ORWAP Report generated in Step 3, with the exception of OF16.

- OF14 In the Watershed Information section of the Report, look at the HUC Best table. See if the column titled Is HUC Best shows “yes” and the column titled Greatest Criteria Met shows a HUC listed as having a large diversity, large area, or large number of wetlands



relative to the area of the HUC. Select all that are true. The methods for determining HUC Best are included in the endnotes of the ORWAP report.

- OF15 In the Watershed Information section of the Report, locate the AA's HUC12 code. Open the *ORWAP\_SuppInfo* worksheet and go to the functional deficit (FuncDeficit) worksheet. Look for the corresponding 12 digit code number (Figure 3-9). Enter 1 for each of the listed function that is noted for the HUC. The origin of this table is described in the ORWAP Technical Supplement document.

	A	B	C	D	E	F	G	H	I	J
1	HUC12	WS	SR	NT	TR	INV	AM	FH	WB	HUC12_NAME
2	170501030802			NT					WB	Mine Basin Creek-Succor Creek
3	170501030803				TR					Dry Creek
4	170501030804				TR					McBride Creek
5	170501030805									Deadman Gulch-Succor Creek
6	170501030901	WS	SR	NT	TR		AM			Carter Creek
7	170501030902	WS	SR							Spring Creek-Succor Creek
8	170501030903									Pole Creek-Succor Creek
9	170501030904		SR		TR					Board Corral Creek-Succor Creek
10	170501030905									Camp Kettle Creek-Succor Creek
11	170501030906		SR		TR	INV		FH		Sage Creek
12	170501030907									South Alkali Creek-Succor Creek
13	170501031001					INV			WB	Upper Jump Creek
14	170501031101									Alkali Creek

Figure 3-9. The Functional Deficit Table can be found in the *ORWAP\_SuppInfo* worksheet called *FuncDeficit*. The data is organized by 6<sup>th</sup> level HUC12.

- OF16 Use the applicable Map Layers as indicated below to answer a, b, and c:
- Use the Half Mile Buffer and the Essential Salmonid Habitat (ESH) layer to determine if the AA is within or connected to a stream or other water body and the stream/water body has been designated as ESH within 0.5 miles of the AA.
  - Use the Wetland Priority Areas layer (under ORWAP Layers) to determine if the AA is within or contiguous to a designated Wetland Priority Area.
    - Include areas not shown as ESH, if ODFW has confirmed they qualify as ESH.
    - Include floodplains, alcoves, and off-channel areas if they appear to be fish-accessible at least during biennial high water.
    - Determine if a connection exists partly by field inspection and by considering connecting stream networks between the AA and tidal waters, using:
      - The Oregon Explorer Map Viewer at [http://tools.oregonexplorer.info/oe\\_map\\_viewer\\_2\\_0/viewer.html?Viewer](http://tools.oregonexplorer.info/oe_map_viewer_2_0/viewer.html?Viewer)

OE. Go to the Restoration layer (under Operational Layers) to see the Fish Passage Barriers layer.

- Many barriers are shown in maps that may be downloaded from: <http://nrimp.dfw.state.or.us/nrimp/default.aspx?pn=fishbarriermaps>

- c. Use the Important Bird Areas map layer to determine if the AA is within a designated Important Bird Area.

### Indicator questions OF17 – OF23

Answer the following questions with information in the ORWAP Report generated in Step 3. Use the Rare Species Scores max score and sum score to determine the range of occurrences. In addition, use any information from qualified local sources (i.e. ODFW biologist). **These questions may need to be revisited after the field visit.**

- OF17 Using the Report's max and sum scores, determine the range (high, intermediate, low, or zero) for the occurrences in the vicinity of the AA of rare non-anadromous fish species listed in the accompanying Supp\_Info file.
- OF18 Using the Report's max and sum scores, determine the range (high, intermediate, low, or zero) for the occurrences of rare amphibian or reptile species in the vicinity of the AA. Those species are listed in the accompanying Supp\_Info file.
- OF19 Using the Report's max and sum scores, determine the range (high, intermediate, low, or zero) for the occurrences of rare non-breeding (feeding) waterbird species in the vicinity of the AA. Those species are listed in the accompanying Supp\_Info file.
- OF20 Using the Report's max and sum scores, determine the range (high, intermediate, low, or zero) for the occurrences of rare nesting waterbird species in the vicinity of the AA. Those species are listed in the accompanying Supp\_Info file.
- OF21 Using the Report's max and sum scores, determine the range (high, intermediate, low, or zero) for the occurrences of rare songbird, raptor, or mammal species in the vicinity of the AA. Those species are listed in the accompanying Supp\_Info file.
- OF22 Using the Report's max and sum scores, determine the range (high, intermediate, low, or zero) for the occurrences of rare invertebrate species in the vicinity of the AA. Those species are listed in the accompanying Supp\_Info file.
- OF23 Using the Report's max and sum scores, determine the range (high, intermediate, low, or zero) for the occurrences of rare wetland-indicator plant species in the vicinity of the AA. Those species are listed in the accompanying Supp\_Info file.

## Indicator questions OF24 - OF34

Note there are indicator questions that, based on the answer, may direct you to SKIP several of the indicators that follow.

- OF24 Use the Rivers and Streams layer, the Headtide (within Water Source & Quality) layer, and the Distance tool to determine if a waterway, at least 50 ft. wide and non-tidal, is within one mile and is contiguous to or downslope from the AA (connected or not).
- **River:** as used here is a channel wider than 50 ft. between its banks.
- OF25 Use Aerial imagery, the Floodplain layers, Distance tool, and knowledge of the area to determine flood risk and damage to areas within 1 mile downslope or downriver from the AA. The Seasonal Nontidal (within Wetlands) layer may also indicate some floodplain areas.
- **Row crops:** do not include pasture or other perennial cover.
- OF26 Use Aerial imagery and the Floodplain layers to determine what type of areas in the floodplain would have the greatest potential financial (economic) damage.
- OF27 Use the Hydrologic Landscapes layer (under Watersheds) and the Point identify tool to obtain the landscape unit classification. The first letter in the code is for the climate class. Climate class is also provided in the Report's Location Information as Hydrologic Landscape Class.
- OF28 Use the Water Quality Streams and Water Quality Lakes layers (under Water Source & Quality) and the Distance tool to determine if there is a water quality-limited water body or stream reach located one mile upstream from the AA. To determine the reason for the listing, use the Point identify tool. When the results show at the bottom of the screen, select Table View to determine which parameters are applicable. Select all the parameters that apply.
- OF29 Use the Rivers and Streams layer and the Persistent, Seasonal, or Saturated Non-tidal layers (under Wetlands) to determine duration of surface water connection, if any, of the upstream area identified in OF28 to the AA. **This may need to be determined or verified in the field.**
- OF30 Use the Water Quality Streams and Water Quality Lakes layers and the Distance tool to determine if there is a water quality limited water body identified within 1 mile downhill or downstream from the AA's edge. To determine the reason for the listing use the Point identify tool. When the results show at the bottom of the screen, select Table View to determine which parameters are applicable. Select all the parameters that apply.
- OF31 Use the Rivers and Streams layer and the Persistent, Seasonal, or Saturated Non-tidal layers (under Wetlands) to determine the connection between the AA and the downhill or downstream problem area identified in OF30. **This may need to be verified in the field.**

- OF32 Use the Surface Water Drinking Source and Ground Water Drinking Source layers to determine the source area that the AA is within.
- OF33 See the maps provided in the Manual's Appendix A to determine if the AA is within a designated groundwater management area or sole source aquifer area.
- OF34 Use the HUC 8 layer (under Watersheds) to determine the location of the AA in the watershed. It helps to turn off all other layers and zoom out to examine the whole watershed. Using the Rivers and Streams layer and the Floodplain: FEMA layer, consider:
- Which end of the HUC is the bottom? Where streams join, the "V" that they form on the map points towards the bottom of the HUC.
  - If the AA is closer to the HUC's outlet than to its upper end, and is closer to the river or large stream that exits at the bottom of the HUC than it is to the boundary (margin) of the HUC, then check "lower 1/3"
  - If the AA is not in a 100-yr floodplain, is closer to the HUC4 upper end than to its outlet, and is closer to the boundary (margin) of the HUC than to the river or large stream that exits at the bottom of the HUC, then check "upper 1/3"
  - For all other conditions, check "middle 1/3"
  - *Note: follow the instructions exactly without making assumptions or interpreting the question in another way*

#### Indicator questions OF35 through OF38

The Runoff Contribution Area (RCA) is the drainage area, catchment area, or contributing upland that contributes runoff directly to the wetland, not via streams or overbank flow (Figure 3-10). The water does not need to travel on the land surface; it may reach the AA slowly as shallow subsurface seepage<sup>2</sup>. The RCA does not include the Streamflow Contributing Area (SCA) (see Indicators OF39 - OF40). The approximate boundary of the RCA will need to be estimated and delimited to answer indicator questions OF35 – OF38.

- Layers that will assist this estimate include: USA Topo Maps, Aerial, Wetlands, Floodplain FEMA, and Hydrologic Boundaries: 6<sup>th</sup> Level (HUC12).
- The Profile tool (Explore Map tab) is helpful for examining topography. The tool will generate an elevation profile from a transect line.
- Draw the RCA with the Polygon tool (Create & Share tab) on the USA Topo Maps layer.
- Print the map so the area can be refined if necessary based on field observations.

The upper limit of an RCA is sometimes synonymous with the boundaries of the HUC 12 watersheds. However, a wetland's RCA will almost always be much smaller than the entire HUC12 watershed. The RCA's highest point will be along a ridgeline or topographic mound

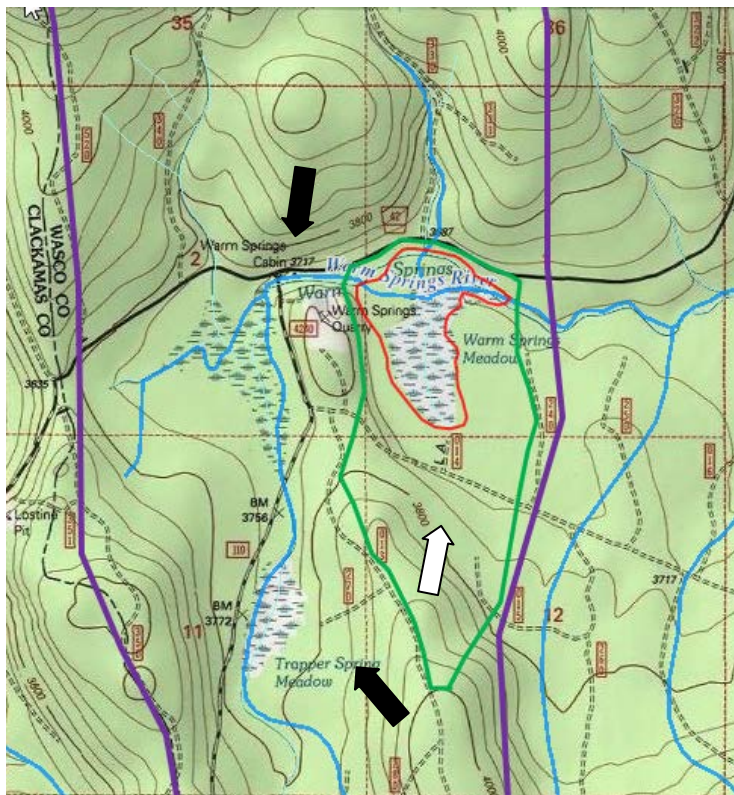
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<sup>2</sup> There are often situations where subsurface flow (especially deep groundwater) that potentially feeds a wetland ignores such topographic divides, but due to the limitations imposed by rapid assessment, no attempt should be made to account for that process.

beyond which water would travel in a direction that would not take it to the AA. The lowest point of an RCA is the lowest point in the AA.

Although it is possible that roads, tile drains, and other artificial features that run perpendicular to the slope may interfere with movement of runoff or groundwater into a wetland (at least seasonally), it is virtually impossible to determine their relative influence without detailed maps and hydrologic modeling. Therefore, in most cases draw the RCA as it would exist *without* existing infrastructure, i.e., based solely on natural topography as depicted in the topographic map. The only exception is where maps, aerial images, or field inspections show artificial ditches or drains that *obviously* intercept and divert a *substantial* part of the runoff before it reaches the wetland, or where a runoff-blocking berm or elevated road adjoins (is contiguous to) a wetland on its uphill side.

A RCA may include other wetlands and ponds, even those without outlets, if they're at a higher elevation. Do not include contiguous perennial deep waters at the same elevation (such as a lake, river, or bay) unless so indicated in the question. The RCA boundaries can be somewhat subjective and estimation in the field may be preferable, especially in urban areas and areas of flat terrain. However, for ORWAP's purposes a high degree of precision is not needed.



Note – for this site's RCA, presence of the road north of the wetland was irrelevant because it was bordered by ditches that redirected runoff from the slopes into the stream before entering the wetland. If this had not been true, the RCA would have extended upslope (minus the stream and banks) creating a U shape RCA."

Figure 3-10. Delimiting a wetland's Runoff Contributing Area (RCA). Wetland (in red) is fed by its Runoff Contributing Area (RCA) whose boundary is represented by the green line. The larger SCA is partially shown here within the purple line. The white arrow denotes flow of water downgradient within the RCA. Black arrows denote the likely path of water away from the RCA and into adjoining drainages, as interpreted from the topography.

Delimit the RCA and answer the following:

- OF35 Use the Area polygon tool (Explore Map tab) to determine what percentage of the RCA the AA wetland encompasses.
- OF36 Use an Aerial layer to determine the proportion of the RCA comprised of buildings, roads, parking lots, exposed bedrock, and other surfaces that are usually unvegetated at the time of peak annual runoff.
- OF37 Determine if a relatively large proportion of the precipitation that falls farther upslope in the RCA reaches this wetland quickly as indicated by the following:
- RCA slopes are steep – use the USA Topo Maps layer.
  - Upslope wetlands historically present have been filled or drained extensively – use the Hydric Soils (in Soils) layer as an indicator and consider human disturbance and management.
  - Land cover is mostly non-forest – use an Aerial layer.
  - Most RCA soils are shallow and/or have high runoff coefficients. Use the Oregon Soils (in Soils) layer to identify the soil unit names within the RCA. Open the following website <https://soilseries.sc.egov.usda.gov/osdname.aspx> and enter each soil series name (without texture or slope percent). For example, for “Elsie silt loam 0 to 7 percent slopes,” only enter Elsie. If the soil is a complex (i.e. Preacher-Bohannon complex), enter only one name (i.e. Preacher) per line and do not enter dashes. After clicking on “process” you can either download the results or view the descriptions.

When viewing the descriptions, the first sentence under the series title will indicate whether the soils are shallow, moderately deep, deep or very deep. Scroll down to “Drainage and Permeability” where information about runoff is found (i.e. ponded to slow runoff).

- OF38 Use the USA Topo Maps layer and the Distance tool to determine the area 200 ft. away and *upslope* of the AA. Turn on the Oregon Soils layer. Identify which soil map unit occupies the largest percentage of the area within 200 ft. upslope. Use the Point identify tool to see the soil units name. In the Results box that pops up below, click on Table View. Scroll across the information columns to “forpehrtdc,” which is the erosion hazard rating.

#### Indicator questions OF39 through OF40

A Stream Contribution Area (SCA), is recognized only if a stream (tributary) or other waters feed into the wetland (Figure 3-11). The SCA is all upland areas that drain into streams, rivers, and lakes (if any) that then feed the AA’s wetland either directly or during semi-annual overbank floods. Normally, the boundary of a SCA will *cross a stream at only one point* — at the SCA’s and AA’s outlet, if it has one.

The SCA will need to be determined to answer indicator questions OF39 – OF40. The same layers and tools are used as above for the RCA.

- Print the map, as the area may need to be refined in the field

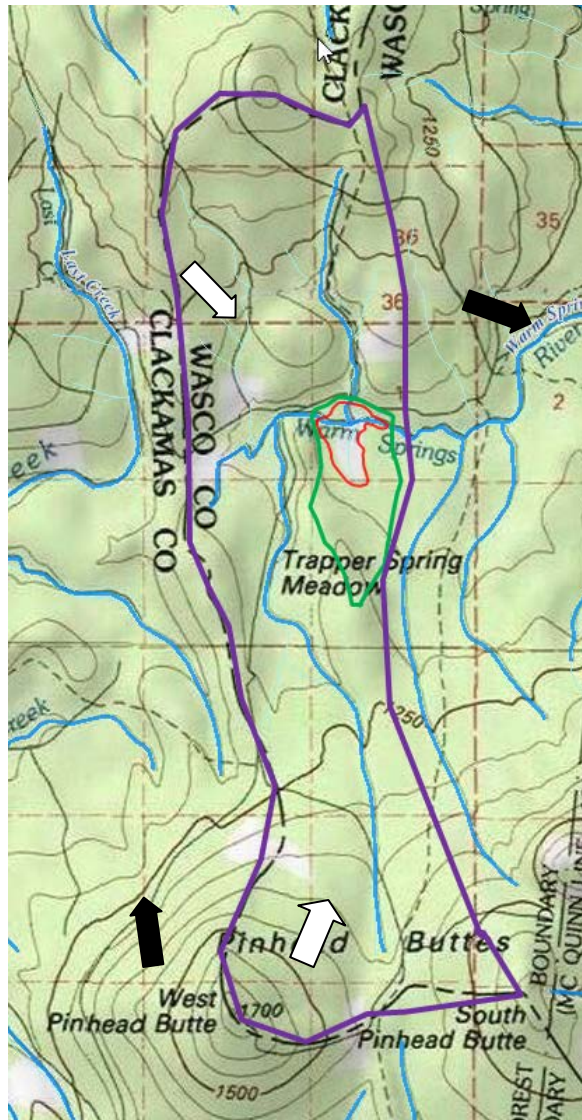


Figure 3-11. Delimiting a wetland's Streamflow Contributing Area (SCA). Wetland (in red) is fed by its Streamflow Contributing Area (SCA) whose boundary is represented by the purple line. The RCA is within the green line. The white arrows denote flow of water downgradient within the SCA. Black arrows denote the likely path of water away from the SCS and into adjoining drainages, as interpreted from the topography.

An alternative method for delimiting a SCA for wetlands intercepted by a mapped stream is StreamStats. The SCA can be delineated and the area calculated automatically by StreamStats at the USGS website:

[http://streamstatsags.cr.usgs.gov/v3\\_beta/viewer.htm?stabbr=OR](http://streamstatsags.cr.usgs.gov/v3_beta/viewer.htm?stabbr=OR). Zoom into the wetland's location. Use the Watershed delineation from a Point tool, which looks like a black circle and + sign. The contributing area will be delineated. When the delineation Results box appears, click on the Compute Basin Characteristics button in the lower bottom left corner. Click on the Compute Basin Chars button and a site report will be generated.

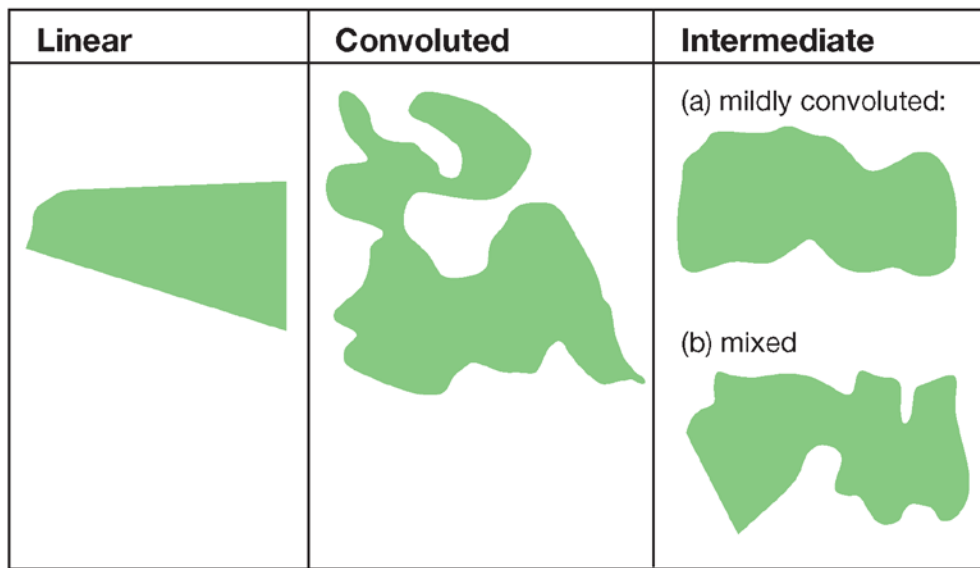
Delimit the SCA and answer the following:

OF39 Use the Area polygon tool (Explore Map tab) to determine the area of the SCA. For large river basins, you may need only to visualize the area. Calculate what percentage of the SCA that the area of the AA (determined in Step 2) encompasses.

OF40 Use the Area polygon tool (Explore Map tab) to determine what percentage of the SCA is unvegetated at the time of the peak annual runoff.

Indicator questions OF41 through OF43

OF41 To determine the wetland’s upland edge shape complexity, compare the wetland to the following types of boundaries as illustrated in Figure 3-12.



*Figure 3-12. Upland Edge Shape Complexity*

OF42 Use an Aerial layer, the Oregon Zoning layer to determine the zoning of undeveloped parcels upslope from the AA and within 300 ft. of the AA’s edge. Use the Point identify tool to click on the dominate unit. In the Results box that pops up below, look under the “Orzdesc” column for the zoning designation.

OF43 Use the Growing Degree Days layer and the Point (identify) tool (Explore Map tab) to determine the category for the AA. In the Results box that pops up below, look under the “Pixel Value” column. This is the number used to determine which growing degree days category should be selected.

### 3.3 Instructions for the Field Component

The field component of the assessment involves visiting as much of the AA as is safely and legally possible, and then filling out the two field forms (Form F or Form T and Form S) and



verifying, as needed, answers on the office Form OF. Based upon the experience of many persons who tested ORWAP, this component will generally require less than 2 hours. Large or complex sites may take longer. If circumstances allow, visit the AA during both the wettest and driest times of year. If you cannot, you must rely more on the aerial imagery, maps, other office information, field indicators, and discussions with the landowner and other knowledgeable sources. If assessing a tidal wetland, try to assess the AA during the daytime high tide on a given day, and preferably as well during the day's low tide.

### 3.3.1 Items to Take to the Field

Take the following with you into the field:

- Blank field data forms: Form F (non-tidal wetlands) or Form T (tidal wetlands) and Form S
- Completed data Form OF (to verify answers)
- Prints made during the office assessment:
  - Aerial images of the AA (to verify AA and use as a base map, if no wetland delineation map available)
  - Aerial image that includes entire wetland (to answer applicable questions)
  - Topographic map with the RCA and/or SCA boundary you drew tentatively (to verify)
  - Soil map (with soil units and names)
- Wetland delineation map (if any, to verify AA and use as a base map)
- Shovel
- Water (for texturing soil)
- Clip board, pencil, rag to clean hands and other items you'd normally take in the field
- The explanatory illustrations in Appendix A that includes the flow chart for texturing soils in the field

Download and print the PDF versions of the plant worksheets from the *ORWAP\_SuppInfo* file, as needed, to help you answer specific questions and also take those into the field for reference:

- Invasive Plants (P\_INVAS worksheet)
- Plants Not Native to Oregon (P\_EXO worksheet)
- Wetland Plants Uncommon in Oregon (P\_UnCom worksheet)
- Salt-tolerant and Low Tidal Marsh Plants (P\_SALT worksheet)
- Plants Reputed to Support Nitrogen Fixation (NFIx worksheet)

Download and print the US Army Corps of Engineers *State of Oregon 2014 Wetland Plant List* from

[http://rsgisias.crrel.usace.army.mil/nwpl\\_static/data/DOC/lists\\_2014/States/pdf/OR\\_2014v1.pdf](http://rsgisias.crrel.usace.army.mil/nwpl_static/data/DOC/lists_2014/States/pdf/OR_2014v1.pdf).

### 3.3.2 Conducting the Field Assessment

**Step 1.** Review the questions on the applicable Form F (or Form T) and Form S to refresh your memory of what to observe during the field visit. Note that questions marked “**W**” on the Form F (or Form T) must be answered for the *entire wetland*. Also review Form OF to see which questions you may have flagged during the office phase for checking during the field visit.

Series of particular questions have been highlighted with various colors in columns A and B of the spreadsheet (Indicator number and name) to assist in locating particular site conditions. Highlights denote questions that all pertain to a particular wetland type or setting (like open water wetlands), or similar themes (like outlet conditions), or allowed "skips" in a block of questions.

**Step 2.** Before answering questions on the data forms, walk as much of the AA and wetland as is safely and legally possible. Plan to visit each major vegetation type (these may be evident on the aerial imagery if the AA is large), each different soil map unit, each area with different topography, the wetland/upland edges and all wetland/water feature edges (e.g., ponds, lakes, streams). As you walk around, do the following steps.

**Step 3.** For your own use, it is suggested that you create or revise a base map showing the AA boundary, location of inlets and outlets, open water, and major patches of the different vegetation forms (herbaceous, woody). If the scale and resolution are appropriate, an aerial image and/or wetland delineation map may be used as the base map. For larger wetlands, marking of "waypoints" along wetland and/or AA boundaries using a handheld GPS can expedite mapping and improve precision.

**Step 4.** Generally note the extent of non-native plant cover within the AA and along its upland edge, as well as any plants you don't often encounter (i.e., are listed in the P\_UnCom worksheet), and other indicators described on the field forms.

**Step 5.** If you have access to the entire wetland, look for inlets and outlets and other hydrologic features addressed by ORWAP.

**Step 6.** Read the instructions at the beginning of Forms F (or Form T) and S and then fill them out, paying attention to all the explanatory notes and definitions in the last column of the data forms, as well as referring to graphics in the Explanatory Illustrations appendix to this manual (Appendix A). As you answer the questions dealing with "percent of the area," pay particular attention to the spatial context (area) which the question is addressing. For example, in regard to a type of vegetation or land cover, be careful to note if it's asking what percentage is occupied within the:

- open water area, or
- vegetated area of *that type* (e.g., compare only with total wooded area), or
- total vegetated area, or
- upland edge, or
- assessment area (AA), or
- entire wetland

**Step 7.** For question F58, determine the composition of the soil in the uppermost layer but exclude living roots and duff, which are fresh leaf, needle, twig, moss, dead roots and lichens that have not undergone observable decomposition. The examined soil should be in the currently unflooded part of the AA and within the AA's predominant soil map unit. Refer to the soil map you made of the AA's soil map units to determine the predominant unit.

You will be asked to categorize the soil simply as *Organic*, *Clayey*, *Loamy*, or *Coarse*. Be aware that soil horizons (layers) can be thin and that there is no minimum horizon (layer) thickness requirement. For ORWAP's intended use, *Organic* includes organic soils (muck, mucky peat, and peat) and mucky mineral, which is a mineral soil with a high content of muck (>10% organic matter and < 17% visible fibers when rubbed). If the surface soil is a mass of living roots, determine its composition at the point just below those roots where the organic soil material is decomposed enough so that the dead fibers can be crushed or shredded with the fingers.

Determine soil composition by using the ORWAP *Soil Composition by Feel* diagnostics flow chart in Appendix A. After you determine the soil composition in the surface layer, compare it with the list of mapped soil units within the AA. Most map unit names indicate the texture of the surface layer <sup>1</sup> (e.g., Omahaling fine sandy loam). If the composition differs from that of all of the listed soil map units, examine soil from a *second* location in the wetland. The intent is to characterize the soil that comprises the majority of the wetland. Be aware that the soil map units do include small areas of other soil series. Since soil surveys are not intended to be used at a point/site scale, you may want to consider the soils that are mapped in the rest of the wetland (if the AA is a portion) and/or the nearby mapped soils. Do not use the mapped soil unit texture class without verifying it with your own determination.

**Step 8.** Look uphill of the wetland to see if any artificial feature that adjoins the wetland *unmistakably* diverts *most* of the surface runoff away from it (e.g., high berm) during normal runoff events. If such is found, redraw the RCA to exclude all areas that drain to that feature and not into the wetland.

**Step 9.** Note what percent of the wetland and the percent of the AA you were able to visit. If the AA was tidal, note the tidal phase during most of the visit.

## 3.4 Instructions for Entering, Interpreting, and Reporting the Data

### 3.4.1 Data Entry

Enter data for lines 19 – 21 on the CoverPg and from the remaining data forms (F, T, and S) into the corresponding Excel worksheets. The scores for the functions and other attributes will compute automatically and appear in the Scores worksheet. If you wish to see how different questions (indicators) contributed to each function or other attribute, click on the function's worksheet and you will see both your responses and the scores for each relevant indicator after being adjusted to a 0 to 1 scale.

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<sup>1</sup> If the map unit name does not include a texture class (i.e., Henkle-lava flows-Fryrear complex) you can view a soil series profile description at <https://soilseries.sc.egov.usda.gov/osdname.aspx>. Enter only the soil series name (i.e. Henkle). Please note that soils of one series can differ in surface layer texture, which is one reason soil series are divided into soil phases (i.e., Omahaling fine sandy loam).

Check to be sure every question on all data forms was answered and entered, except where the form directed you to skip one or more questions.

### **3.4.2 Evaluating Results**

Before accepting the scores that were computed by *ORWAP\_Calculator* and shown in the Scores worksheet, think carefully about those results. From your knowledge of wetland functions, do they make sense for this wetland and/or AA? If not, review the worksheet for that function or other attribute, as well as Appendix B (Narrative Descriptions of Scoring Models), to see how the score was determined. If you disagree with some of the assumptions that led to that score, write a few sentences explaining your reasoning on the bottom portion of the CoverPg form (add additional sheets if needed). Remember, ORWAP is just one tool intended to help the decision-making process, and other important tools are your common sense and professional experience with a particular function, wetland type, or species. Review again the caveats given in the User Advisories section (section 1.3).

If you believe some of the scores which ORWAP generated do not match your understanding of a particular wetland function or other attribute, first examine the summary of your responses that pertain to that by clicking on the worksheet with that attribute's code (e.g., NR for Nitrate Removal). If you want to reconsider one of your responses (perhaps because you weren't able to see part of the AA, or view it during a preferred time of year), change the 0 or 1 you entered on *Form OF, F, T or S*. Then check the Scores worksheet to see what effect that had. If the results still don't match your judgment of that attribute, you may write your reasons in the space provided at the bottom of the CoverPg form.

You may do the same (changing various 0's and 1's) if you'd like to simulate the potential effect of an enhancement or restoration measure on function scores, or the impact on those scores from some controllable or uncontrollable alteration or management activity within the AA or wetland, its contributing area, or surrounding landscape out to within 2 miles. However, understand that ORWAP is not intended to predict changes to an AA – only to estimate the likely direction and relative magnitude of those changes, if they occur, on various functions and other attributes.

### **3.4.3 ORWAP Products**

A completed ORWAP assessment should include these products:

- Scores worksheet (computed by ORWAP)
- Completed forms on Excel spreadsheet (CoverPg, OF, F or T, S)
- Aerial photograph showing boundaries you drew for the AA, RCA, and SCA.
- Topographic map showing AA, RCA, and SCA boundaries
- Soils map showing soil units in AA
- ORWAP report generated by the Map Viewer.
- Base map created during field assessment (section 3.3.2)

### **3.4.4 Archiving ORWAP Data**

In addition to submitting the above to regulatory agencies, if pertinent, you are encouraged to voluntarily upload your completed spreadsheet to a permanent online repository of completed ORWAP assessments at the Oregon State University Library. In the ORWAP Map Viewer, simply click on the toolbar icon labeled "Upload ORWAP Spreadsheet" and navigate to the location on your computer where that spreadsheet is located. Due to the need for confidentiality that sometimes is necessary for assessments of wetlands on private property, users who wish to archive their spreadsheets need not identify the exact location—only the name of the county and the nearest town. Data from the spreadsheets will be used mainly to further characterize the statistical distribution of scores for each function. Knowledge of that statistical distribution could eventually be used to add sensitivity to ORWAP's scoring and improve our ability to interpret the results of future ORWAP assessments. This will be particularly true if users are able to reveal exact locations, such as for sites on public lands, by providing geographic coordinates of those assessments. At this time the website has no provision for online data entry and processing, or for reporting the results of quality-assured ORWAP assessments done in other locations by other users.

## **4.0 Using ORWAP**

### **4.1 Regulatory Applications**

Assessing wetlands for purposes of state and federal permitting was the primary driver for developing ORWAP. However, assessing wetlands where impacts are proposed is just one step in a complex process of evaluating existing wetlands, assessing wetlands to be enhanced or restored for compensatory mitigation, evaluating potential effects of projects, and determining wetland function and value replacement. Because applying ORWAP is just one part, albeit a critical one, of this process, DSL initiated a parallel interagency effort to develop guidance for how ORWAP output may be used for permitting purposes.

The *Guidance for Using the Oregon Rapid Wetland Assessment Protocol (ORWAP) in State and Federal Permit Programs* (Oregon Department of State Lands, November 2016) provides guidance to permit applicants, consultants and regulatory staff for using ORWAP to meet state and federal wetland regulatory objectives and requirements. The guide specifically offers instruction on: (1) selecting the assessment area for regulatory application of ORWAP; (2) using the ORWAP outputs for wetland mitigation planning; and (3) presenting assessment results in the Joint Permit Application (JPA). Two elements from the guide are important to understand when assessing a wetland using ORWAP for purposes of a state or federal permit application. The guide is available on the Department of State Lands Technical Resource web page or by contacting DSL.

### **4.2 Wetlands Planning and Protection**

Although ORWAP was developed primarily for state and federal wetland regulatory program use, it was also designed to be suitable for wetlands planning by local governments and for wetland assessments by watershed councils and other entities. When used for these purposes, the

AA should be the entire wetland, not portions of wetlands. Follow the “Defining the Assessment Area (AA)” guidance in section 3.2.2.

DSL establishes the requirements that cities and counties must follow when inventorying and assessing wetlands (Local Wetlands Inventory) and using that information to designate Locally Significant Wetlands (OAR 141-086). These steps must be followed prior to adopting a local wetland protection program under Goal 5 or Goal 17 of the Statewide Land Use Planning Program. ORWAP is not required for this purpose, but it may be used in place of the Oregon Freshwater Wetland Assessment Methodology (1996) or the newly developed (2016) ORWAP-Local Planning (ORWAP-LP) upon written approval by DSL. All portions of ORWAP must be completed. ORWAP’s score sheet now includes function and value score ratings of Higher, Moderate, and Lower based on natural breaks in score distributions.

Local Wetland Inventories are generally conducted for all areas within a city’s urban growth boundary. Not all property owners allow access to their property for this purpose, and due to time and funding constraints, not all wetlands can be visited. Therefore, much of the inventory and assessment work must be completed without benefit of onsite access to all wetlands or all portions of a wetland. Most ORWAP questions can be answered adequately by an experienced wetland professional using aerial photos and a variety of maps, and by viewing the wetland if possible from public roads and other properties. Optional information sources (see section 3.1.3) may be very helpful, and newer imagery as it becomes available (e.g., LIDAR) may also provide valuable information. Inevitably, there will be some questions that will require best professional judgment. However, ORWAP is sufficiently robust that the final scores and the determination of Locally Significant Wetlands will not be adversely affected.

For additional guidance on using ORWAP for Goal 5 or Goal 17 wetlands inventories and planning, contact the Aquatic Resource Planner at DSL.

### **4.3 Wetland Assessments under the Food Security Act**

ORWAP may be used by Natural Resources Conservation Service (NRCS) staff for assessing wetland functions for implementation of the Wetland Conservation (a.k.a., Swampbuster) provisions of the Food Security Act of 1985 (e.g., minimal effects determinations, or functions to be replaced by mitigation for conversions). NRCS staff participated on both ORWAP Technical Advisory Committees (TACs) and assisted with field testing and other ORWAP development tasks to ensure that ORWAP would be suitable for their program needs.

When using ORWAP for Swampbuster purposes, the AA will ordinarily be the portion of the wetland that will be or has been affected, rather than the entire wetland. ORWAP’s values scores should not be used for Swampbuster and may be disregarded.

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## **6.0 Appendices**



## Appendix A: Additional Explanatory Definitions and Illustrations

### Definitions as used in ORWAP indicators

Adjacent	Used synonymously with abutting, adjoining, bordering, and contiguous - means no upland (manmade or natural) completely separates the described features along their directly shared edge. Features joined only by a channel are not necessarily considered to be adjacent -- a large portion of their edges must match. The features do not have to be hydrologically connected in order to be considered adjacent.
Bare ground	Includes unvegetated soil, rock, sand, or mud between stems if any.
Contiguous	Abutting, with no major physical separation that prohibits free exchange or flow of surface water, if any is present.
Convolutd wetland edge shape	Wetland perimeter is many times longer than maximum width of the wetland, with many alcoves and indentations ("fingers").
Corridor of perennial cover	An elongated patch of perennial cover that is not narrower than 150 ft. at any point.
Distinct wetlands	Wetlands that the map shows as being separate (not connected). Consider them separate and distinct even when connected to the AA by a stream.
Emergent	Erect herbaceous or woody plants whose roots and/or foliage are inundated by tide at least once daily, on the average.
Flat terrain	Slopes of less than 5%.
Forbs	Flowering non-woody vascular plants (excludes grasses, sedges, ferns, mosses).
Forested patch	A land cover patch that currently has >70% cover of woody plants taller than 20 ft. May be in a plantation.
Herbaceous openland	Includes both perennial and non-perennial cover. For example, it can include pasture, herbaceous wetland, meadow, prairie, ryegrass fields, row crops, herbaceous rangeland, golf courses, grassed airports, and hayfields. Does not include open water of lakes, ponds, or rivers; or unvegetated surfaces; or areas with woody vegetation.
Impeded	Causing a delay or reduction in water velocity or volume.
Intermediate upland edge shape	Wetland's shape is (a) ovoid, or (b) mildly ragged edge, and/or (c) contains a lesser amount of artificially straight edge.
Linear upland edge shape	A significant proportion of the wetland's upland edge is straight, as in wetlands bounded partly or wholly by dikes or roads, or the AA is entirely surrounded by water or other wetlands.
Low marsh	Covered by tidal water for part of almost every day.
Major runoff events	Includes biennial high water caused by storms and/or rapid snowmelt.
Maximum vertical fluctuation	The difference between the highest annual and lowest annual water level during an average year. Use field indicators to assess.

Microtopography	Refers mainly to vertical relief of <3 ft. and is represented only by inorganic features, except where plants have created depressions or mounds of soil.
Non-breeding (feeding) waterbird species	Mainly refers to waterbird feeding during migration and winter.
Open Water	Surface water of any depth that contains no emergent herbaceous or woody vegetation. Open water may contain floating-leaved or completely submersed plants.
Perennial cover	Vegetation that includes wooded areas, native prairies, sagebrush, vegetated wetlands, as well as relatively unmanaged commercial lands in which the ground is disturbed less frequently than annually such as perennial ryegrass fields, hayfields, lightly grazed pastures, timber harvest areas, and rangeland. It does not include water, row crops (vegetable, orchards, and Christmas tree farms), residential areas, golf courses, recreational fields, pavement, bare soil, rock, bare sand, or gravel or dirt roads.
Perennial cover corridor	A corridor is simply an elongated patch of perennial cover that is not narrower than 150 ft. at any point.
Ponded	Most surface water is not visibly flowing. These include pools in floodplains and may be either large (e.g., an off-channel pond) or small (size of a puddle).
Recent onsite observation	Within 5 years.
Regular traffic	At least 1 vehicle per hour during the daytime throughout most of the growing season. Assess this based on local knowledge, type of road, and proximity to developed areas.
Repeatedly	The condition occurred in at least half of the last 10 years
River	A channel wider than 50 ft. between its banks.
Robust vines	Include Himalayan blackberry and others that are generally erect and taller than 1 ft.
Row crops	Do not include pasture or other perennial cover.
Runoff Contributing Area (RCA)	The drainage area, catchment area, or contributing upland that contributes runoff directly to the wetland, not via streams or overbank flow. The water does not need to travel on the land surface; it may reach the AA slowly as shallow subsurface seepage. Includes only the areas that potentially drain directly to the AA's wetland rather than to channels that flow or flood into that wetland. Does not include the Streamflow Contributing Area (SCA).
SAV	Herbaceous plants that characteristically grow at or below the water surface, i.e., whose leaves are primarily and characteristically under or on the water surface during most of the part of the growing season when surface water is present. Some species are rooted in the sediment whereas others are not.
Sheet-flow swale	An area where surface water exits downhill into a contiguous wetland or channel, but is very shallow and intermittent.
Shorebird habitat	These areas must have (a) grasses shorter than 6", or a mudflat, during any part of this period, AND soils that either are saturated or covered with <2 inches of water during any part of this period, AND (c) no detectable surrounding slope (e.g., not the bottom of an incised dry channel), AND (d) not shaded by shrubs

	or trees.
Snags	Snags are standing trees at least 20 ft. tall that are mainly without bark or foliage.
Stream Contributing Area (SCA)	Is recognized only if a stream (tributary) or other waters feed into the wetland. This includes all upland areas that drain into streams, rivers, and lakes (if any), which then feed the AA's wetland, either directly or during semi-annual overbank floods. Normally, the boundary of a SCA will cross a stream at only one point — at the SCA's and AA's outlet, if it has one.
Tidal wetland	A wetland that receives tidal water at least once during a normal year, regardless of salinity, and dominated by emergent or woody vegetation. Tidal flooding occurs on a 6-hour cycle DURING THE TIME it is flooded by tide, which may be as infrequent as once per year.”
Throughflow complexity	This mainly refers to surface water that moves between the inlet and outlet. Some judgment is required in assessing straight vs. indirect flow path.
Unsheltered fence	Open to flying waterfowl on both sides, i.e., not entirely within an area of tall dense vegetation.
Upland edge	The land within 3 ft. of the wetland's perimeter that is not wetland.
Valley width	Delimited by an abrupt increase in slope on both sides of the channel
Vegetated part	Should not include floating-leaved or submersed aquatics.
Wooded upland edge	Includes woody plants located within one tree-height of the wetland-upland boundary. DBH is the diameter of the tree measured at 4.5 ft. above the ground.

## **Explanatory Illustrations**

This section contains photographs, drawings and maps that illustrate many of the indicators used by ORWAP. These are provided only as examples of some of the many conditions that may be encountered while assessing the indicators; not all indicators are illustrated.

The illustrations are intended to augment the definitions and explanations on the data forms and in section 3.0 of the manual. The illustrations are presented in numerical order, beginning with the Office OF data form then the Field F, Field T, and Field S data forms. Users getting accustomed to ORWAP may wish to print these illustrations and refer to them frequently while performing their first several wetland assessments. Printing in color is recommended.

## Office OF Data Form Illustrations

**OF11**

### Herbaceous Open Land



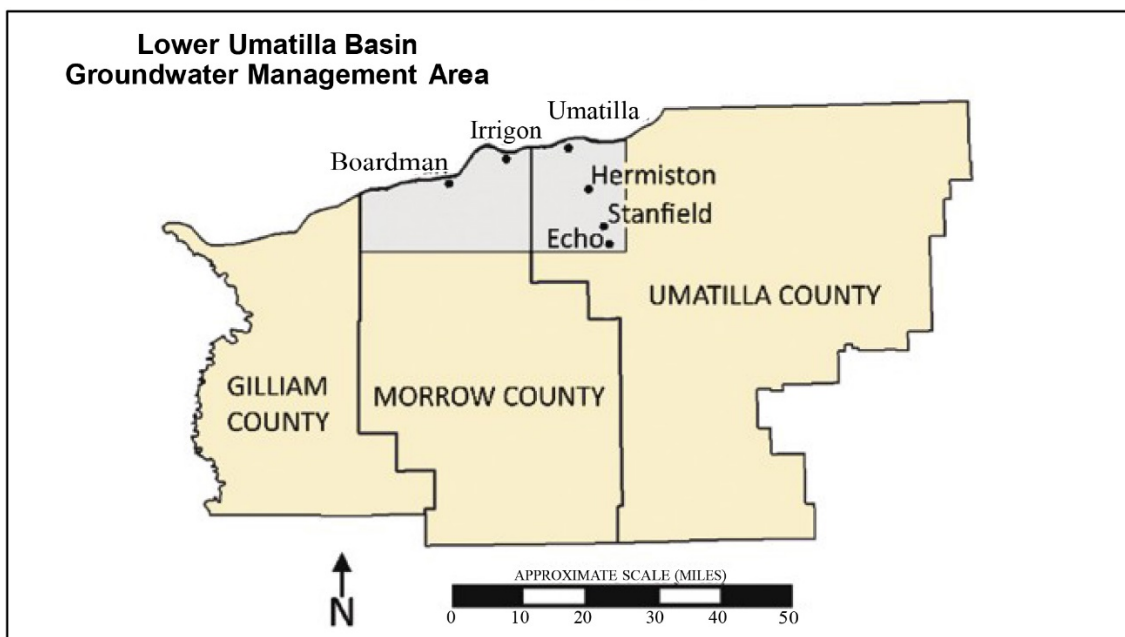
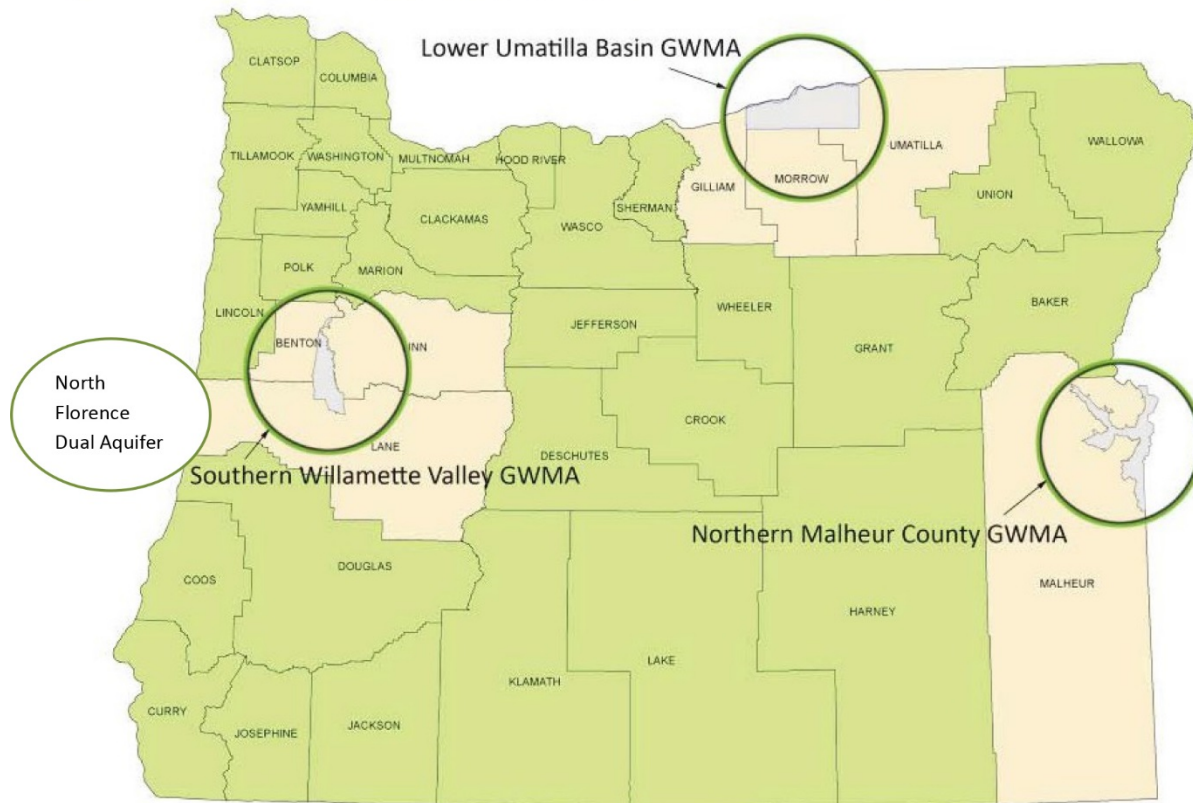
*Flat cropland near wetlands provides excellent feeding habitat for many wetland species, such as Sandhill Crane. Summer Lake Wildlife Area, Lake County, Oregon.*

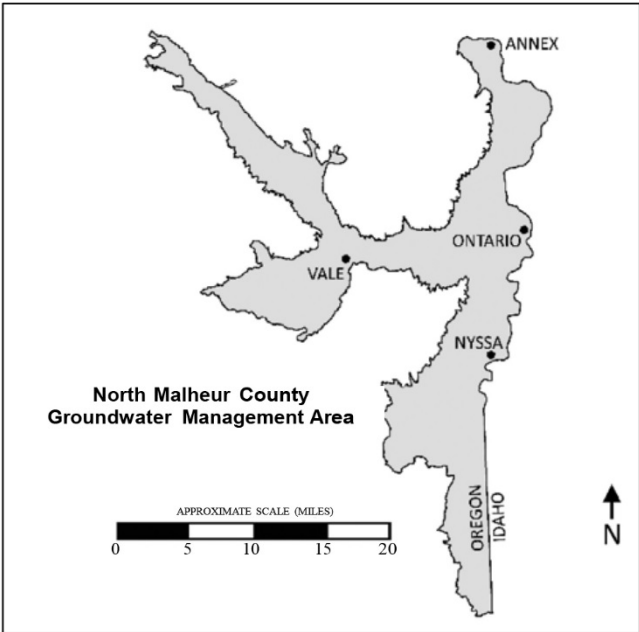
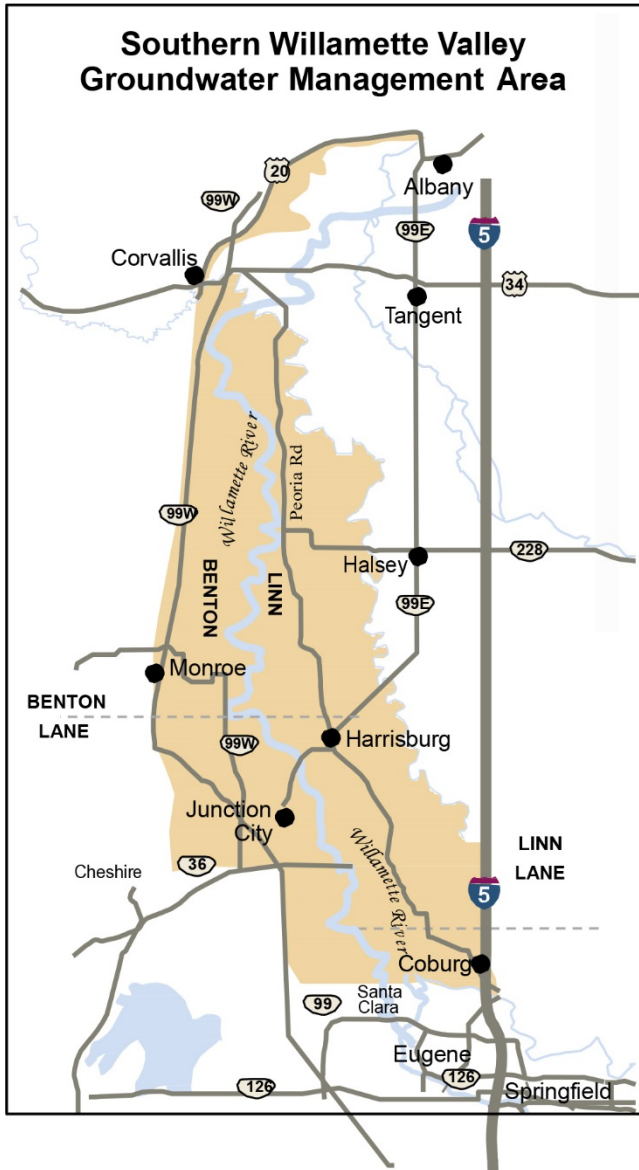


*Flat land in valley bottoms includes pasture, grass fields, cropland and herbaceous wetland and provides feeding habitat for migratory shorebirds and other species. Open land on hill slopes, as shown in the background, is not considered “open land” for indicator OF11.*

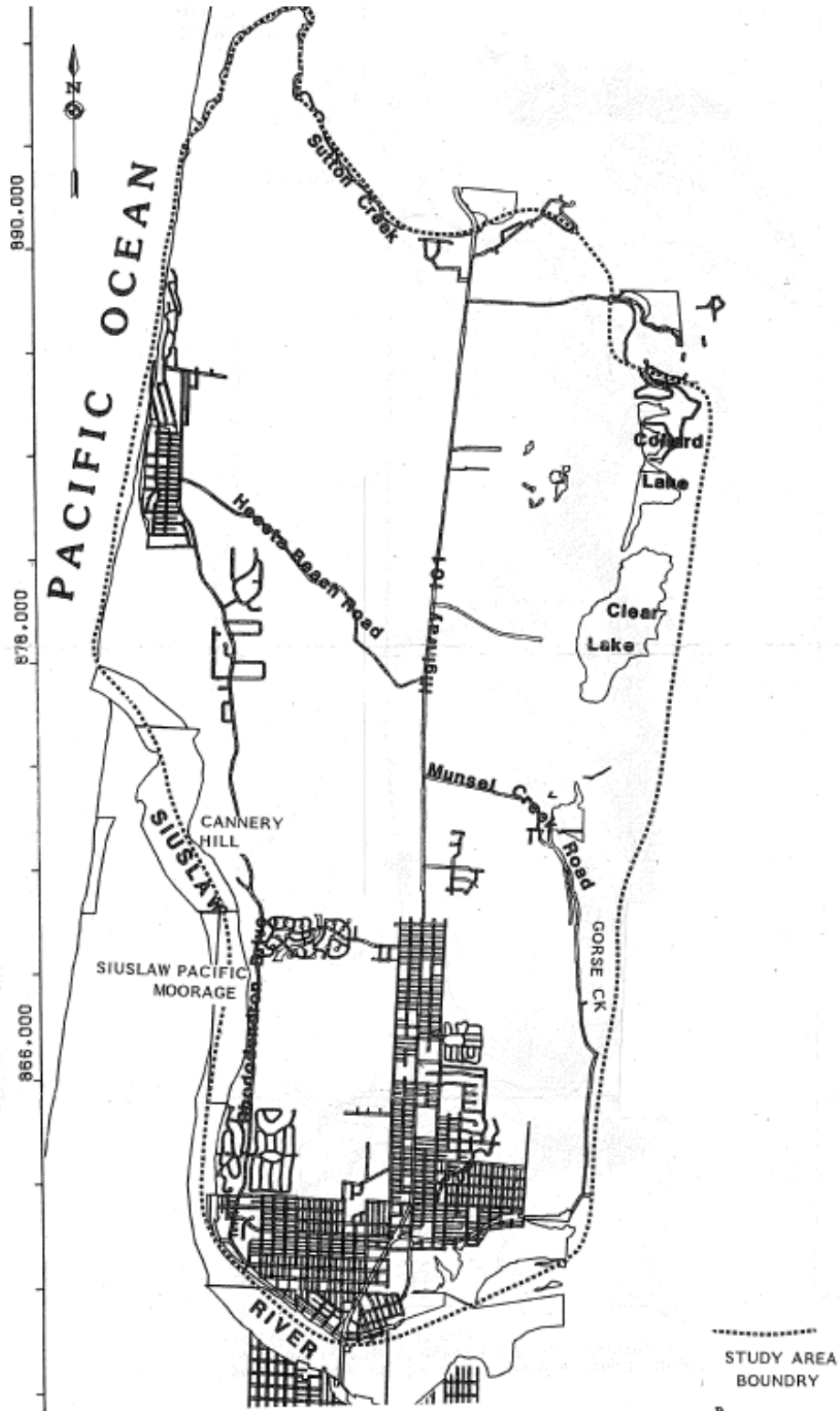
### Oregon's Groundwater Management Areas

CLICK ON AREAS BELOW FOR MORE DETAIL





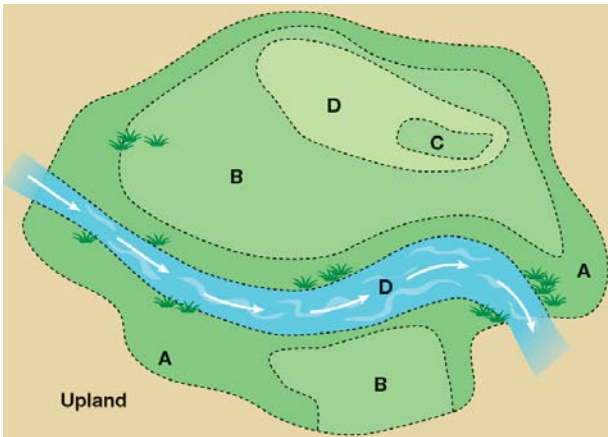
Locator map for the North Florence Dual Aquifer showing study area boundaries, roads, streams and lakes.





## Field F Data Form Illustrations

### **F5** Depth Class Predominant and **F6** Depth Class Distribution



*The depth in most of this AA is Class B during most of the time surface water is present. No depth class comprises > 90% of the AA's inundated area, but Class B comprises > 50%.*

### **F20** Floating-leaved and Submerged Aquatic Vegetation (SAV)



### **F25** Predominant Water Fluctuation Range



*Water line on lichen-covered rocks, indicating extent of seasonal fluctuation in vernal pool water level. Also, different lichen species grow above and below the water line. The Dalles, Oregon.*



*Stranded algae in foreground indicates extent of seasonal fluctuation in water level. Interdunal wetland, Newport/ South Beach, Oregon.*

**F29** Non-native Aquatic Animals



*Large populations of carp, such as these dead ones, can deplete dissolved oxygen and light in many wetlands, thus limiting the habitat available for many native fish species. Malheur Lake, Harney County, Oregon.*

**F30** Shorebird Feeding Habitats



*For brief periods during spring or early fall recently plowed or flooded soils in farmed wetlands provide important feeding opportunities for migratory shorebirds. Coburg, Oregon.*

**F31** Outflow Duration

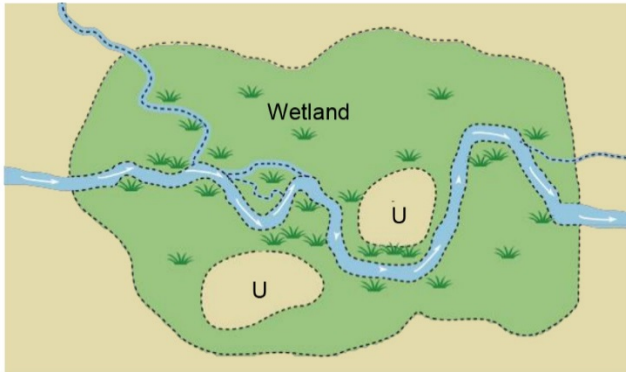


*Seasonal outlet channel in the Warner Basin, Lake County, Oregon.*



*A small outlet channel that carries water only seasonally.*

**F35** Throughflow Complexity



Throughflow complexity in this example is great (sinuous and braided channel, indirect flow path). U = upland inclusion.

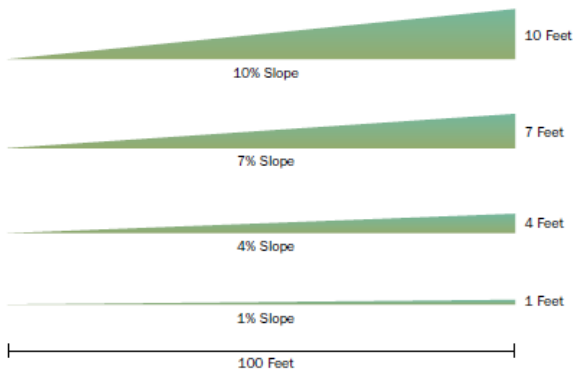
**F37** Groundwater Strength of Evidence



Groundwater is likely to be a major source of water to wetlands that are near the toe of naturally steep slopes, especially in eastern Oregon. Jack Lake, Lake County, Oregon.

**F36** Internal Gradient

Assessment Area Cross Sections



**F48** Abovewater Wood



*Abovewater wood provides perches for cormorants and other wetland birds, as well as turtles and frogs. Wood River, Klamath County, Oregon.*



*Mike Miller Park, Newport, Oregon.*

**F56** Bare Ground Accumulated Plant Liner



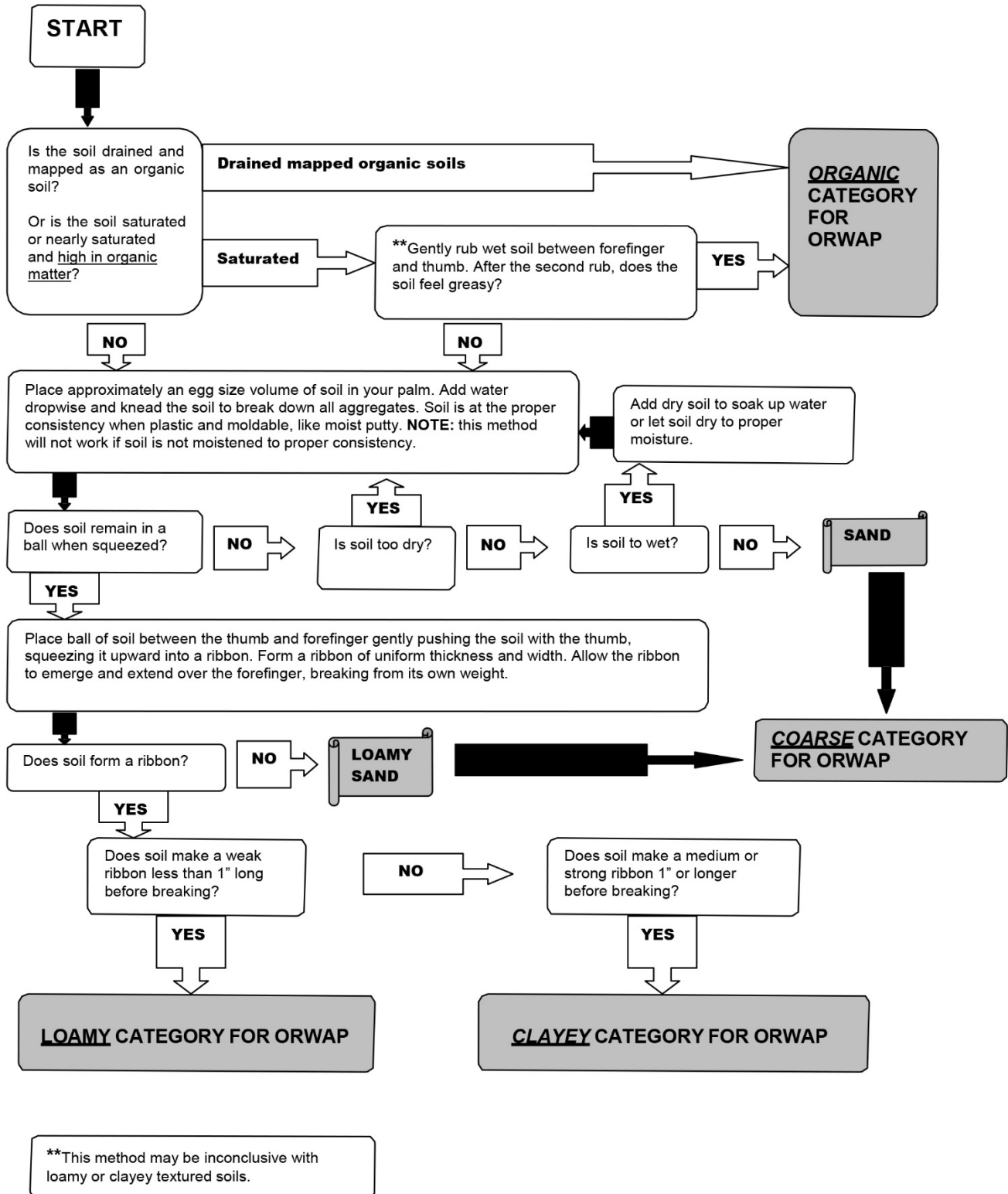
*In this photo, much (20-50%) bare ground or plant litter is visible and stem density is low.*



*This AA exhibits mostly (>50%) bare ground or plant litter.*

## F58 Soil Composition in the Soil Pit

Use this flow chart to estimate the soil composition in your soil pit. Also read the explanation in Section 2.3.2 of this Manual.



**F59** Cliffs, Banks, or Beaver



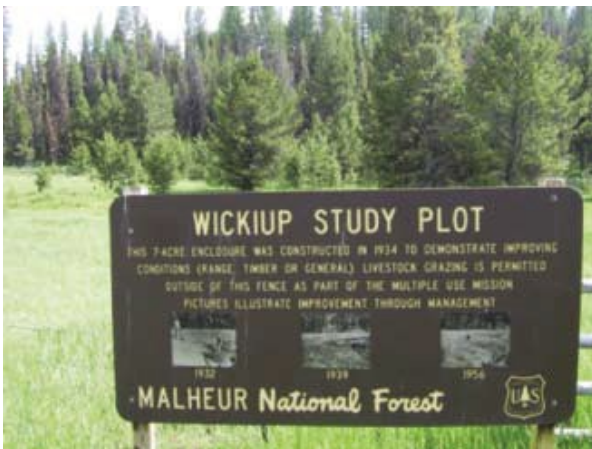
*High vertical banks and cliffs can provide important nest sites for wetland-dependent birds and mammals. La Grande, Oregon.*

**F67** Cliffs, Banks, or Beaver



*This wetland can be accessed most of the year by boat (non-consumptive use), and fishing is popular (consumptive use). Wood River wetland, Klamath County, Oregon.*

**F65** Cliffs, Banks, or Beaver



*Evidence of sustained research in a riparian wetland. Grant County, Oregon.*

**F72** Wetland Type of Conservation

**Bog or Fen**



*Fen with Sphagnum moss. Crater Lake National Park, Oregon.*



*Sphagnum*

**Playa or Salt Flat**



*Salt crust on soil in a seasonal salt flat wetland. Haines, Oregon*

**Native Wet Prairie, West of Cascades**



*Wet prairie with Camas in bloom, Willamette Valley, Oregon.*

**Vernal Pool**



*Vernal pool over hardpan, part of a complex of dozens of vernal pool wetlands. White City, Oregon.*



*Vernal pool in the dry season, White City, Oregon.*



*Vernal pool over basalt bedrock terrace above the Columbia River, The Dalles*

**F72** Continued...

**Interdunal Wetland**



*Interdunal wetland. South Jetty, Florence, Oregon.*



*Interdunal wetland, Coos Bay, Oregon.*



*Interdunal wetland. Newport-South Beach, Oregon.*



## Field T Data Form Illustrations

### T3 Low Marsh

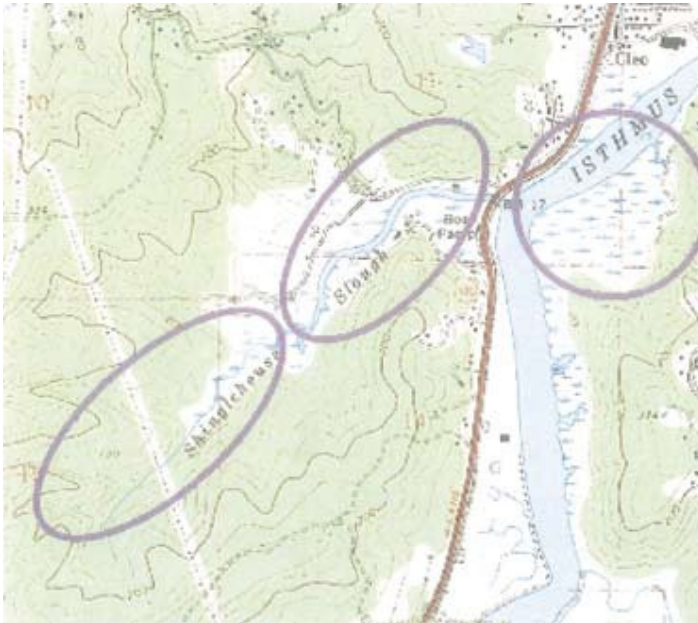


*Along Siuslaw River, Cushman, Oregon.*

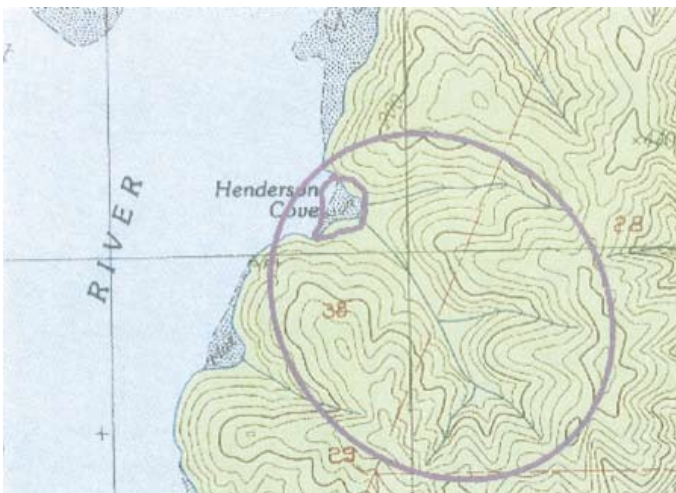


*Salicornia virginica, a succulent forb characteristic of low tidal marsh.*

### T10 Tidal-Nontidal Hydroconnectivity



*The tidal wetland in the middle is contiguous to the non-tidal wetland on its left, and fish can access parts of both wetlands. In question T10, the first choice would be the correct one. The tidal wetland circled on the right is not contiguous to a non-tidal wetland and has no inflowing stream. In question T10, the last choice would be the correct one.*



*This tidal wetland is not contiguous to a non-tidal wetland. Although it has an inflowing stream, the stream does not connect it to a non-tidal wetland. In question T10, the last choice would be the correct one.*

### T33 Ground Irregularity



*Microtopographic relief resulting from livestock.*



*Microtopography resulting from tidal action. Seaside, Oregon.*

## Field S Data Form Illustrations

**S2** Accelerated Inputs of Nutrients

**S3** Accelerated Inputs of Contaminants and/or Salts



*Buildings, roads, and road ditches alter the timing of runoff entering wetlands, and may shift the wetland's predominant source from groundwater to surface water. Even when sewerred, residential areas contribute and accelerate inputs of nutrients and contaminants. Hillsboro, Oregon.*

**S4** Excessive Sediment Loading from Runoff Contributing Area



*Washed out forest roads are a potentially significant source of accelerated sediment movement into wetlands. Grant County, Oregon.*

## Appendix B: Narrative Descriptions of the ORWAP Scoring Models

### WATER STORAGE AND DELAY (WS)

Function Definition: The effectiveness of a wetland for storing water or delaying the downslope movement of surface water for long or short periods (but for longer than a tidal cycle), and in doing so to potentially influence the height, timing, duration, and frequency of inundation in downstream or downslope areas.

Scientific Support for This Function in Wetlands Generally: Moderate to High. Being flat areas located low in the watershed; many wetlands are capable of slowing the downslope movement of water, regardless of whether they have significant storage capacity. When that slowing occurs in multiple wetlands, flood peaks further downstream are muted somewhat. When wetlands are, in addition, capable of storing (not just slowing) runoff, that water is potentially available for recharging aquifers and supporting local food webs.

### FUNCTION MODEL

Full model structure: A non-tidal wetland is automatically scored “10” for this function if it lacks an outlet. If the site has surface water for fewer than seven consecutive days during an average growing season, the score increases with decreasing wetland gradient (2/3 of the score) and with greater microtopographic variation, coarser soil texture, denser ground cover, and lack of evidence of significant groundwater inputs (the average score of these counting for 1/3). For all other wetlands, 3/4 of the score is from the average of the scores for outlet duration (shorter periods of outflow indicating potential for more water storage) and *Live Storage*, and the other 1/4 of the score is from the average of the scores for *Friction* and *Subsurface Storage*. The submodels are described below.

#### Submodel structures:

- *Friction* reflects an average of the following: flatter gradient, greater ponding, constrictedness of the outlet, microtopographic variation, ground cover, and surface throughflow that encounters woody vegetation and takes an indirect path through the wetland.
- *Subsurface Storage* is represented by organic or coarse soil texture, absence of evidence of discharging groundwater, and smaller runoff and streamflow contributing areas relative to the size of wetland.
- *Livestore* is higher when soils are periodically unsaturated and water ponds over a larger area during the wet season (2/3 of the score), and when a smaller portion of the wetland has permanent water and the water fluctuation in the wetland during the year is higher (1/3 of the score).

If the wetland is tidal, it is automatically scored “0” for this function.

Approach for Future Validation: The volume, duration, and frequency of water storage could be measured in a series of wetlands that encompass the scoring range, and flows could be measured

at their outlets if any, and at various points downstream. Measurements should especially be made during major storm or snowmelt events. Procedures are partly described by Warne & Wakely 2000, US Army Corps of Engineers 2005, and NJ Dept. of Environmental Protection 2007.

## VALUES MODEL

Full model structure: When there is evidence of or potential for river flood-related damage to downslope areas containing infrastructure or row crops, the value score is equivalent to the score for flood damage (*Fdam*). Otherwise, the value score results from averaging *Fdam* (1/2 of the score) with an average reflecting the relative scarcity in the watershed of other wetlands likely to effectively perform this function, a zoning classification of Development or (secondarily) Agriculture, and increasing water yield from the wetland's contributing area (*Yield*). The submodels are described below.

### Submodel structures:

- *Fdam* increases with evidence of flood-damage to downslope areas, particularly in areas with damage to infrastructure, and close proximity of the wetland to a river.
- *Yield* increases with decreasing elevation in the watershed (weight of 3); the for increasing impervious surface in the contributing area, greater transport capacity in the contributing area, and smaller ratio of wetland area to wetland catchment area (the average score for these counting as a weight of 2); and percent cover of trees within 100 feet upslope of the wetland (weight of 1).

## SEDIMENT RETENTION AND STABILIZATION (SR)

Function Definition: The effectiveness of a wetland for intercepting and filtering suspended inorganic sediments thus allowing their deposition, as well as reducing energy of waves and currents, resisting excessive erosion, and stabilizing underlying sediments or soil. The performance of this function has both benefits (e.g., reduction in turbidity in downstream waters) and negative values (e.g., progressive sedimentation of productive wetlands, slowing of natural channel migration).

Scientific Support for This Function in Wetlands Generally: High. Being flat areas located low in the landscape, many wetlands are areas of sediment deposition, a process facilitated by wetland vegetation that intercepts suspended sediments and stabilizes (with root networks) whatever sediment has been deposited.

## FUNCTION MODEL

Full model structure: If the site is not tidal or an outlet is lacking, the site is automatically scored a "10". If the site has an outlet but the site has surface water for fewer than seven consecutive days during an average growing season, the score is equivalent to the score for *Dry Interception*. For all other wetlands, the score is a weighted average of three groups: *Hydrologic Connectivity*

(weight of 3), the average of *Hydrologic Entrainment* and *Live Storage* (weight of 2), and the average of *Dry and Wet Interception* (weight of 1). The submodels are described below.

Submodel structures:

- *Live Storage* is the average of increasing percentage of the wetland that floods only seasonally, and intermediate water level fluctuations.
- *Hydrologic Entrainment* is the capacity of the wetland to capture and retain suspended sediment and is represented by the average of increasing water depth, wetland width, and area of emergent vegetation.
- *Dry Interception* is the average of two groups. One group is the average of flatter gradient and smaller runoff and streamflow contributing areas relative to wetland size. The other group is the average of increasing ground cover and microtopographic variation, and lack of severe grazing and soil disturbance.
- *Wet Interception* is the average of increasing area and percent cover of emergent vegetation, greater wetland width and diversity of water depths, and more sinuous water path through the wetland.
- *Hydrologic Connectivity* is the average of decreasing outflow duration and greater constriction of the wetland outlet.

If the wetland is tidal, the score is the average of two groups. One group reflects increasing percentage of the wetland that is high marsh and wider wetland width (whichever scores higher). The other group is the average of decreasing wave exposure, denser ground cover, and brackish salinity (which facilitates precipitation of clay particles).

Approach for Future Validation: The volume of accreted sediments could be measured in a series of wetlands that encompass the scoring range. This might be done with sediment markers, with isotopic analysis of past sedimentation rates, or with SET tables (Boumans & Day 1993). Suspended sediment could be measured at inlets and outlets if any, with simultaneous measurement of changes in water volume and flow rate (e.g., Detenbeck et al. 1995).

## VALUES MODEL

Structure: For non-tidal wetlands, the value is reflected by the weighted average of one indicator and four groups. The indicator is a representation of whether the wetland's watershed has few other wetlands that are likely to retain suspended sediment. However, most of the value score is driven by one group that indicates presence of sedimentation or turbidity problems in waters a short distance up or downslope from the wetland, or presence of erosion or impervious surfaces in the wetland's contributing area (the maximum score for these counting for 3/7). A second group is the average of increasing transport potential for runoff to the wetland, presence of a tributary, and potential for development upslope. The third group is the average of decreasing buffer width and more of the wetland perimeter with an upland perennial buffer. A fourth group reflects lowland location and proportionally large contributing area. For tidal wetlands, a very similar but simplified version of the non-tidal wetland model was used.

## PHOSPHORUS RETENTION (PR)

Function Definition: The effectiveness for retaining phosphorus for long periods (>1 growing season) as a result of chemical adsorption, or from translocation by plants to belowground zones with less potential for physically or chemically remobilizing phosphorus into the water column.

Scientific Support for This Function in Wetlands Generally: Moderate to high. Many wetlands do not retain phosphorus for long periods, but may be significant by converting inorganic to organic forms. Sediment dynamics (erosion-deposition) and local geology largely determine whether a wetland is a source, sink, or converter of phosphorus over the long term.

### FUNCTION MODEL

Full model structure: If the non-tidal wetland lacks an outlet, it is automatically scored “10” for this function. If the wetland contains surface water for fewer than seven consecutive days during the growing season, its score is the average of *Dry Interception* and *Adsorption* (see below for definitions). For all other non-tidal wetlands, higher scores are determined by the weighted average of *Adsorption* (weight of 3), the average of *Desorption* and *Connectivity* (weight of 2), and the average of *Wet and Dry Interception*. The submodels are described below.

#### Submodel structures:

- *Intercept Dry* is represented by the average of flatter gradient (half the group score) and the average for a group consisting of increasing ground cover and microtopographic variation, larger ratio of wetland area to area of the wetland's contributing areas, and absence of soil disturbance.
- *Intercept Wet* is the average of increasing wetland width, emergent vegetation area and percentage, shorter duration of ice cover, and a more circuitous water path through the wetland.
- *Connectivity* is the average of decreasing outflow duration and greater constriction of the wetland outlet.
- *Adsorption* is considered optimal where soil is clay and salinity is brackish. Scores for these indicators are averaged.
- *Desorption* is considered to be minimized if the wetland has not recently been created, little or none of the wetland contains surface water persistently, and when surface water is present it is moderately shallow, not extensively covered with algae or duckweed, and its level does not fluctuate significantly. Scores for these indicators are averaged.

If the wetland is tidal, higher scores are determined by four indicators or groups weighted equally: (1) soils are clayey, (2) the site is in the upper estuary or has low salinity, (3) the larger of scores reflecting greater width and percentage of high marsh, and (4) the average of scores reflecting less wave exposure and denser ground cover.

Approach for Future Validation: Among a series of wetlands spanning the scoring range, total phosphorus could be measured simultaneously at wetland inlet and outlet, if any, and adjusted for any dilution occurring from groundwater or runoff (or concentration effect from evapotranspiration) over the intervening distance. Measurements should be made at least once

monthly and more often during major runoff events (e.g., Detenbeck et al. 1995). A particular focus should be on the relative roles of soil composition vs. vegetation, as they affect chemical adsorption vs. uptake.

## VALUES MODEL

**Structure:** For non-tidal wetlands, a wetland's value for the Phosphorus Retention function is reflected by the weighted average of four groups. One group, accounting for half the value score, is the average of scores that reflect connectivity to nutrient problems upstream or downstream (or downslope). A second represents presence of a tributary, potentially erosive adjoining slopes, more impervious surface in the runoff and streamflow contributing areas, and large potential for runoff reaching the wetland. A third is the average of decreasing buffer width, a zoning designation of Development or Agriculture, and being in a watershed believed to be relatively limited in other wetlands that can store nutrients effectively. The fourth group reflects location near the bottom of a watershed and small ratio of a wetland's area to that of its contributing area. For tidal wetlands, a very similar but simplified version of the non-tidal wetland model was constructed.

## NITRATE REMOVAL AND RETENTION (NR)

**Function Definition:** The effectiveness for retaining particulate nitrate and converting soluble nitrate and ammonia to nitrogen gas, primarily through the microbial process of denitrification, *while generating little or no nitrous oxide* (a potent "greenhouse gas"). Note that most published definitions of Nitrate Removal do not include the important restriction on N<sub>2</sub>O emission.

**Scientific Support for This Function in Wetlands Generally:** High. Wetlands are perhaps the most effective component of the landscape for removing nitrate from surface water.

## FUNCTION MODEL

**Full model structure:** If the non-tidal wetland lacks an outlet, it is automatically scored "10" for this function. If the wetland contains surface water for fewer than seven consecutive days during an average growing season, its score is the average of *Warmth* and *Organic* (see below for definitions). For all other non-tidal wetlands, higher scores are determined by the weighted average of increasing *Redox* (weight of 3), *Hydrologic Isolation* (weight of 2), and *Warmth*, *Interception*, and *Organic Content* (each with a weight of 1). The submodels are described below.

### Submodel structures:

- *Warmth* averages the scores for increasing growing season length, groundwater input, and diminished extent of shading woody vegetation.
- *Interception* averages the scores for flatter gradient, greater vegetated width, denser ground cover, and more diffuse throughflow.
- *Hydrologic Isolation* is the average of decreasing outflow duration and greater constriction of the wetland outlet.



- *Organic Content* score increases with increasing emergent vegetation percentage, moss cover, and peat soils. Those are averaged and count for 3/4 of the Organic Content score. The other component is an average of soil intactness and wetland is not a new wetland.
- *Redox* is represented by increasing percentage of the wetland that is flooded only seasonally (half the score) with the average of scores that represent intermediate percentage of persistent surface water, greater interspersions of vegetation and water, minimal water level fluctuation, more microtopographic variation, and larger edge-to-area ratio.

If the wetland is tidal, Nitrate Removal is represented by the average of denser ground cover and greater wetland width, as well as lower estuarine position (or higher salinity).

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), nitrate and ammonia could be measured simultaneously at wetland inlet and outlet, if any, and adjusted for any dilution occurring from groundwater or runoff (or concentration effects from evapotranspiration) over the intervening distance. Measurements should be made at least once monthly and more often during major runoff events (e.g., Detenbeck et al. 1995). Denitrification rates (at least potential), the nitrogen fixing rates of particular wetland plants, and nitrous oxide emissions should also be monitored.

## VALUES MODEL

Structure: A non-tidal wetland's value for the Nitrate Removal function is higher if there are domestic drinking water wells nearby, the wetland is in an Oregon DEQ-designated drinking water contributing area or groundwater risk area, or if the value of Phosphorus Retention is high (because many of the factors that reflect Phosphorus Retention value, such as a zoning designation of Agriculture or Development, are similarly reflective of Nitrate Removal value). For tidal wetlands, the value is higher if the wetland is in a lower estuary position, if the value of Phosphorus Retention is high, and cover by potential nitrate sources such as alder is higher. Proximity to wells or vulnerable aquifers are not factors in judging tidal wetland value.

## ANADROMOUS FISH HABITAT (FA)

Function Definition: The capacity to support an abundance of native anadromous fish (chiefly salmonids) for functions other than spawning. See worksheet *WetVerts* in the *ORWAP\_SuppInfo* file for list of the species. The model described below will not predict habitat suitability accurately for every species, nor is it intended to assess the ability to restore fish access to a currently inaccessible wetland.

Scientific Support for This Function in Wetlands Generally: Moderate-high, depending mainly on accessibility of a wetland to anadromous fish. Many accessible wetlands provide rich feeding and rearing opportunities, shelter from predators, and thermal refuge (especially if groundwater is a significant water source).

## FUNCTION MODEL

Full model structure: For non-tidal wetlands, a score of “0” is assigned if anadromous fish cannot access any part of the wetland, if the wetland is not connected to a stream or other water body within 0.5 mile that has been designated as Essential Indigenous Anadromous Salmonid Habitat (ESH), or if the wetland contains surface water for fewer than seven consecutive days during an average growing season. Otherwise, the function score is the average of wetland *Hydrologic Regime*, *Structure*, *Cool Water*, *Landscape* condition, and a lack of human-related *Stressors*. The submodels are described below.

### Submodel structures:

- *Hydrologic Regime* score increases as the duration of connection to other waters increases, as more of the wetland has surface water at least seasonally, and as both flowing and deep ponded water are present. Scores for these indicators are averaged.
- *Structure* beneficial to anadromous fish is represented by a group average representing increased channel braiding, cover of emergent vegetation, and large instream wood. A score is not calculated for this submodel if the site retains surface water for 4 weeks or less during an average growing season.
- *Cool Water* is indicated by a group average based on evidence of groundwater input, wetland location near headwaters of a watershed, larger percent of the wetland and its buffer that is forested, and larger percent of the wetland's surface water that is shaded.
- *Landscape* condition is assumed to be better when land cover in the runoff and streamflow contributing areas and area closest to the wetland is mostly natural and lacking impervious surfaces. Scores for these indicators are averaged.
- *Stressors* are represented by known or suspected contaminants, other sediment inputs in excessive concentrations, altered flows, algal blooms, and non-native fish. Scores for these indicators are averaged. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.

If the wetland is tidal, the score for Anadromous Fish Habitat is set to “0” if anadromous fish cannot access the wetland. Otherwise, the score is the weighted average of three groups. One group represents increasing frequency of connection between the tidal marsh and marine waters (2/3 of score). A second group's average reflects greater internal channel complexity, adjacency to an accessible non-tidal wetland, more large partly-submerged wood, and a larger portion of the water being shaded. The third group's average reflects increasing wetland width, less impervious surface in the wetland's contributing area, and natural conditions within its buffer.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), the number of anadromous fish and their duration of use would need to be measured regularly throughout the times when usually expected to be present, and weight gain during the period of wetland habitation should be measured (for techniques see Johnson et al. 2007, Lestelle et al. 1996, Scheuerell et al. 2006).

## VALUES MODEL

Structure: The value score is automatically set at “10” if the wetland adjoins or is connected to a stream or other water body within 0.5 mile that has been designated as Essential Indigenous Anadromous Salmonid Habitat (ESH). Otherwise, the score is the average of scores for three indicators: a zoning designation of Development or Agriculture, located in a watershed where Anadromous Fish Habitat in wetlands may be deficient, and having a relatively high score for Waterbird Feeding Habitat.

## RESIDENT FISH HABITAT (FR)

Function Definition: The capacity to support an abundance and diversity of *native* non-anadromous fish (both resident and visiting species). See worksheet *WetVerts* in the *ORWAP\_SuppInfo* file for list of the species. The model described below will not predict habitat suitability accurately for every species, nor is it intended to assess the ability to restore fish access to a currently inaccessible wetland.

Scientific Support for This Function in Wetlands Generally: High. Many accessible wetlands provide rich feeding opportunities, shelter from predators, and thermal refuge (especially if groundwater is a significant water source). Even isolated (inaccessible) wetlands are important to some fish species, such as Oregon chub.

## FUNCTION MODEL

Full model structure: For non-tidal wetlands, a score of “0” is assigned if it is an alkaline playa, or if it has surface water for fewer than seven consecutive days during the growing season, or if known to contain no fish (not even seasonally). For all other non-tidal wetlands, the score is the average of *Hydrologic Regime*, *Structure*, and *Stressors*. The submodels are described below.

### Submodel structures:

- *Hydrologic Regime* is assumed most favorable for resident fish when surface water is present persistently or at least seasonally and there is at least a temporary connection to other surface waters, both ponded and flowing water are present, groundwater is likely to flow into the wetland, and a variety of water depths is present in fairly equal proportions. These indicators are considered equally predictive and so are averaged.
- *Structure* beneficial to resident fish is represented by increasing area and percent cover of emergent and submersed aquatic vegetation, extensive amounts of partly submerged wood, and presence of a more complex internal channel network, especially one that intersects woody vegetation. Scores for these indicators are averaged. A score is not calculated for this submodel if the site retains surface water for 4 weeks or less during an average growing season.
- *Stressors* are represented by the presence of non-native fish (half the score) with the average of two groups of scores. The first group represents known and accelerated toxicity of contaminants in the input water, more persistent connection with this input water, excessive sediment inputs, and artificially altered flow timing. The second group

is the average of winter ice cover and a shorter growing season. The *Stressors* score is actually the reverse of these conditions, such that their absence raises the overall score for this function.

If the site is tidal, the function model is the same as for Anadromous Fish Habitat in tidal wetlands.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), the number of native non-anadromous fish and their onsite productivity and diversity would need to be measured regularly. For visiting species, the duration of use and weight gain throughout the times when usually expected to be present should be determined.

## VALUES MODEL

Structure: If the wetland contains a rare fish species the value score is automatically set at “10”. Otherwise its value score reflects an average based on some evidence for rare species in the vicinity, evidence of fishing, a zoning designation of Development or Agriculture, and the function score for Feeding Waterbird Habitat.

## AMPHIBIAN AND REPTILE HABITAT (AM)

Function Definition: The capacity of a wetland to support an abundance and diversity of native amphibians and native wetland-dependent reptiles, e.g., western pond turtle. See worksheet *WetVerts* in the *ORWAP\_SuppInfo* file for list of the species. The model described below will not predict habitat suitability accurately for **every** species.

Scientific Support for This Function in Wetlands Generally: High. Many frog and turtle species in Oregon occur almost exclusively in wetlands. Densities of amphibians can be exceptionally high in some wetlands, partly due to high productivity of algae and invertebrates, and partly because submerged vegetation provides shelter and sites for egg-laying.

## FUNCTION MODEL

Full model structure: For non-tidal wetlands, the function score is represented by the average of three indicator groups. One of the groups is the average of *Hydrologic Regime*, *Aquatic Structure*, *Terrestrial Structure*, *Landscape*, and *Biological Stressors*. A second group is *Waterscape* and a third is *Physical & Water Quality Stressors*. The submodels are described below.

### Submodel structures:

- *Hydrologic Regime* is the average of increasing water persistence and ponding, decreasing water level fluctuation, higher likelihood of beaver activity, and flatter wetland gradient.

- *Aquatic Structure* that is more suitable for amphibians is represented by a larger percent cover and wider zone of emergent or submersed aquatic vegetation, or presence of abovewater wood, and large interspersions of intermediate proportions of vegetation and ponded water.
- *Terrestrial Structure* is considered to be best for amphibians where a wetland has a large buffer of natural vegetation, a moderate density of ground cover, extensive microtopographic variation, much downed wood, and a longer growing season. Scores for these indicators are averaged.
- *Waterscape* is represented by greater vegetated connectivity to another wetland, proximity to a ponded water, and located in a watershed with relatively large total wetland area and diversity of wetland types. Scores for these indicators are averaged.
- *Landscape* conditions are considered better for amphibians where natural cover comprises a large and proximate part of the upland cover, and the wetland is in an area of relatively high annual precipitation. Scores for these indicators are averaged.
- *Physical & Water Quality Stressors* of potential detriment to amphibians are represented by higher salinity, proximity to a road, and presence of likely contaminant sources. Scores for these indicators are averaged. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.
- *Biological Stressors* are represented by human visitation frequency and actual or potential presence of fish. Scores for these indicators are averaged. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.

If the wetland is tidal, the score is the result of one indicator multiplied by a weighted average of three groups. For the indicator, Salinity, increased scores correspond with decreasing salinity. The first group (weight of 3) represents a higher position in the watershed, a greater proportion of low marsh, and decreased salinity. The second group (weight of 2) represents a wider vegetated area, greater connectivity to non-tidal wetlands, and decreased outflow duration. The third group (weight of 1) represents closer proximity to ponded water, a larger buffer with perennial cover, and further distance from roads.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), amphibian and reptile species richness, density, and (ideally) productivity and survival would need to be measured during multiple years and seasons by comprehensively surveying (as applicable) the eggs, tadpoles, and adults.

## VALUES MODEL

Structure: The value of Amphibian Habitat receives a “10” if the non-tidal wetland is known to support a rare amphibian or reptile species. Otherwise, the value score reflects an average based on some evidence for rare species in the vicinity, the wetland containing one of the only patches of herbaceous or woody vegetation within 0.5 mile, a zoning designation of Development or Agriculture, is in one of the drier watersheds in the state, is in a watershed believed to have relatively few other wetlands that provide good amphibian habitat, and has a high function score for Feeding Waterbird Habitat.

## WATERBIRD NESTING HABITAT (WBN)

Function Definition: The capacity to support an abundance and diversity of wetland-breeding waterbirds, such as ducks, grebes, bitterns, and rails. See worksheet *WetVerts* in the *ORWAP\_SuppInfo* file for list of the species. The model described below will not predict habitat suitability accurately for every species in this group.

Scientific Support for This Function in Wetlands Generally: High. Dozens of waterbird species nest almost exclusively in wetlands. Breeding densities can be exceptionally high in some non-tidal wetlands, partly due to high productivity of vegetation and invertebrates, and partly because wetland vegetation provides nest sites in close proximity to preferred foods. It is recognized that some waterbirds may occasionally nest in tidal wetlands where the tidal water is relatively fresh and water level fluctuation due to tidal inundation is infrequent, but such nesting is rare.

### FUNCTION MODEL

Full model structure: Non-tidal wetlands are automatically scored “0” for this function if they have more than a 10% slope. If they contain surface water for 4 weeks or less during the growing season, their score is the average of a longer hydroperiod, a larger percentage of unshaded herbaceous cover, *Waterscape*, *Landscape*, and *Stressors*. Otherwise, the function score is represented by the average of the scores for *Water Regime*, *Structure & Size*, and *Waterscape* (2/3 of the score) and the average of the scores for *Stressors*, *Landscape*, and *Productivity* (1/3 of the score). The submodels are described below.

#### Submodel structures:

- *Water Regime* is indicated by increased persistence of ponded surface water but with some seasonally inundated portions, moderate water level fluctuation, flatter wetland gradient, a diversity of water depths with moderately shallow water predominating, and large area of ponded open water. The scores of these are averaged.
- *Structure & Size* is represented by the average of three indicators or groups. One group average represents increasing wetland width and proportion of herbaceous vegetation that is unshaded and not overgrazed. Another reflects intermediate cover of emergent vegetation especially cattail/bulrush, a high degree of interspersed vegetation and open water, and presence of islands for nesting. The third indicates greater amounts of emergent vegetation.
- *Stressors* are indicated by likely pollution sources in the wetland's contributing area and higher frequency of human visitation. Scores for these indicators are averaged. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.
- *Waterscape* influence is represented by closer proximity to ponded water, and being located in a watershed having more extensive and collectively diverse wetlands. Scores for these indicators are averaged.
- *Landscape* influence is represented by closer proximity to open land and greater percent of the surrounding landscape that is open land, decreasing percent of open water that is shaded, and decreasing percent of the wetland perimeter occupied by trees. Scores for these indicators are averaged.

- *Productivity* of the wetland is indicated by increased cover of submersed aquatic plants and algae, longer growing season, and paucity of moss cover. The scores of these are averaged.

If the wetland is tidal, the function score is automatically set at “0”.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), nesting waterbird species richness and density would need to be determined during the usual breeding period -- approximately April through July (see USEPA 2001 for methods). Ideally, nest success and juvenile survival rates should be measured.

## VALUES MODEL

Structure: A wetland gets a “10” if it is known to support a rare waterbird species during the nesting season, or is within an area that has been officially designated as an Important Bird Area (IBA). Otherwise, its value score reflects an average based on some evidence for rare species in the vicinity, zoning designation of Developed or Agriculture, increased visibility of the wetland from a public road, the site being one of the only herbaceous wetlands within 0.5 mile, and being located in one of the drier watersheds in the state.

## WATERBIRD FEEDING HABITAT (WBF)

Function Definition: The capacity to support an abundance and diversity of feeding waterbirds, primarily outside of the usual nesting season. See worksheet *WetVerts* in the *ORWAP\_SuppInfo* file for list of the species. The model described below will not predict habitat suitability accurately for every species in this group.

Scientific Support for This Function in Wetlands Generally: High. Dozens of waterbird species occur almost exclusively in wetlands during migration and winter. Densities can be exceptionally high in some wetlands, partly due to high productivity of vegetation and invertebrates, and partly wetland vegetation provides shelter in close proximity to preferred foods.

## FUNCTION MODEL

Full model structure: Non-tidal wetlands are automatically scored “0” for this function if they have more than a 10% slope. If they contain surface water for fewer than seven consecutive days during the growing season, their score is the average of a longer hydroperiod, a larger percentage of unshaded herbaceous cover, *Waterscape*, *Landscape*, and *Stressors*. Otherwise, the function score is represented by a longer hydroperiod averaged with the scores for *Water Regime*, *Structure & Size*, and *Waterscape* (weight of 2) and the average of the scores for *Stressors*, *Landscape*, and *Productivity* (weight of 1). The submodels are described below.

### Submodel structures:

- *Water Regime* is indicated by increased persistence of ponded surface water but with some seasonally inundated portions, flatter wetland gradient, a diversity of water depths with moderately shallow water predominating, and large area of open water. Scores for these indicators are averaged.
- *Structure & Size* is represented by the average of two indicators and two groups. The two indicators are a large area of mud flats and larger extent of emergent vegetation. One group average represents increasing proportion of unshaded herbaceous vegetation, intermediate cover of emergent vegetation, absence of a single dominant herbaceous plant species, and increasing wetland width. Another is the presence of islands or a high degree of interspersed vegetation and open water.
- *Stressors* are indicated by likely pollution sources in the wetland's contributing area and higher frequency of human visitation. Scores for these indicators are averaged. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.
- *Waterscape* influence is represented by closer proximity to ponds, lakes, and tidewater, as well as being located in a watershed having more extensive and collectively diverse wetlands. Scores for these indicators are averaged.
- *Landscape* influence is represented by proximity to open land and percent of the surrounding landscape that is open land, increasing proportion of the surrounding land that is perennial land cover, and decreasing percent of the wetland perimeter occupied by trees. Scores for these indicators are averaged.
- *Productivity* of the wetland is indicated by increased cover of submersed aquatic plants and algae, decreased duration of ice cover, and lack of invasive plant and moss cover. The scores of these are averaged.

If the wetland is tidal, the score is represented by the weighted average of three indicator groups. One group (1/2 of total score) indicates increasing wetland area, width, and proportion of wetland flooded daily by tide. A second group (1/3 of total score) indicates increasing area of mud flat, tidal channel complexity, adjacency to non-tidal wetlands, and diversity of vegetation forms. The third group (1/3 of total score) reflects decreasing extent of disturbance by human visitors and absence of powerlines and other hazards to flying waterbirds.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), feeding waterbird species richness and density would need to be determined monthly and more often during migration (see USEPA 2001 for methods). Ideally, daily duration of use and seasonal weight gain should be measured.

### VALUES MODEL

Structure: A wetland gets a “10” for this function if it is known to support a rare waterbird species outside of the nesting season, or is within an area that has been officially designated as an Important Bird Area (IBA). Otherwise, its value score reflects an average based on some evidence for rare species in the vicinity, zoning designation of Developed or Agriculture, increased visibility of the wetland from a public road, and the site being one of the only herbaceous wetlands within 0.5 mile.



## AQUATIC INVERTEBRATE HABITAT (INV)

Function Definition: The capacity to support an abundance and diversity of invertebrate animals which spend all or part of their life cycle underwater or in moist soil. Includes dragonflies, midges, crabs, clams, snails, crayfish, water beetles, shrimp, aquatic worms, and others. See worksheet *WetInverts* in the *ORWAP\_SuppInfo* file for list of freshwater aquatic invertebrates known or likely to occur in Oregon wetlands. The model described below will not predict habitat suitability accurately for every species.

Scientific Support for This Function in Wetlands Generally: High. All wetlands support invertebrates, and many wetlands support aquatic invertebrate species not typically found in streams, thus diversifying the local fauna. Densities of aquatic invertebrates can be exceptionally high in some wetlands, partly due to high primary productivity and partly because submerged vegetation provides additional structure (vertical habitat space).

### FUNCTION MODEL

Full model structure: For non-tidal wetlands, half of the score is determined by *Structure* and half by the average of *Hydroperiod*, *Landscape* and *Stressors*. The submodels are described below.

#### Submodel structures:

- *Structure* is assumed to increase with increases in three indicators and one indicator group average. The indicators are interspersion of water and emergent vegetation, complexity of surface water flow paths through the wetland, and percent cover of submersed aquatic vegetation. Less influential is the average of increasing emergent vegetation area, emergent vegetation percentage, herbaceous plant diversity, depth diversity, ground cover, downed wood, nitrogen fixing plants, and microtopographic variation.
- *Hydroperiod* is assumed most favorable when a moderate to large percentage of the wetland contains surface water persistently (1/2 of score), and secondarily, when most of the water is ponded, levels fluctuate moderately and seasonally, depths are shallow, there is evidence of groundwater discharging to the wetland, and there is an intermediate proportional extent of persistent water (scores for those indicators are averaged).
- *Landscape* condition is assumed better for invertebrates when land cover in the contributing area is mostly natural, as represented by the average of three indicators which reflect that.
- *Stressors* are represented partly by the average of increased soil disturbance, excessive sediment inputs, and altered timing of the water regime. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.

If the wetland is tidal, the score is the weighted average of one indicator and two groups. A higher score results from having proportionally more area as low marsh (accounting for half the score), as well as a group average that accounts for one-third the score and reflects greater internal channel complexity, adjacency to a connected non-tidal wetland, greater diversity of vegetation forms, unaltered tidal exchange regime, and non-sandy soils. The other group

average reflects lower risk of invasive marine invertebrates being present and increased amount of driftwood, large partly-submerged wood, ground cover, and shade.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), the aquatic invertebrate richness, density, and (ideally) productivity would need to be measured regularly throughout the year.

## VALUES MODEL

Structure: If the wetland is tidal, the value score for Invertebrate Habitat is the average of the function scores for Resident Fish Habitat, Feeding Waterbird Habitat, and Songbird-Raptor-Mammal Habitat. For non-tidal wetlands, the value is the maximum of (1) documentation of a rare invertebrate species within the wetland, (2) the wetland's watershed is relatively lacking in good invertebrate habitat, (3) the zoning designation is Development or Agriculture, (4) there is some evidence for rare species in the vicinity the wetland or the wetland contains nearly the only patch of herbaceous or woody vegetation within 0.5 mile, and (5) the average of the scores for the following functions is large: Resident Fish Habitat, Amphibian Habitat, Feeding Waterbird Habitat, Songbird-Raptor-Mammal Habitat.

## NATIVE PLANT DIVERSITY (PD)

Function Definition: The capacity to support, at multiple spatial scales, a diversity of native, hydrophytic, vascular and non-vascular (e.g., bryophytes, lichens) plant species, communities, and/or functional groups, especially those that are most dependent on wetlands or water. See worksheet *P\_WetIndic* in the *ORWAP\_SuppInfo* file for list of the species.

Scientific Support for This Function in Wetlands Generally: High. Many plant species grow only in wetlands and thus diversify the local flora, with consequent benefits to food webs and energy flow.

## FUNCTION MODEL

Full model structure: If a tidal or non-tidal wetland has more than 10 percent cover of invasive herbaceous plants and more than 80 percent cover of all non-native plants, its function score is "0". Otherwise, for non-tidal wetlands the function score is the weighted average of the scores for *Species-Area* (weight of 3), *Stressors* (weight of 2), *Aquatic Fertility*, *Competition/Light*, and *Landscape*. The submodels are described below.

Submodel structures:

- *Species-Area* reflects the fact that wetland plant species richness often increases rapidly with increasing wetland size. This is represented by the average of increasing emergent vegetation area, wetland width, wetland buffer width and extent, and increasing percentage of the wetland that is inundated only seasonally.
- *Stressors* are indicated by the average of two indicators. One represents greater percent cover of non-native or invasive plants, and the other is a group average of greater

proximity to roads, larger percent cover of invasive plants along the upland edge, higher frequency of human visitation, altered timing of runoff, soil disturbance, and overgrazing. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.

- *Aquatic Fertility* of the wetland is indicated by presence of a tributary, circuitous water path through the wetland, organic soils, mildly fluctuating water level with relatively even distribution of multiple water depth classes, a higher degree of interspersed vegetation and open water, stronger evidence of groundwater input, and not being recently constructed or restored. The scores of these indicators are averaged.
- *Competition/Light* influence scores highest where there are intermediate proportions of emergent and woody vegetation, lack of any strongly dominant herbaceous species, and extensive microtopographic variation. The scores of these indicators are averaged.
- *Landscape* influence is represented by greater proximity and connectivity to large tracts of natural land cover (especially forest), and presence of beaver. The scores of these indicators are averaged.

For tidal wetlands, the function score is an average that reflects less cover of invasive plants, lack of altered timing of runoff, lower salinity (or location closer to head-of-tide); a group that includes greater marsh area, width, and less daily inundation; a group that includes greater vegetation form diversity and lack of overgrazing or a strongly dominant species; a group that emphasizes larger buffer width and extent; and a group that reflects greater channel complexity, microtopographic variation, and non-sandy soils.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), all plant species would be surveyed and percent-cover determined at their appropriate flowering times during the growing season. Standardized protocols for wetland plant surveys are well-established.

## VALUES MODEL

Structure: A non-tidal wetland gets a “10” for this function if it is known to support an especially rare plant species or is a rare wetland type. Otherwise, its value score reflects an average based on some evidence for rare species in the vicinity, proximity to a large area of perennial cover, a zoning designation of Developed or Agriculture, high function scores for Pollinator Habitat and Songbird-Raptor-Mammal Habitat, and is one of the only herbaceous or wooded wetlands within 0.5 mile. A tidal wetland gets a “10” if it is a tidal forested wetland. Otherwise, its value score reflects an average based on support of or proximity to rare species, a zoning designation of Developed or Agriculture, and high function scores for Pollinator Habitat and Songbird-Raptor-Mammal Habitat.

## POLLINATOR HABITAT (POL)

Function Definition: The capacity to support pollinating insects, such as bees, wasps, butterflies, moths, flies, and beetles.

Scientific Support for This Function in Wetlands Generally: Moderate. Many wetlands may be important to pollinators because they host different plant species than those in surrounding uplands, which implies they may flower at different times than those in the uplands, and may do so over a prolonged season due to greater water availability in wetlands. Little is known about pollinators in tidal wetlands.

## FUNCTION MODEL

Full model structure: A non-tidal wetland is automatically scored “0” if it is almost entirely and persistently flooded. Otherwise, the function score is represented by the average of the scores for *Pollen Onsite*, *Pollen Offsite*, and *Nest Sites*. The submodels are described below.

### Submodel structures:

- *Pollen Onsite* is represented by the average of the scores for greater percent cover of forbs (1/2 of score) and an average reflecting less cover of invasive plants, lack of one dominant herbaceous species, and intermediate extent of ground cover (1/2 of score).
- *Pollen Offsite* is represented by the average of the scores for increased buffer width and extent, proximity to perennial cover, and the percentage and proximity to open land.
- *Nest Sites* available for pollinating insects are assumed to increase with increased snags, large-diameter trees, downed wood, microtopographic variation, and cliffs. Loose rock associated with cliffs or talus slopes provides nest areas for some pollinating insects. The scores of these indicators are averaged.

For tidal wetlands, the function score is the weighted average of two groups. One group accounts for two-thirds of the score and reflects greater forb cover, a larger proportion of high marsh, and greater marsh width. The other group reflects lack of a single dominant plant species and proximity to cliffs.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), the frequency with which flowers of dominant wetland plants are visited by various pollinating species should be monitored throughout the periods when each species is flowering.

## VALUES MODEL

Structure: A wetland gets a higher value score for this function if it has a zoning designation of Agriculture (due to pollinator importance to crops), is surrounded by very little other natural cover, provides one of the only patches of herbaceous, shrub, or forested land within 0.5 mile, and/or hosts a rare plant species. The scores of these indicators are averaged.

## **SONGBIRD, RAPTOR, AND MAMMAL HABITAT (SBM)**

Function Definition: The capacity to support an abundance and diversity of songbirds, raptors, and mammals, especially species that are most dependent on wetlands or water. See worksheet

*WetVerts* in the *ORWAP\_SuppInfo* file for list of the species. The model described below will not predict habitat suitability accurately for every species in this group.

Scientific Support for This Function in Wetlands Generally: High. Dozens of songbirds, raptors, and mammals depend almost exclusively in wetlands. Densities can be exceptionally high in some wetlands, partly due to high productivity of vegetation and invertebrates, and partly because wetland vegetation provides nest sites in close proximity to preferred foods.

## FUNCTION MODEL

Full model structure: The function score for non-tidal wetlands is represented by the weighted average of the scores for *Structure* (30% of the total score), *Productivity* (30%), *Landscape* (20%), *Waterscape* (20%) and *Stressors* (10%). The submodels are described below.

### Submodel structures:

- *Structure* is represented by the average of increasing emergent vegetation area (1/2 of total score) and a group average of 13 indicators. Those indicators reflect intermediate levels of shrub and herbaceous vegetation cover especially emergents and cattail/bulrush, extensive woody cover next to surface water, a high degree of interspersion between vegetation and open water, intermediate extent of ground cover, large microtopographic variation, and increased extent of snags, down wood, large trees, and cliffs.
- *Productivity* of the wetland is indicated by longer growing season, larger percentage of the wetland that is flooded only seasonally, and larger wetland width. The scores of these are averaged.
- *Landscape* influence is represented by increasing width, coverage and perimeter complexity of a vegetated buffer, proximity to large tracts of natural land cover, percent forest cover within 2 miles, and lack of developed land within that distance. The scores of these are averaged.
- *Waterscape* is represented by presence of beaver, greater vegetated connectivity to another wetland, proximity to a ponded water, and located in a watershed with relatively large total wetland area and diversity of wetland types. The scores of these are averaged.
- *Stressors* are indicated by greater proximity to roads and higher frequency of human visitation. The score is actually the reverse of these conditions, such that their absence raises the overall score for this function.

If the wetland is tidal, the function score is automatically set to “10” if the wetland is a forested tidal wetland (those are rare in Oregon and likely provide excellent songbird habitat). Otherwise, it is the weighted average of three groups. One group (1/2 of the total score) is the average of scores for greater tidal wetland area, width, and percentage not flooded daily by tides. Another group (1/3 of the total score) averages the scores indicating fresher salinity, a wider and more extensive buffer of natural vegetation, and adjacency to a non-tidal wetland. The third group indicates denser ground cover, presence of multiple vegetation forms with none strongly dominant, and proximity to cliffs or banks.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), species richness and density of songbirds,

raptors, and mammals would need to be determined monthly and more often during migration or seasonal movements (see USEPA 2001 for methods). Ideally, daily duration of use and seasonal weight gain of key species should be measured.

## VALUES MODEL

**Structure:** A wetland gets a score of “10” for this function if it is known to support a rare songbird, raptor, or mammal species. Otherwise, its value score reflects an average based on some evidence for rare species in the vicinity, a zoning designation of Developed or Agriculture, is one of the only herbaceous or wooded wetlands within 0.5 mile, is highly visible to the public, or is located in one of the drier watersheds in the state.

## WATER COOLING (WC)

**Function Definition:** The effectiveness of a wetland for maintaining or reducing summertime water temperature, and in some cases, for moderating winter water temperature. In earlier versions of ORWAP this was called Thermoregulation.

**Scientific Support for This Function in Wetlands Generally:** Low to moderate. Most wetlands are areas of groundwater discharge, and ground water tends to be cooler than surface water, so wetlands have the potential to mediate wide daily and seasonal fluctuations in surface water temperature. However, wetlands are also wide flat areas with long water retention times, and the influence of those factors on surface water temperature can sometimes offset the influence of groundwater input.

## FUNCTION MODEL

**Full model structure:** For non-tidal wetlands, the function score increases if evidence of groundwater input is strong. That accounts for half of the score. Another one-fourth of the score is increasing extent of surface water shaded by woody wetland vegetation during the summer, averaged with a group representing greater wetland width, larger proportion of the wetland containing woody or emergent vegetation, and denser ground cover. The remaining one-fourth of the score represents less ponding of water, presence of surface water for shorter periods, and deeper water depth. If the site has surface water for 4 weeks or less during the growing season, the function score results from averaging groundwater influence (2/3 of score) with a group average representing denser ground cover and a larger portion of area containing woody vegetation.

If the wetland is tidal, the site is scored a “0” because the volume of water flowing out of tidal wetlands is typically dwarfed by the huge volume of water exchanged hourly within the connected estuary, thus virtually nullifying the thermal effects of tidal wetlands on the estuary.

**Approach for Future Validation:** Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), water temperature loggers could be measured continuously at wetland inlet and outlet, if any, using thermodata loggers (Dunham et al. 2005).

Alternatively, when appropriate, ORWAP scores could be compared with results from more deterministic models such as Shade-o-Lator (Boyd & Kasper 2003).

## VALUES MODEL

Structure: If there is no outflow or temporary outflow from the wetland, the value is set to “0”. Otherwise, half the value of this function is attributed to the zoning designation of the location, with water cooling assumed to be valued most where Agriculture or Development is the designation. The other half of the value score increases with an increasing weighted average of four groups. One group, with a weight of 4, reflects the presence of anadromous fish habitat (ESH), connection to known problems with excessively warm water, or a wetland being located in a watershed identified as being deficient in wetlands with water cooling capacity. A second group reflects increasing persistence of outflow from the wetland. A third reflects absence of a wide wetland buffer and increasing extent of impervious surfaces in the wetland contributing area. The fourth is an average of scores for increasing ratio of wetland area to area of the wetland's streamflow contributing area, headwater position, lower elevation, and longer growing season.

## ORGANIC MATTER EXPORT (OE)

Function Definition: The effectiveness of a wetland for producing and subsequently exporting organic matter, either particulate or dissolved.

Scientific Support for This Function in Wetlands Generally: Moderate-High. Wetlands which have outlets are potentially major exporters of organic matter to downstream waters. That is partly because many wetlands support exceptionally high rates of primary productivity. Numerous studies have shown that watersheds with a larger proportion of wetlands tend to export more dissolved and/or particulate carbon that is important to downstream food webs, compared with watersheds that have few wetlands. Value to food webs depends partly on the quality and timing of the exported carbon.

## FUNCTION MODEL

Full model structure: For non-tidal wetlands, the site scores “0” for this function if it has no surface water outlet. Otherwise, the score is the weighted average of *Export Potential* (weight of 3), *Productivity* (weight of 2), and *Historical Accumulation*. The submodels are described below.

### Submodel structures:

- *Export Potential* increases according to the average of (1) increased duration of surface water outflow, (2) flatter wetland gradient, (3) location in part of the state with higher annual precipitation, and (4) a group average based on less outlet constriction, less ponding, narrower vegetated width, more submersed aquatic plant cover, lower elevation in a watershed, and greater interspersed of vegetation and open water.

- Current *Productivity* is comprised of three factors that are averaged: *Frozen Duration*, *Nutrient Availability*, and *Plant Cover*. These are described as follows:
  - *Frozen Duration* is assumed to decrease with longer growing season and presence of discharging groundwater. The scores of these are averaged.
  - *Plant Cover* available for rapid export is assumed to be greater with greater area of emergent vegetation, averaged with a group average of decreasing bare ground extent, shallower water depth, and greater percentage of the wetland occupied by emergent vegetation.
  - Greater *Nutrient Availability* is reflected by moderately fluctuating water levels, increased cover of nitrogen fixing plants, greater proportion of the wetland that is inundated only seasonally, more flowing than ponded water, and the wetland not being recently constructed. These are considered equally predictive of Nutrient Availability and so their scores are averaged.
- *Historical Accumulation* (existing carbon store or stock) is based on soil texture, with organic soils considered most important, averaged with extent of moss ground cover, with moss wetlands typically having limited opportunity to export organic matter.

If the wetland is tidal, the score increases with the average of four indicator groups. The most influential of these, accounting for half the score, is an average that reflects increasing percentage of the site that is tidally inundated daily, unimpeded tidal exchange, and multiple blind channels. A second group average is greater if the marsh is steeply sloping but wide, has a tributary with steep slope, an unstricted outlet, and is exposed to waves. A third group is the greater of salinity or proximity to the ocean (estuarine position). The fourth is the average for increasing shading of tidal waters (an indirect indicator of detrital input), increasing connection to non-tidal wetlands, lack of a single dominant plant species, and greater dominance by emergent or woody vegetation.

VALUES MODEL: No model is provided because this function's values are diffused throughout all receiving water bodies.

## CARBON SEQUESTRATION (CS)

Function Definition: The effectiveness of a wetland both for retaining incoming particulate and dissolved carbon, and through the photosynthetic process, converting carbon dioxide gas to organic matter (particulate or dissolved), and to then retain that organic matter on a net annual basis for long periods *while emitting little or no methane* (a potent “greenhouse gas”). Note that most published definitions of Carbon Sequestration do not include the important limitation on methane emission.

Scientific Support for This Function in Wetlands Generally: Although many wetlands support exceptionally high rates of primary productivity, many other factors determine whether a wetland is a net source or sink for carbon. Artificial disturbances or extreme events, such as increased frequency of drought, wildfire, or increased water levels (e.g., from global warming, tsunamis, artificial drainage), can quickly reverse gains in the amount of carbon sequestered in a



wetland. Moreover, some of the most productive non-tidal wetlands also tend to be among the most significant emitters of methane, a potent greenhouse gas.

## FUNCTION MODEL

Full model structure: For non-tidal wetlands, the score is higher if (1) its existing ("legacy") carbon stores (*Historical Accumulation*) are large or the wetland has a great ability to physically retain organic matter it produces or receives from upgradient sources (*Physical Accumulation*), (2) the average of *Warmth* and *Plant Cover* indicates higher productivity, and (3) it lacks factors that suggest it has substantial methane emissions (*Methane Limitation*). In the final model, *Methane Limitation* is weighted equally with the accumulated score of the other processes (those which indicate carbon retention). The submodels are described below:

### Submodel structures:

- *Historical Accumulation* (existing carbon store) considers first if this is a new wetland. If so, Historical Accumulation is based only on its estimated age. If not, this factor is calculated as the average of greater extent of moss cover, organic soils, and lack of soil disturbance. To a lesser degree, the score for this factor increases with increasing percent cover of trees and shrubs, outlet constriction, wetland vegetated width, and a shorter growing season.
- *Physical Accumulation* is half-attributable to less persistent outflow and half to the average of a flatter wetland gradient, an intermediate percentage of ponded water, and an artificial (presumably more constricted) outlet if an outlet is present at all.
- *Warmth* facilitates plant productivity and is indicated by longer growing season and lack of evidence of groundwater input. The scores of these indicators are averaged.
- *Plant Cover* score is half-attributable to wetland vegetated width and half to the average of increasing ground cover density, shallow water depth, and extensive cover of either woody or emergent vegetation.
- *Nutrient Availability* is assumed greater if some water level fluctuation occurs and results in a large percentage of the wetland being inundated only seasonally. The scores of these indicators are averaged.
- *Methane Limitation* is considered to occur if the wetland has higher salinity, little permanent surface water, tree cover (if any) that is coniferous, and extensive moss cover. These are considered equally predictive of Methane Limitation and so are averaged.

If the wetland is tidal, the score is the average of five indicators or groups. One is the greater of the scores for estuarine position (closer proximity to ocean is preferable) and salinity (more saline is preferable). A second represents vegetation form, with emergent herbaceous and especially woody considered more likely to support Carbon Sequestration much more than eelgrass and seaweed. A third is time elapsed since restoration, if the wetland is a restored wetland. A fourth is soil texture, with organic and fine-texture soils considered to have the highest carbon content. The fifth represents increasing wetland width, ground cover density, and percentage of the wetland that is inundated daily.

Approach for Future Validation: Among a series of wetlands spanning the function scoring range and a range of wetland condition (integrity), particulate and dissolved organic carbon

would need to be measured regularly at wetland inlet and outlet, if any, along with measurements of changes in water volume. Equally important, emissions of methane and carbon dioxide would need to be measured regularly throughout the year and throughout the day/night cycle. Plant productivity rates (especially belowground), hydrology, and carbon accumulation in sediments or soils would require measurement as well. Results might be extrapolated to a broader range of conditions using existing site-scale models that require such detailed data (e.g., Froelking et al. 2002, St. Hilaire et al. 2008).

**VALUES MODEL:** No model is provided because this function's values are diffused throughout the planet.

## **PUBLIC USE & RECOGNITION (PU)**

Definition: Prior designation of the wetland, by a natural resource or environmental protection agency, as some type of special protected area. Also, the potential and actual capacity of a wetland to sustain low-intensity outdoor recreation (such as hiking or nature photography), education, and research. The model assumes that more human use of a wetland means that the particular wetland is more valued by the public. However, it is recognized that some individuals would value more those wetlands that receive less human use because heavy use compromises the solitude sought and valued by some.

Full model structure: The score for Public Use & Recognition, for both tidal and non-tidal wetlands, is assumed to increase with an increase in scores for Ownership (1/2 of score) and the average of Zoning, *Convenience & Outputs*, and *Investment* (1/2 of score). The submodels are described below.

Submodel structures:

- *Convenience & Outputs:* For non-tidal wetlands, the score is greater where most of wetland is physically accessible and visited often, is near a road and mostly visible from it, has a zoning designation of Development, is near a visitor center or has similar educational or recreational enhancements, has evidence that multiple sustainable resources (e.g., hay, timber, fish) are harvested, and adjoins a large expanse of open water. Scores for these are averaged. For tidal wetlands, the model is the same except visibility from a road and proximity to a large expanse of open water are not used as indicators.
- *Investment:* This is intended to reflect positively any past expenditure of public funds for the wetland's conservation, as well as designation as a mitigation site or regular use for scientific research or non-regulatory monitoring. The metric's score is based on the maximum of these indicator scores.

## **WETLAND SENSITIVITY (SEN)**

Definition: the lack of intrinsic resistance and resilience of the wetland to human and natural stressors (Niemi et al. 1990), including but not limited to changes in water chemistry, shade,

frequency and duration of inundation or soil saturation, water depth, biological invasion, habitat fragmentation, and others as described in the USEPA report by Adamus et al. (2001).

Full model structure: The function score for non-tidal wetlands is represented by the average of the scores for Rare Wetland Type, *Abiotic Resistance/ Sensitivity*, *Biotic Resistance/ Sensitivity*, *Resilience/ Recovery Duration- Colonizer Availability Influence*, and *Resilience/ Recovery Duration- Veg Growth Rate Influence*. The submodels are described below.

- *Abiotic Resistance* is assumed to be less (i.e., more sensitive) in wetlands that either (1) have organic or clay soil, (2) are a rare wetland type, (3) lack a persistent surface water outlet, or (4) are in a headwater location, have more ponded water than flowing water, have extensive pavement in the runoff contributing area, have shallow water depth and artificial drainage. The maximum score of these four indicator groups is selected to represent the overall submodel score.
- *Biotic Resistance* is assumed to be less (i.e., wetland more sensitive) in wetlands that either (1) host a rare wetland plant species, or (2) contain one of the only patches of herbaceous or woody vegetation within 0.5 mile, have relatively intact native vegetation with no strongly dominant species, or are a newly established wetland with sparse ground cover. The maximum score of these two indicator groups is selected to represent the overall submodel score.
- *Resilience/ Recovery Duration- Colonizer Availability Influence* is calculated as the greater of two group averages. One reflects smaller and less extensive buffer width, and farther distance to the nearest big tract of perennial cover. The other reflects farther distance and poorer vegetative connectivity to the nearest other pond or wetland, and generally low diversity and area of wetlands in the associated watershed.
- *Resilience/ Recovery Duration- Veg Growth Rate Influence* averages the scores for increasing moss cover, shorter growing season, absence of nitrogen fixing plants, greater wooded extent (especially older-growth trees), presence of beaver, and location in a relatively arid watershed.

If the wetland is tidal, its sensitivity score is the average of three indicators and one group. The group is the average of fewer vegetation forms, sparser ground cover, less extensive cover of invasive plants, and higher native plant diversity. The three indicators reflect rare wetland types, soil texture (organic and clayey soils considered more sensitive), and a narrow width of vegetated wetland.

## **WETLAND ECOLOGICAL CONDITION (EC)**

Definition: The integrity or health of the wetland as defined primarily by its vegetation composition (because that is the only meaningful indicator that can be estimated rapidly). More broadly, the structure, composition, and functions of a wetland as compared to reference wetlands of the same type, operate within the bounds of natural or historic disturbance regimes. However, in the case of ORWAP, no attempt was made to normalize the model outputs to least-altered reference wetlands.

Structure: Wetlands that are scored as being in the best ecological condition (i.e., have the highest integrity) are those that contain rare species, no plant or animal pest species, a large wide portion that is flooded only seasonally, extensive microtopographic variation, dense ground cover, have no strongly dominant species, and haven't been overgrazed. The indicator scores of these are averaged. For tidal sites, the score is the average of the scores for percent cover of invasive plants and extent of overgrazing.

## **WETLAND STRESSORS**

Definition: The degree to which the wetland is or has recently been altered by, or exposed to risk from, primarily human-related factors capable of reducing one or more of its functions.

Structure: Wetlands are automatically scored a “10” if input water has a water quality issue. Otherwise, the score is the maximum of *Hydrologic Stressors*, *Water Quality Stressors*, *Fragmentation Stressors*, and *Disturbance Stressors*. These submodels are described below.

- *Hydrologic Stressors* represents altered timing of water inputs, changes in confinement where surface water exists the wetland, and for non-tidal wetlands a relatively large proportion of the precipitation in the runoff contributing area reaching the wetland quickly. The scores of these indicators are averaged.
- *Water Quality Stressors* indicates accelerated inputs of nutrients, contaminants, and sediment from the runoff of stream contributing area. The scores of these indicators are averaged.
- *Fragmentation Stressors* represents fewer, smaller and more distant areas of perennial cover, few other connected wetlands, and lack of buffers. The scores of these indicators are averaged.
- *Disturbance Stressors* is an average of scores representing proximity to a road and higher visibility, frequent visitors to a larger portion of the wetland, and a higher percentage of invasive plants along the edge of the wetland.

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## Appendix C: Map Layers and Data in the ORWAP Section of the Wetlands Explorer

Wetlands. This coverage is a compilation of polygon data from numerous sources, and represents the most comprehensive dataset available for the location, type, and extent of the state's wetlands. It uses as a base all available digital data from the National Wetlands Inventory (U.S. Fish and Wildlife Service), to which has been added draft NWI mapping (ORNHIC and The Wetlands Conservancy), Local Wetlands Inventories (approved by DSL), wetlands along state highways (Oregon Department of Transportation), Wetland Reserve Program sites (NRCS), wetland mitigation banks (DSL), and mapping of individual sites by a variety of federal, state, academic, and nonprofit sources. Despite the contributions from many sources, huge numbers of jurisdictional wetlands are not shown in this coverage. As noted on the website, the wetland maps shown there must not be used to represent jurisdictional wetlands or jurisdictional wetland boundaries.

Hydric Soils. This coverage is a compilation of polygon data from numerous sources, and represents the most comprehensive dataset available for the location, composition, and extent of the state's hydric soils. It uses as a base all available digital data from the SUURGO layer (NRCS; "hydric" and "partially hydric" soils, the latter with a variable percentage of hydric inclusions), to which has been added Soil Resource Inventory data (USDA Forest Service; "somewhat poorly drained" to "poorly drained" soils), Unique Habitat data (USDA Forest Service; e.g., "wet meadow"), and soil survey mapping by Weyerhaeuser Company ("imperfectly drained" to "poorly drained"). Note that soils have not been identified and mapped on much of the federally-owned land in Oregon, and soil surveys are periodically updated.

100-year Floodplain. Obtained from FEMA, this is their Q3 "Regulatory Floodway" layer that shows the area that will be inundated by a flood event having a 1 percent chance of being equaled or exceeded in any given year. Such floodplains have been mapped mainly near developed areas. In areas that have experienced extensive development only recently, the boundary may be wider than shown unless new regulating dams or detention basins have been simultaneously installed. The Q3 Flood Data are derived from the Flood Insurance Rate Maps (FIRMS) published by the Federal Emergency Management Agency (FEMA). The file is georeferenced to earth's surface using geographic projection and decimal degree coordinate system. The specifications for the horizontal control of Q3 Flood Data files are consistent with those required for mapping at a scale of 1:24000.

Wetland Priority Areas. This coverage identifies areas with concentrations of important wetland habitats and opportunities for wetland enhancement and restoration. It was created by overlaying the ODFW's "Conservation Opportunity Areas" (COA) map, the wetlands layer described above, and NRCS hydric soils mapping, and then retaining areas of overlap. COA's are primarily areas notable for their rare habitat types or wildlife species, and were defined systematically by a public process as part of Oregon's *Comprehensive Wildlife Conservation Strategy* (ODFW 2006). The full COA layer can be viewed at: [https://nrmp2.dfw.state.or.us/arcgis/rest/services/Compass/ODFW\\_2015\\_COAs\\_Draft/MapServer](https://nrmp2.dfw.state.or.us/arcgis/rest/services/Compass/ODFW_2015_COAs_Draft/MapServer). In the Willamette Valley, the map is based on The Nature Conservancy's (TNC) Willamette Synthesis project, with subsequent adjustments and additions made by ORNHIC and The

Wetlands Conservancy (TWC). The Willamette Synthesis represents a two-year effort that integrates (1) TNC's portfolio sites identified by ecoregional planning, (2) ODFW's COAs, (3) NRCS hydric soils mapping, (4) FEMA floodplain mapping, (5) Army Corps of Engineers historical floodway maps, and a number of other sources. To improve the focus on wetlands, ORNHIC and TWC then removed the larger upland portions (e.g., oak savanna and woodland, upland prairie) from the Synthesis map, and included additional wetland information based on conservation data, restoration opportunities, and cluster analysis of USFWS NWI mapping. As a matter of policy, it should not be assumed that DSL is necessarily in agreement with the "Priority Area" designation of all wetlands labeled as such.

Essential Salmonid Habitat. Essential salmonid habitat is defined as the habitat necessary to prevent the depletion of native salmon species (chum, sockeye, Chinook and coho salmon, and steelhead and cutthroat trout) during their life history stages of spawning and rearing. The designation applies only to those species that have been listed as "Sensitive, Threatened or Endangered" by a state or federal authority. The Department of State Lands, in consultation with the Oregon Department of Fish and Wildlife (ODFW), designates essential salmonid habitat areas based on field surveys and/or the professional judgment of ODFW's district biologists, and is the source of this coverage. Designations are periodically reviewed and updated. The last update was in 2015. Stream reaches used only by non-native salmonids, or used only as passageways, are not included.

Springs. This coverage was created by The Nature Conservancy using springs information obtained from Pacific Northwest Hydrography Framework and from the Geographic Names Information System (GNIS). Thus, it shows mainly the points that are named "springs" on topographic maps. Many such areas would qualify as slope wetlands in the HGM classification because subsurface flow is a major water source. Many more wetlands are groundwater-dependent but their springs have not been mapped. See TNC's report, *Groundwater and Biodiversity* (Brown et al. 2007).

Watersheds. This shows the boundaries of HUC8, HUC10, and HUC 12 watersheds as obtained from the State of Oregon's GEO website. Those had been delineated manually by the source agency. Some imprecision is apparent (e.g., where boundaries intersect streams, which they should not) and is probably the result of using too-coarse topographic information when the delineations were originally done. The boundaries may be refined as more detailed topographic data (e.g., LiDAR) become available for parts of Oregon.

In addition to information contained in the above map layers, the ORWAP support tool reports several other types of information near the right margin of the web page:

HUC12. This is the name and code number of the HUC12 watershed in which the entered point is located, based on the Watersheds layer described above.

Presettlement Vegetation Class. The reported class, if any, is from a layer developed by ORNHIC (John Christy), mainly from interpretations of General Land Office (GLO) surveyor notes made at quarter-section intervals during the mid-1800's. The spatial resolution is consequently very coarse.



Rare Wetland Type. This information is from ORBIC's database, and includes wetland types considered to be Special Areas of Concern (SAC's) by DSL and other agencies. Four SAC's have been excluded from this web tool because more accurate information can be obtained by direct field inspection while using ORWAP. They are: Intertidal Salt and Brackish Marsh, Intertidal Mudflat, and Subtidal Salt and Brackish Aquatic Bed. In addition, the following names were changed to maintain consistency with ORWAP and the terminology used for these types by the National Vegetation Classification.

- Dune Wetland → Interdunal Wetland
- Intertidal Brackish and Freshwater Shrub Swamp and Forested Wetland → Wooded Tidal Wetland
- Intertidal Freshwater Marsh → Tidal Freshwater Wetland
- Serpentine Riparian, Spring, Seep, and Fen → Ultramafic Soil Wetland
- Westside Valley Wet Prairie → Wet Prairie

Special Protected Area. These include BLM Areas of Critical Environmental Concern (ACEC) or Outstanding Natural Area (ONA), federal Research Natural Areas (RNA) or Special Interest Areas (SIA), or Natural Heritage Conservation Areas (NHCA), Land Trust and Nature Conservancy Preserves, and other lands protected specifically for their high ecological significance.

Rare Species Scores. The scores are computed using information from ORBIC's database. The scores have taken into account several factors for each rare species record contained in the official database of the Oregon Biodiversity Information Center (ORBIC): (a) the regional rarity of the species (S1, S2, etc.), (b) their proximity to the point defined by the coordinates you entered (up to within 1 mile and/or the HUC6), and (c) the "certainty" that ORBIC assigns to each of those records. These 3 factors were combined, across all rare species in the vicinity, into the value score that the Wetland Explorer tool reports for each group.

**CAUTION:** Keep in mind that many areas will have low scores for Rare Species only because few or no prior attempts have been made to survey the area for such species, which may actually be present.

Element of Occurrence Records (number of). This is tallied using information from ORBIC'S database. This reports the number of rare species records (not the number of rare species) known from the exact coordinate you entered, and/or within 1 mile, and/or from other parts of the watershed (HUC12). The names of the particular rare species that have been tallied are reported only for the HUC12. A list of all wildlife species predicted to occur in the HUC12 can be viewed by clicking on the last row of the box. **CAUTION:** For compliance with state and federal legal requirements related to rare species reporting, online querying of this website is not a substitute for submitting directly to the responsible agencies a written request for such information, or conducting required field surveys. A written request is important because the agency's response may contain information that is more recent, spatially explicit, and/or complete than what is posted online.

## **Appendix D: Acknowledgements**

### **2011 – 2016**

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**Environmental Protection Agency, Western Ecology Division:** Tony Olsen, Mary Kentula, and Marc Weber.

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