Manual for the Oregon Rapid Wetland Assessment Protocol (ORWAP)

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The supporting website should be cited as:
Rempel, M., P. Adamus, and J. Kagan. 2018. Oregon Explorer - ORWAP and SFAM Map Viewer: an internet tool for ORWAP wetland assessment and SFAM stream assessment support. Oregon State University Library and Institute for Natural Resources, Oregon State University, Corvallis, OR. Internet:
https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam

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' web page https://www.oregon.gov/dsl/WW/Pages/ORWAP.aspx or the Oregon Explorer's Aquatic Mitigation Topic Page https://oregonexplorer.info/topics/aquatic-mitigation?ptopic=38, or 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) 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.

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.

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 C). 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." Testing showed that a typical application of ORWAP requires fewer than 4 hours to complete. Among independent users, repeatability of the scores for most functions was found to be within ± 0.6 point or less on a 0-to-10 scoring scale.

A website created collaboratively for ORWAP 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. The ORWAP and SFAM Map Viewer is hosted on the Oregon Explorer's Aquatic Mitigation Topic Page and can be accessed by navigating to https://oregonexplorer.info/topics/aquatic-mitigation?ptopic=38.

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ACKNOWLEDGMENTS

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 the 3.1 version (2011-2016). The list of participants for the past versions and the current 3.2 version (2018-2020) can be found in Appendix E. 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

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 (Dorney et al. 2018).

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.

2.0 Overview of ORWAP

2.1 Ecological Functions & Values Conceptual Basis

Functions and Values

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).

Indicators

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

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).

2.2 Limitations of Use

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 C** 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 ± 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 can anticipate 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) in **Appendix F** 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 in sections 3.0 through 6.0.

2.3 Measures of Function & Value

ORWAP's logic models, which are programmed into an Excel spreadsheet, use information from 77 (non-tidal) or 52 (tidal) indicators that are assessed onsite, as well as information from 43 indicators gathered mainly from one website and from aerial imagery. After data from the three-part assessment forms are entered into the ORWAP_Calculator Excel spreadsheet, ORWAP automatically generates scores intended to reflect a wetland's ability to support seventeen functions. The individual functions are also condensed into thematic groups, called "grouped services." Definitions of the functions and the group services' categorization are proved in Table 2.1. 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."

For all but three of the seventeen functions, scores are given for both components of an ecosystem service: function and value. ORWAP provides three primary score outputs, three "other attribute" scores, and three output types as shown in Table 2.2. Although, 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 C**).

Table 2.1 Wetland Function Categorization, Definition, and Ecosystem Services Provided.

GROUP SERVICES	SPECIFIC FUNCTIONS OR VALUES	DEFINITION AND SERVICES/VALUES PROVIDED
Hydrologic function	Water Storage & Delay (WS)	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.
Water Quality Support	Sediment Retention & Stabilization (SR)	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).
	Phosphorus Retention (PR)	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.
	Nitrate Removal & Retention (NR)	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_2O emission.
Fish Habitat	Anadromous Fish Habitat (FA))	The capacity to support an abundance of native anadromous fish (chiefly salmonids) for functions other than spawning. Many accessible wetlands provide rich feeding and rearing opportunities, shelter from predators, and thermal refuge (especially if groundwater is a significant water source). See worksheet *WetVerts* in the *ORWAP_SuppInfo* file for list of the species. The model 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.
	Resident Fish Habitat (FR)	The capacity to support an abundance and diversity of *native* non-anadromous fish (both resident and visiting species). 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. See worksheet *WetVerts* in the *ORWAP_SuppInfo* file for list of the species. The model 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.

Aquatic Habitat	Amphibian & Reptile Habitat (AM)	The capacity of a wetland to support an abundance and diversity of native amphibians and native wetland-dependent reptiles, e.g., western pond turtle. 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. See worksheet *WetVerts* in the *ORWAP_SuppInfo* file for list of the species. The model will not predict habitat suitability accurately for **every** species.
	Waterbird Nesting Habitat (WBN)	The capacity to support an abundance and diversity of wetland-breeding waterbirds, such as ducks, grebes, bitterns, and rails. Dozens of waterbird species nest almost exclusively in wetlands. Breeding densities can be exceptionally high in some non-tidal wetlands. See worksheet *WetVerts* in the *ORWAP_SuppInfo* file for list of the species. The model will not predict habitat suitability accurately for every species in this group.
	Waterbird Feeding Habitat (WBF)	The capacity to support an abundance and diversity of feeding waterbirds, primarily outside of the usual nesting season. Dozens of waterbird species occur almost exclusively in wetlands during migration and winter. See worksheet *WetVerts* in the *ORWAP_SuppInfo* file for list of the species. The model will not predict habitat suitability accurately for every species in this group.
Ecosystem Support	Aquatic Invertebrate Habitat (INV)	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. 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. See worksheet *WetInverts* in the *ORWAP_SuppInfo* file for list of freshwater aquatic invertebrates known or likely to occur in Oregon wetlands. The model will not predict habitat suitability accurately for every species.
	Songbird, Raptor, Mammal Habitat (SBM)	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 will not predict habitat suitability accurately for every species in this group.
	Water Cooling (WC)	The effectiveness of a wetland for maintaining or reducing summertime water temperature, and in some cases, for moderating winter water temperature. 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.

	Native Plant diversity (PD)	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. Many plant species grow only in wetlands and thus diversify the local flora, with consequent benefits to food webs and energy flow. See worksheet *P_WetIndic* in the *ORWAP_SuppInfo* file for list of the species.
	Pollinator Habitat (POL)	The capacity to support pollinating insects, such as bees, wasps, butterflies, moths, flies, and beetles. 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.
	Organic Nutrient Export (OE)	The effectiveness of a wetland for producing and subsequently exporting organic matter, either particulate or dissolved. Dissolved and/or particulate carbon is important to downstream food webs.

OTHER SERVICES	**SPECIFIC FUNCTIONS OR VALUES**	**DEFINITION AND SERVICES/VALUES PROVIDED**
	Carbon Sequestration (CS)	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”).
	Public Use & Recognition (PU)	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.

Table 2.2 ORWAP Outputs and Definitions

Primary outputs	**Function**	The physical, chemical and biological processes that characterize wetland ecosystems.
	Value	Importance or worth of a wetland function to societal needs. Represents the wetland's opportunity to provide a given function and the local significance of that function based on its location. ORWAP considers land uses in both the "contributing" and down slope areas from the wetland when calculating value.[1]
	Groups	These are a "roll-up" of individual functions and their associated values organized into thematic categories.
Other attributes	**Ecological Condition**	The integrity or health of a wetland, as defined operationally by its vegetation composition. More broadly, the similarity of a wetland's structure, composition, and function with that of a reference wetland of the same type and landscape setting, operating within the bounds of natural or historical disturbance regimes.
	Stressors	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 the performance level of one or more of its functions.
	Sensitivity	A wetland's lack of intrinsic resistance and resilience to human and natural stressors. A higher score represents higher sensitivity.
Output types	**Normalized Score**	The numeric score of a function, value, or attribute after it has been mathematically adjusted to the full 0-10-point scale, based on calibration data from 200 test sites.
	Rating	Each normalized score is assigned to one of three categories (Lower, Moderate, Higher) to convey the relative meaning of the numeric score and to allow for comparison across different functions and values. See ORWAP's Technical Supplement for a description of the statistical process used to assign ratings.
	Rating Break Proximity	Alerts the user when a score and associated rating lies within the repeatability error of ORWAP. "LM" is displayed when the score could be assigned either a lower or moderate rating; "MH" is displayed when the score could be assigned either a moderate or higher rating.

2.4 ORWAP Version 3.2 Changes

ORWAP Version 3.2 includes changes to the Calculator workbook, Technical Supplement, Manual, and Map Viewer. In 2018 – 2019, the Map Viewer underwent major changes that

[1] Users should note that the meaning given to the term "services" in ORWAP is different than that given in the federal mitigation rule (33 CFR 332). The latter describes "services" as the benefits that human populations receive from functions that occur in ecosystems.

included creation of a shared ORWAP & SFAM Map Viewer, a software program upgrade, updated data layers, and enhancements to the ORWAP Report. The Department of State Lands used this opportunity to correct or clarify issues in the Calculator that were brought to the Department's attention. Several corrections were made to the Calculator's internal coding. As a result, rating thresholds on the ORWAP scoresheet were adjusted.

3.0 Overview of the ORWAP Assessment Process

The Oregon Rapid Wetland Assessment Protocol (ORWAP) is a rapid, science-based approach to assessing the ecological functions and values of a wetland. Both office work (data collection from maps, online resources and other sources) and field work (observations) are required to assess indicators and calculate ORWAP scores. Testing showed that a typical application of ORWAP requires fewer than 4 hours to complete the office and field components, depending on the size and complexity of the site. It takes an additional 1-2 hours to input and review data and evaluate the results.

An ORWAP Assessment may be conducted any time of the year. However, the wet season is recommended for onsite data collection. If possible, visit the site at least once during the driest time of the year and once during the wet season.

There are several ORWAP components:

- **ORWAP Calculator (ORWAP_Calculator.xls):** Excel spreadsheets that calculate function and value scores and ratings based on the indicators assessed for a given site.
- **ORWAP Supplemental Information (ORWAP_SuppInfo.xls):** Excel spreadsheets that provide helpful resource material.
- **User Manual** (this document): instructions and guidance on completing an ORWAP assessment.
- **ORWAP Technical Supplement:** document describing the development and refinement of ORWAP V.3.1 and V.3.2 (calibration, weighting and scoring, normalization, groups).
- **ORWAP and SFAM Map Viewer:** online resource of wetland-related datasets from state and federal agencies, local governments, and the scientific community.

3.1 Basic Steps to Completing an ORWAP Assessment

Completing an assessment consists of filling in four Excel forms within the ORWAP_Calculator:

- Cover Page (**CoverPg**) asks general information about the wetland location and characteristics, and information on comprehensiveness of the site visit.
- 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.
- Field **Form F** for non-tidal wetlands or **Form T** for tidal wetlands have a series of questions (indicators) to be answered during a comprehensive site visit.
- Field **Form S** (stressors) has a series of questions to be answered during a comprehensive site visit.

Each indicator in the ORWAP_Calculator is evaluated at a scale or spatial extent applicable or relevant for the indicator being assessed. To accomplish this, ORWAP establishes three or four assessment area extents:

- The **Assessment Area (AA)** is the wetland area to be evaluated with ORWAP. The AA is either the entire wetland or some portion.

- The **Entire Wetland Area** comprises the entire (estimated) wetland that the AA is either part of or equal to.

- The **Runoff Contributing Area (RCA)** is the drainage area, catchment area, or contributing upland that contributes runoff directly to the wetland, not via streams or overbank flow. The RCA does not include the Streamflow Contributing Area.

- The **Stream Contributing Area (SCA)** is recognized only if a stream (tributary) or other waters feed into the wetland.

The basic steps to complete an ORWAP assessment are as follows:

1. Download the most recent version of the two Excel spreadsheet files: *ORWAP_ Calculator* and *ORWAP_ SuppInfo* (section 3.2).

2. Download and print the PDF files of the Calculator's data forms (section 3.2) to be completed in the field (Form F for non-tidal wetlands or Form T for tidal wetlands, and Form S).

3. Use the ORWAP Map Viewer and other available resources to complete the "office component," which involves filling out the CoverPg and Form OF worksheets in the *ORWAP_Calculator* file (section 4.0).

4. Conduct a site visit and complete the "field component" by filling out Form F or Form T and Form S (section 5.0). You may need to refine some answers to questions on Form OF 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, which provides additional guidance for interpreting some of the questions. Note that questions marked **"W"** in column D must be answered for the entire wetland.

5. Once back in the office, refer to the ORWAP_SuppInfo file, web resources, and other resources (section 3.4) 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 into the *ORWAP_Calculator.*

6. Review and interpret the results (section 6.0).

The following sections of this User Manual provide detailed instruction on completing each of these steps.

3.2 Obtaining and Navigating the ORWAP_Calculator

All assessment documents can be downloaded from the Oregon Explorer Aquatic Mitigation Topic Page (http://oetest.library.oregonstate.edu/topics/aquatic-mitigation?ptopic=38) or the Oregon Department of State Lands website https://www.oregon.gov/dsl/WW/Pages/ORWAP.aspx.

Download the *ORWAP_Calculator.xls* and the *ORWAP_ SuppInfo*.xls files. 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.

Save a copy of the ORWAP_Calculator with your site name and date of assessment (or using another naming protocol you have established). The ORWAP_Calculator contains 26 tabs, each with its own specific purpose as described in Table 3.1.

Download and print the Calculator’s data forms (PDFs) that are to be completed in the field (Form F for non-tidal wetlands or Form T for tidal wetlands and Form S).

Table 3.1 Purpose and Description of ORWAP_Calculator Tabs.

Tab	***Purpose***	**Description**
Cover Page	Data entry	Worksheet for entering information about the general characteristics of your site and assessment notes.
OF	Data entry	Worksheet for entering office-collected data about your site. Contains 43 questions/measures.
F	Data entry	Worksheet for entering field-collected data about your site. Contains 72 questions/measures (nontidal).
T	Data entry	Worksheet for entering field-collected data about your site. Contains 47 questions/measures (tidal).
S	Data entry	Worksheet for entering field-collected data about your site. Contains 5 questions/measures related to wetland stressors.
Scores	Summary of scores (automatically calculated)	Worksheet with outputs of: <u>Specific Functions & Values</u> • Numerical scores (between 0.0 and 10.0) of function and value • Rating (Lower, Moderate or Higher) for functions and values • Rating Break Proximity (LM and MH) <u>Other Attributes</u> • Wetland Sensitivity • Wetland Ecological Condition • Wetland Stressors <u>Groups</u> • Hydrologic Function • Water Quality Support • Fish Habit • Aquatic Habitat • Ecosystem Support
WS - PU	Informational	Specific Functions or Values (auto-populate when data is entered into the data entry worksheets)
Sens	Other Attributes	Wetland Sensitivity
EC	Other Attributes	Wetland Ecological Condition
STR	Other Attributes	Wetland Stressors

3.3 Navigating the ORWAP and SFAM Map Viewer

The Oregon Rapid Wetland Assessment Protocol (ORWAP) and Stream Function Assessment Method (SFAM) Map Viewer is an online, publicly accessible data viewing tool created to facilitate collection of necessary data for an ORWAP or an SFAM assessment. The Map Viewer is hosted on the Oregon State University Library's Oregon Explorer website, which integrates and provides access to wetland-related data from state and federal agencies, local governments, and the scientific community. The Map Viewer can be used for viewing and overlaying statewide spatial data sets, generating a report of summary information for a site, and creating basic site maps.

Some of the available layers are intended to help the user understand the landscape context of their project area (e.g. hydrography, precipitation, soils, etc.), while others are required for answering assessment questions (e.g. water quality data, zoning, Essential Salmonid Habitat, etc.). The Map Viewer can generate a site-specific ORWAP Report that provides important summary information about the project area, which is used to complete some assessment questions. Instruction for generating an ORWAP report is in section 4.2.

The ORWAP and SFAM Map Viewer can be accessed by navigating to the Aquatic Mitigation Topic page at https://oregonexplorer.info/topics/aquatic-mitigation?ptopic=38 and clicking on the ORWAP Map Viewer or by navigating directly to https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam.

The Map Viewer contains several tabs (Figure 3.1), each with a set of tools designed for navigation, viewing and identifying data, and creating images and reports that will be used in the ORWAP assessment.

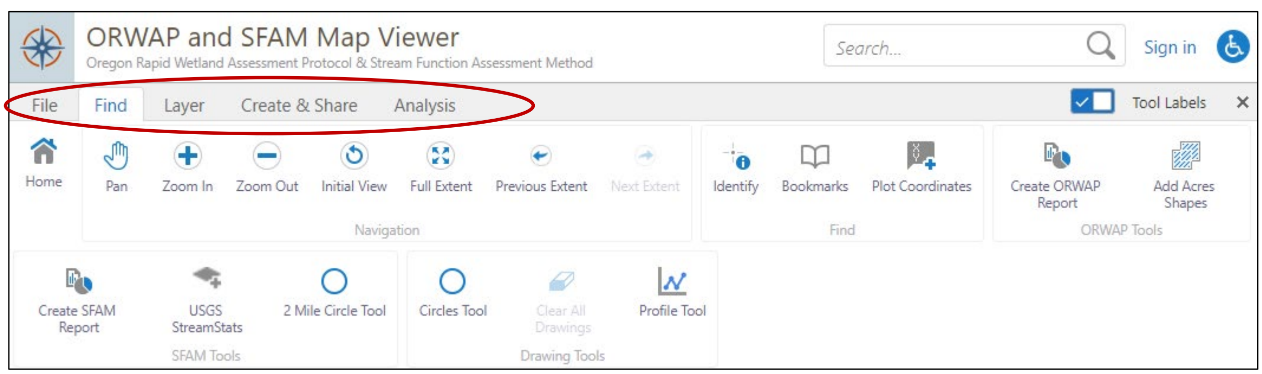


Figure 3.1. Tabs (red circle) and select mapping tools in the ORWAP and SFAM Map Viewer.

The purpose of each of the main ORWAP and SFAM Map Viewer tabs is described in Table 3.2.

Table 3.2. Description of ORWAP and SFAM Map Viewer Tabs.

Tab	Purpose
File	Tool to create a printable version of the map displayed
Find	This is the main tab. A suite of navigation tools (Zoom, Pan, etc.) allow for manual exploration of the map. It is also possible to navigate to a known location by entering latitude and longitude using the Plot Coordinates tool. The Identify tool allows users to obtain information about specific features of active data layers. The Create ORWAP Report tool prompts users to outline an assessment area and then produces a data report for that area (see "Create an ORWAP Report" in Section 4.2). Additional tools assist in spatial observations.
Layer	Spatial data layers are grouped into themes: Wetlands, Hydrology, Water Quality and Quantity, Floodplain, Soils, Land Classification, Habitat, Restoration, and Basemaps. Selecting the box next to the Layer group name and clicking the + button, expands the list of individual data layers within that group. Selecting an individual layer loads the data from that layer into the Map Viewer and provides the layer key. The Layer tab has several tools for advanced users who wish to Filter or Query information from specific data layers. The Upload Data tool allows the user to load and view data layers (.csv, .xlsx, .kml, .shp, .gpx, or a .zip containing a FileGDB or shapefiles) that are imported from other sources. Any external data uploaded to the Map Viewer will need to be reloaded each time a new session of the Map Viewer is launched. Information (including the metadata and web service data) is available for each layer by clicking the grey arrow to the right of the layer name.
Create & Share	Drawing tools allow a user to add points, lines, polygons, and/or text to the map before saving or printing. Basic instructions for each tool will appear in the top of the Map Viewer once it is selected. The Edit tool allows users to make edits after a line or shape has been created. Users can then Export their drawings (without the map imagery) as a shapefile or they can export the entire map (imagery and drawings) as a PDF or image file.
Analysis	Measurement tools allow the user to calculate distance or area. Once a line or polygon is drawn, the relevant measurements appear in the Map Viewer and additional tools appear in the toolbar, allowing the user to choose the unit of measurement.

Tip:

In addition to the tabs, the Map Viewer provides quick access or shortcuts to some common tasks.

Home takes you to the introductory screen of the Map Viewer

Layers takes you to the list of SFAM data layers that can be loaded for analysis

Coordinates provides options for determining the latitude and longitude of your site

Basemaps allows you to select from different maps (e.g. aerial imagery, topographic) as the basemap

Scale allows you to select from a range of fixed map scales or to enter a specific map scale

The ORWAP and SFAM Map Viewer contains three sets of layers (Figure 3-2), which allows the user to filter data layers depending on the type of assessment they are conducting.

Choose **ORWAP**

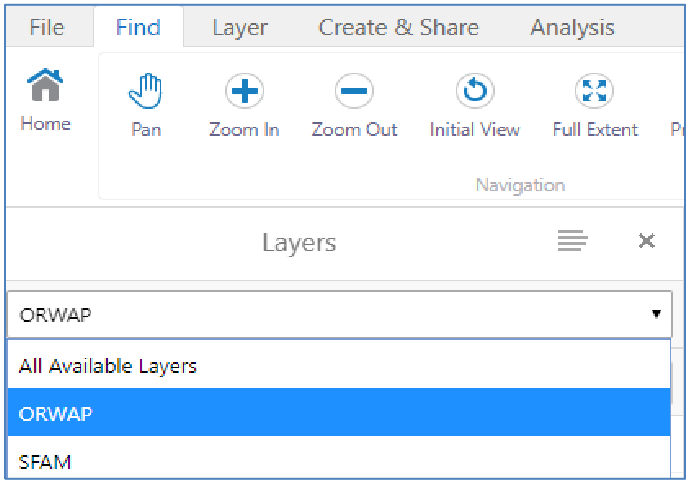


Figure 3.2. Selection of available layers.

Helpful hints and additional instructions for using the various tools in the ORWAP Map Viewer are provided in **Appendix A.** A description of ORWAP-relevant data layers included in the Map Viewer is provided in **Appendix D.**

3.4 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, which provides historic imagery. 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:

- Google Earth Pro:
  - Latitude/Longitude
  - 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.

- 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.

- Microsoft Imagery: http://www.bing.com/maps/

- 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.richardsonscharts.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. https://www.oregongeology.org/lidar/

4.0 Office Component Instructions

The Office Component of an ORWAP Assessment uses data and information available from online resources, reports, maps, etc., about the site and surrounding area to generate scores for the values or services provided by the site. The Office Component should be completed prior to the Field Component. Review this entire section before proceeding to follow the instructions and completing the forms. In addition, you may want to review the detailed instructions **(Appendix A)** on completing common ORWAP and SFAM Map Viewer functions and tasks.

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 imagery.

4.1 Create Site Maps

These instructions will guide you in developing maps of the ORWAP site. Some of the maps can be done on other digital or printed maps, however the ORWAP Map Viewer has been designed specifically for this purpose. The Map Viewer provides a wide variety of base imagery and tools that can be used to produce site maps. Maps can be printed or exported in a variety of formats. The site maps will be used for locating the three or four assessment area extents and answering questions on the data forms. Once on site, users should verify the AA boundaries and other extents, as reasonably possible.

Quality maps and aerial imagery of the site are desirable for efficient work and good documentation. It is best to have a few maps of different scale in aerial imagery and topography, with streams and roads indicated. Aerial imagery should be centered on the project site and include the surrounding landscape. Images should be the most recent available and at an appropriate scale of 1:24,000 (1 inch = 0.5 mile) or finer. Site maps will be one of the products submitted to regulatory agencies as part of an ORWAP Assessment.

Step 1. Locate the Site

Open the ORWAP and SFAM Map Viewer in your web browser from the Aquatic Mitigation Topic page at https://oregonexplorer.info/topics/aquatic-mitigation?ptopic=38 or by navigating directly to https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam. Navigate to your project site using the Zoom or Plot Coordinates tools on the Find tab, or by searching an address, place name, or latitude/longitude coordinates in the Search box on the left-side of the home page.

Step 2. Define 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. If a wetland delineation has not been completed, follow the guidance under Step 4 for determining the boundaries until a site visit is conducted to delimit the AA boundaries with more certainty.

The AA preferably will consist of the entire wetland plus, in some cases, some or all 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 the following 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 7.1 and **Appendix F.**

*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 4.1), 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.

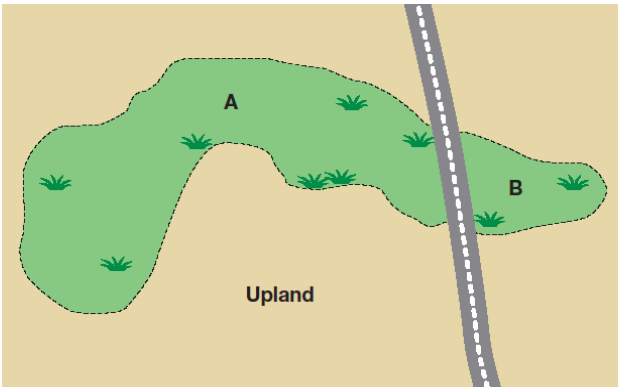


Figure 4.1. Dissected Wetland.

b. **Fringe Wetland (type 1).** A fringe wetland is a wetland that borders a bay, estuary, pond, or river in which the contiguous stretch of open water is more than 3x wider than the wetland. For a fringe 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 4.2).

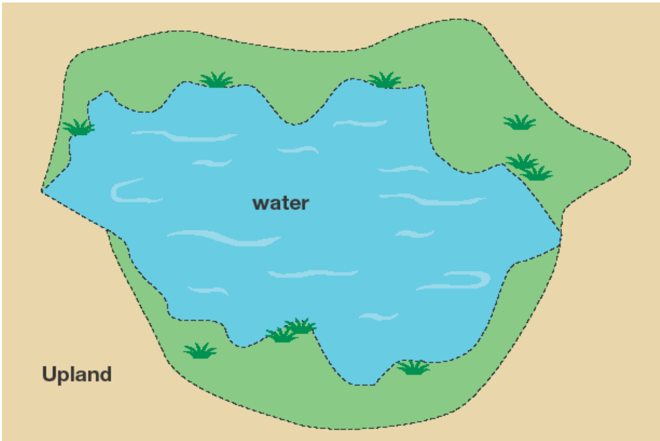


Figure 4.2. Fringe Wetland Type 1.

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 4.3) 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.

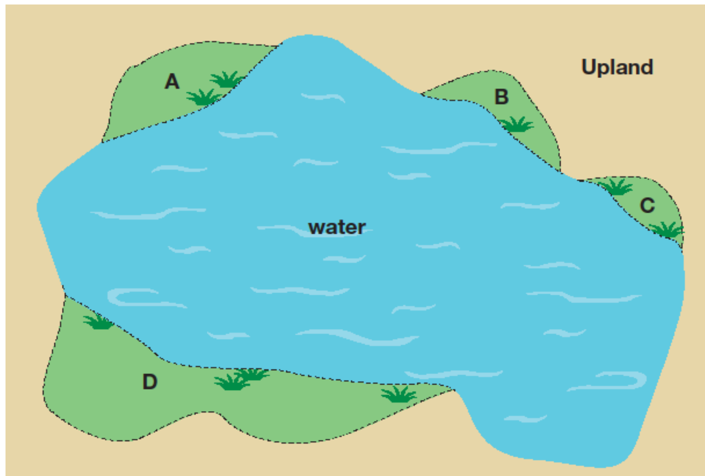


Figure 4.3. Fringe Wetland Type 2 (fringe wetland patches). Wetland patches B and C would be included in the same AA, if separated by no more than 100 ft. by water, bare substrate, algal flats, or upland. Wetland patches A and D would be in the same AA if separated by 100 ft. or less, or if they are 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 4.4) 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).

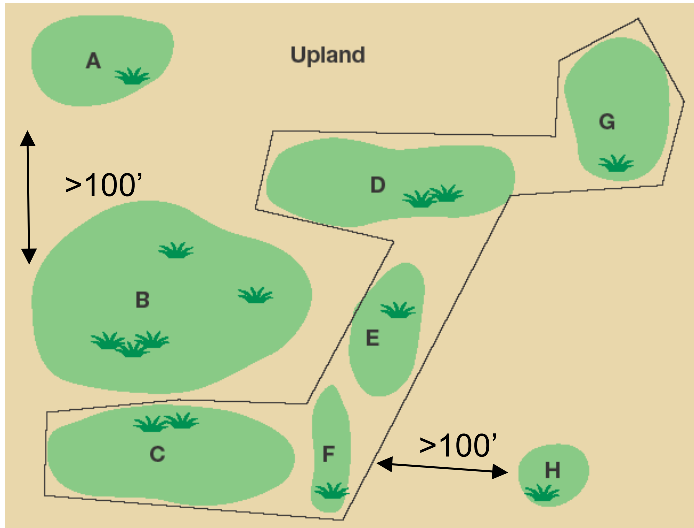


Figure 4.4. Wetland Mosaic Assessment Area (AA). The dark line defines the mosaic. The circles are wetlands and the areas between them are upland. Wetlands C, D, E, F, and G comprise a mosaic because they occupy more than 50% of the total area bounded by the dark line. Wetland B is excluded because it 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.

Step 3. Draw the Assessment Area (AA)

Delineate the extent of your AA on the ORWAP Map Viewer Basemaps' aerial image by creating a polygon using the Draw tools (Create & Share tab). Instructions on how to use the Draw tool features can be found in **Appendix A**. Print the AA map for use in the field as a base map by using the Print tool (Create & Share tab). 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.

Tip: To modify a shape, select the Edit tool, drag the vertices to the desired locations, then click again on the Edit tool to stop modifying. To erase a drawing, select the Erase tool then click on the drawing. Using the Clear tool will eliminate all drawings made on the map.

Tip: You can save maps using the Export Drawings tool (Create and Share tab). See **Appendix A** for detailed instructions.

Step 4. Draw the entire Wetland Area (if applicable)

If the AA was only part of a larger wetland, the estimated size (acres) and approximate boundaries of the entire wetland (or wetland plus contiguous pond, lake, or river if a fringe wetland) will need to be determined. On Form OF and Form F or Form T, a few questions **must** be answered in terms of the **entire** wetland (Table 4.1), 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 as shown in Figure 4.5.

Table 4.1. Indicators That Must be Applied Considering the Entire Wetland.

Office Form "OF"		Field Form "F" or "T"	
OF35	Runoff Contributing Area (RCA) - wetland as % of RCA	F7/T21	Emergent Plants - Area
OF36	Unvegetated % in the RCA	F13	Ponded Open Water Area - Wettest
OF37	Transport from Upslope	F17	Ponded Open Water Area - Driest
OF39	Streamflow Contributing Area (SCA)- wetland as % of SCA	F31/T7	Outflow Duration
OF40	Unvegetated % in the SCA	F32/T8	Outflow Confinement
OF41	Upland Edge Shape Complexity	F72	Wetland Type of Conservation Concern

Runoff Contributing Area (RCA) - Wetland as % of (WetPctRCA)	Delimit the wetland's Runoff Contributing Area (RCA) using a topographic base map. The area of the AA's wetland is:	W
	<1% of its RCA.	0
	1 to <10% of its RCA.	0
	10 to 100% of its RCA.	0
	Larger than the area of its RCA. **Enter 1 and SKIP TO OF39.**	0

Figure 4.5. Example of an Indicator with the W designation.

The best wetland map to use is a wetland delineation map. If a wetland delineation of the entire wetland that includes the AA has not been completed, search for any existing mapping in ORWAP Map Viewer's Wetlands theme layer. This mapping includes NWI wetlands streamed from the USFW, a Local Wetlands Inventory Subset from DSL's Statewide Wetlands Inventory, Oregon's Greatest Wetlands identified by The Nature Conservancy and the Institute for Natural Resources, and Other Wetlands compiled by the Institute for Natural Resources and Oregon State University Libraries and Press from numerous sources.

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 boundaries coincide with that of visible surface water or saturated soil signatures in aerial images or with mapped hydric soils. See the ORWAP Map Viewer's Hydric Soils layer (expand Soils), if using mapped hydric soils as an estimate for wetland boundaries. If the hydric mapping is extensive, a map (at an appropriate scale) showing the hydric soils layer(s) is sufficient.

Use the Map Viewer Area tool (Analysis tab) to draw the approximate boundaries of the entire wetland on a Basemaps' aerial image. Instructions on how to use the Area tool features can be found in **Appendix A**. Note the total acreage shown for input into the Cover Page of the Calculator. Print the Wetland map using the Print tool (Create & Share tab). Before printing, the map can be decluttered by removing labels using the Hide Labels tool. Take a copy for use in the field to answer applicable questions relating to the entire wetland.

Tip: To modify the polygon shape and change the drawing's transparency see instructions in **Appendix A.**

Step 5. Draw the Estimated Runoff Contributing Area (RCA)

The approximate boundary of the RCA will need to be estimated and delimited to answer indicator questions OF35 – OF38. The Runoff Contributing 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 4.6). The water does not need to travel on the land surface; it may reach the AA slowly as shallow subsurface seepage[2]. The RCA does not include the Streamflow Contributing Area (SCA).

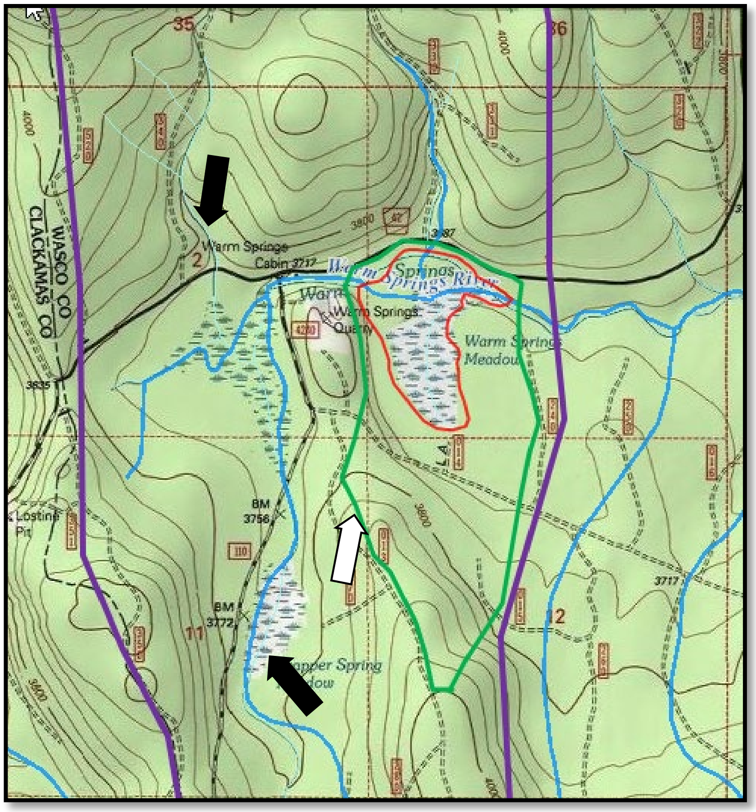
Tip: Layers that will assist this estimate include: Topo, Aerials, Wetlands, Floodplain, and Hydrologic Boundaries 6th Level (HUC12). The Profile tool (Find tab) generates an elevation profile from a transect line and can be helpful for examining topography.

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 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.

The 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.

[2] 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.



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 4.6. Delimiting a wetland's Runoff Contributing Area (RCA). Wetland (red line) is fed by its Runoff Contributing Area (RCA) (green line). The larger SCA is partially shown (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.

Use the <u>Area</u> tool (Analysis tab) to draw the approximate boundaries of the RCA on the Basemaps <u>Topo</u> layer. Instructions on how to use the <u>Area</u> tool features can be found in **Appendix A**. Or, users can upload data such as a shapefile of the Runoff Contributing Area (RCA) for their site. See the section on Upload Data in **Appendix A**.

Print and save the RCA map using the <u>Export</u> tools and <u>Print</u> tool (Create and Share tab) so the area can be refined, if necessary, based on field observations.

Step 6. Draw the Estimated Stream Contributing Area (SCA)

The approximate boundary of the SCA will need to be estimated and delimited to answer indicator questions OF39 – OF40. A Stream Contributing Area (SCA), is recognized only if a stream (tributary) or other waters feed into the wetland (Figure 4.7). 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.

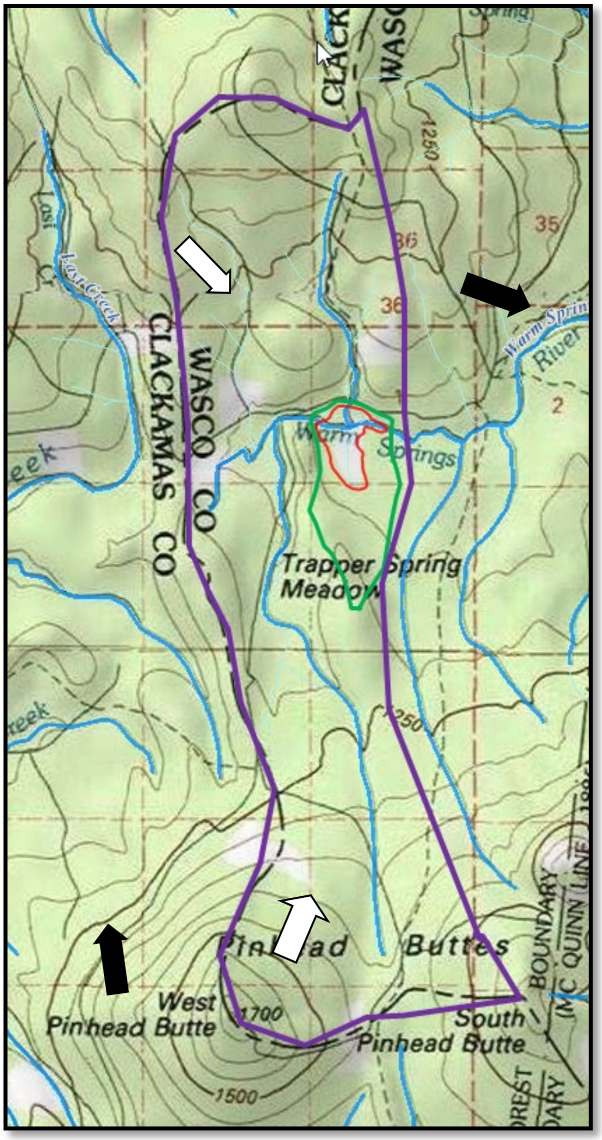


Figure 4.7. Delimiting a wetland's Streamflow Contributing Area (SCA). Wetland (red line) is fed by its Streamflow Contributing Area (SCA) (purple line). The RCA is within the green line. The white arrows denote flow of water downgradient within the SCA. Black arrows denote the likely path of water away from the SCA and into adjoining drainages, as interpreted from the topography.

The same layers and tools are used as above for the RCA. Use the Area tool (Analysis tab) to draw the approximate boundaries of the SCA on the Basemaps Topo layer. Instructions on how to use the Area tool features can be found in **Appendix A**. Or users can upload data such as a shapefile of the Stream Contributing Area (SCA) for their site. See the section on Upload Data in **Appendix A**.

Print and save the SCA map using the Export tools and Print tool (Create and Share tab) so the area can be refined, if necessary, based on field observations.

StreamStats provides an alternative method for delimiting a SCA for wetlands intercepted by a mapped stream. The SCA can be delineated and the area calculated automatically by StreamStats (USGS website: https://streamstats.usgs.gov/ss/. Enter the coordinates, select Oregon, select Delineate, zoom to level 15 or finer, and click on a stream.

Step 7. Create a Soil Map

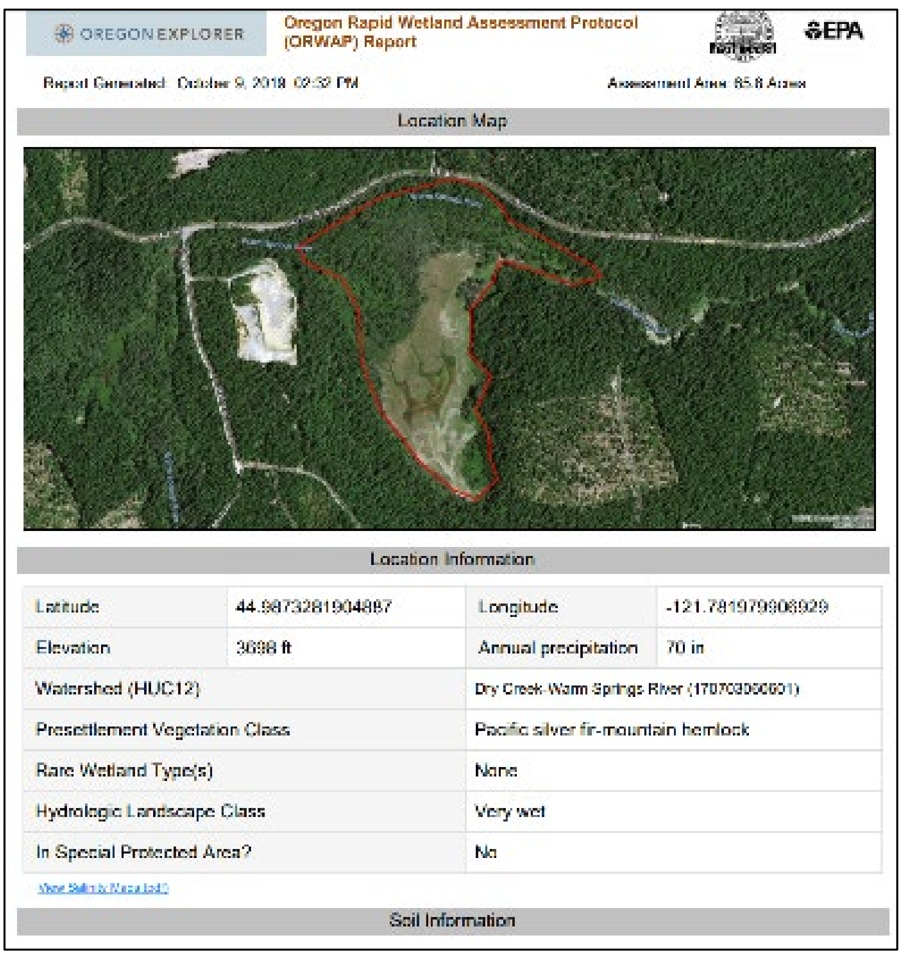
The predominant soil unit within the AA will need to be recorded on the CoverPg. In addition, the location of soil units within the AA will need to be known to obtain soil data in the field for indicator F58 on Form F.

To obtain a soil map of the assessment area from the ORWAP Map Viewer, use the Oregon Soils layer (expand Soils). The map units display as colored polygons. The opacity of the soil units can be changed by moving the sliding bar to the left, which will make the mapping partially transparent. Map unit names can be obtained by left clicking within a map unit.

Print the map by using the Print tool (Create & Share tab). There are two ways the print area can be changed: (1) choose a new map center, right click on the chosen point, and click “Center the Map Here” on the pop-up box, or (2) uncheck the box in the sidebar labeled “Lock print preview with map.” This option locks the print box to its initial scale and location. Now the box can be moved by left clicking and dragging.

4.2 Generate an ORWAP Report

The Map Viewer can generate a site-specific report (ORWAP Report) to provide important summary information about the project area, which is used to complete some ORWAP assessment questions. An example ORWAP Report is shown in Figure 4.8.


OREGON EXPLORER

Oregon Rapid Wetland Assessment Protocol (ORWAP) Report

EPA

Report Generated: October 9, 2018 02:32 PM

Assessment Area: 85.8 Acres

Location Map

Location Information

Latitude	44.9873281904887	Longitude	-121.781979906929
Elevation	3698 ft	Annual precipitation	70 in
Watershed (HUC12)		Dry Creek-Warm Springs River ([illegible])	
Presettlement Vegetation Class		Pacific silver fir-mountain hemlock	
Rare Wetland Type(s)		None	
Hydrologic Landscape Class		Very wet	
In Special Protected Area?		No	

Soil Information

Figure 4.8 Example ORWAP Report.

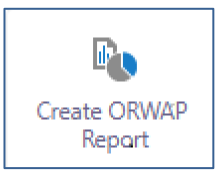
Polygon-based data and centroid-based data

The Report contains both centroid-based and polygon-based data. The Location Information and Watershed Information sections contain centroid-based data (data from a specific radial distance from the center point of the polygon). The remaining sections are polygon-based (determined from the entire polygon).

The purpose of the centroid-based data query is to retrieve data that describes contextual characteristics of the area surrounding the site (i.e. spatial data features that are present within a certain distance from a site). The purpose of polygon-based data queries is to retrieve data that describes characteristics of the area (i.e. spatial data features that are contained within, or intersected by, the drawn polygon).

Create an ORWAP Report

Click the Create ORWAP Report icon on the top toolbar (Find tab) and follow the instructions provided in the left sidebar.



You will be prompted to delineate the Project Area boundary (the AA) using a polygon tool. While the ORWAP Report cannot be generated directly from the polygon previously drawn for the AA, you can simply trace over the previous AA polygon. Double click to finish the polygon and click the continue button.

When prompted, download the ORWAP Report by viewing the report and save the PDF file to your computer.

4.3 Complete the Cover Page

Open the *ORWAP_ Calculator* and go to the first worksheet tab called "CoverPg." Complete lines 2-18 and 22-24 using information about your site as well as data from the ORWAP Map Viewer and ORWAP Report. 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.

- Tax lot: ORMAP http://www.ormap.net/flexviewer/index.html.

Information for the remaining questions (lines 19-21) on the CoverPg will be obtained during field work.

4.4 Complete the Office Data Form

Open the Calculator's second worksheet tab called "OF." It is recommended that you read through the entire indicator question, possible answers and additional guidance in column E of the worksheet before answering the question. Data is entered by changing the 0 in the “Data” column (column D) of the worksheet cell to “1.”

Note that indicators marked W *in the Data column must be answered for the entire wetland.*

Tip: Color highlighting in column A (indicator number) denotes 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 ORWAP Map Viewer data layers and tools. In the left side column of the Map Viewer, under Layers choose “ORWAP” to access map layers used for the ORWAP forms.

Answer the following indicator questions while viewing aerial images at various scales in the ORWAP Map Viewer

Indicator questions OF1 through OF13

While viewing the aerial 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 land cover types will be assessed in *every* zone:

- Within a circle of radius 2 miles (10,560 ft. or 3,219 m)
- Within a circle of radius 0.5 mile (2,640 ft. or 805 m)

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

Tip: To estimate the *percentages* of a given land cover, imagine all the patches of the 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

OF1 Distance to Extensive Perennial Cover

Use the Add Acres Shapes tool (Find tab) and add the 100 acres square shape (Figure 4.9) to help locate an area of **perennial cover** larger than 100 acres. The square shape can be moved around by left clicking and dragging.

With the Distance tool (Analysis tab), 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.

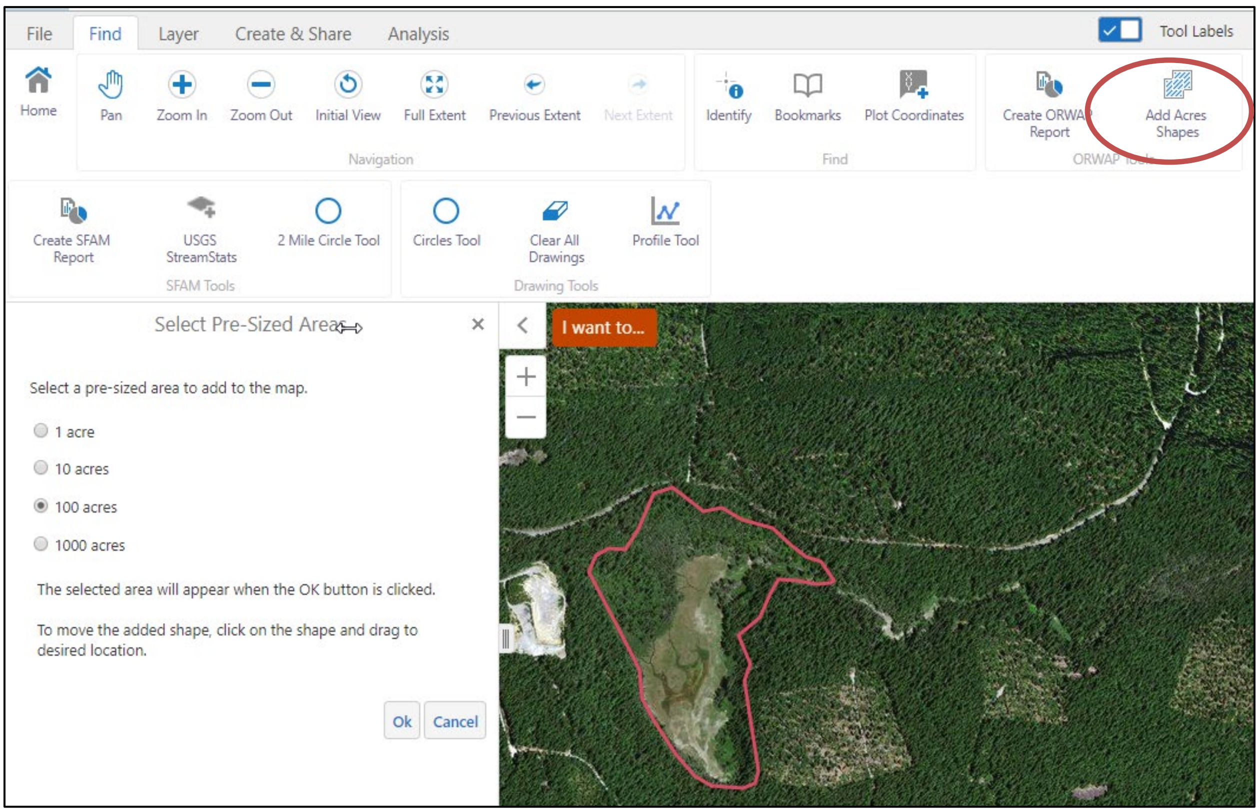


Figure 4.9. "Add Acres Shapes" tool gives you the option of four square sizes (1, 10, 100, and 1,000 acres).

OF2 Distance to Tidal Waters

If applicable, use the Heads of Tide layer (expand Hydrology) and the Circles Tool (Find tab) or the Distance tool (Analysis tab) to determine the distance of the closest body of tidal water from the AA edge.

OF3 Distance to Ponded Water

Use the Persistent Nontidal layer (expand Wetlands/National Wetlands Inventory) to locate the closest non-tidal freshwater body (wetland, pond, or lake) that is separated from the AA and is ponded all or most of the year. Use the Circles Tool or Distance tool to determine the distance of the closest fresh waterbody from the AA edge.

OF4 Distance to Lake
Use the Persistent Nontidal layer (expand Wetlands/National Wetlands Inventory) to locate the closest non-tidal freshwater body that is separated from the AA, is ponded all or most of the year, and is larger than 20 acres. Use the Circles Tool or Distance tool to determine the distance from the AA edge.

OF5 Distance to Herbaceous Open Land
Use the Add Acres Shapes tool (Find tab) and select the 10-acre shape. Along with the Circles Tool 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 (does not include pasture or other perennial cover), 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.
- **Flat terrain:** means slope of less than 5%.

OF6 Distance to Nearest Busy Road
Use the Circles Tool 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 Size of Largest Nearby Patch of Perennial Cover
Use the Add Acres Shapes tool or the Area tool (Analysis tab) 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 Wetland Type Local Uniqueness
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 more than 10% of the AA, use the ½ mile Circles Tool and the Area tool (Analysis tab) to determine if that vegetation class also comprises less than 10% of the ½ mile circle (~50 acres).

Tip: Questions OF9 – OF11 refer to a percentage of a 2-mile circle around 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 Perennial cover Percentage
Use the Circles Tool 2 Mile circle to estimate percentage of land with **perennial cover** within 2 miles of the AA center.

- **Perennial cover**: see definition in OF1.

OF10 Forest Percentage
Use the Circles Tool 2 Mile 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   Herbaceous Open Land Percentage
Use the Circles Tool 2 Mile circle to estimate the amount of **herbaceous open land** in flat terrain that is within 2 miles of the AA center. The Topo layer (expand Basemaps) may be needed to identify **flat terrain.** Decreasing the transparency of the aerial layer (with the slider bar) allows the aerial to be seen along with the topo. See illustrations in **Appendix B.**

- **Herbaceous open land**: see definition in OF5
- **Flat terrain:** means slope of less than 5%.

OF12   Landscape Wetland Connectivity
Use the Circles Tool 2 Mile circle, and the various wetland layers (expand Wetlands) 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. Much of the wetland mapping in Oregon did not include agricultural wetlands and did not capture many seasonal wetlands.

OF13   Local Wetland Connectivity

Use the Circles Tool ½ Mile circle, and the various wetland layers (expand Wetlands) to determine local wetland connectivity within 0.5 miles of the AA center. See OF12 instructions.

- **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.

Answer OF14 and OF15 using information from the ORWAP Report and OF16 using the ORWAP Map Viewer

OF14   Wetland Number & Diversity Uniqueness
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   Landscape Functional Deficit
In the Watershed Information section of the Report, look at the HUC 12 Functional Deficit table. Enter 1 for each of the listed functions that are noted for the HUC. The origin of this table is described in the ORWAP Technical Supplement document.

OF16   Conservation Designations of the AA or Local Area
Use the applicable Map Layers as indicated below to answer a, b, and c:

a. Use the Circles Tool ½ Mile circle and the Essential Salmonid Habitat (ESH) layer (expand Habitat) 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.

b. Use the Oregon's Greatest Wetlands layer (expand Wetlands) to determine if the AA is within or contiguous to a wetland identified as being biologically and ecologically significant.
   - 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 looking at the Fish Passage Barriers layer (expand Habitat). Consider connecting stream networks between the AA and tidal waters.

c. Use the Important Bird Areas layer (expand Habitat) to determine if the AA is within a designated Important Bird Area.

Answer the following indicator questions using information from the ORWAP Report

Indicator questions OF17 – OF23

Use the Rare Species Scores rating (high, intermediate, low, none) from the ORWAP Report. Ratings are based on calculations from three different databases to assess the likelihood that various rare species will access and use a site as habitat. Species within each category are listed in the accompanying Supp_Info file.

Rare species ratings are provided for seven categories of species:
OF17 Non-anadromous Fish Species of Conservation Concern
OF18 Amphibian or Reptile of Conservation Concern
OF19 Feeding (Non-breeding) Waterbird Species of Conservation Concern
OF20 Nesting Waterbird Species of Conservation Concern
OF21 Songbird, Raptor, Mammal Species of Conservation Concern
OF22 Invertebrate Species of Conservation Concern
OF23 Plant Species of Conservation Concern

Answer the following indicator questions using information from the ORWAP Map Viewer and ORWAP Report

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

Indicator questions OF24 - OF34

OF24 River Proximity
Use the National Hydrography Dataset- Flowline layer (expand Hydrology), the Heads of Tide layer (expand Hydrology) and the Distance tool to determine if a **river**, 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 Floodable Property
Use an Aerial layer (expand Basemaps), 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 layer (expand National Wetlands Inventory) may also indicate some floodplain areas.

OF26 Type of Flood Damage
Use an Aerial layer (expand Basemaps) and the Floodplain layers to determine what type of areas in the floodplain would have the greatest potential financial (economic) damage.

OF27 Hydrologic Landscape
In the ORWAP Report, look under the Location Information section for the Hydrologic Landscape Class.

OF28 Input Water – Recognized Quality Issues
Use the Water Quality Streams and Water Quality Lakes layers (expand Water Quality and Quantity) 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 Identify tool (Find tab). The results will show in the left-side window. Select all the parameters that apply.

OF29 Duration of connection Between Problem Area & the AA
Use the National Hydrography Dataset- Flowline and Waterbody layers (expand Hydrology), and the Persistent, Seasonal, or Saturated Non-tidal layers (expand National Wetlands Inventory) 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 Downslope Water Quality Issues
Use the Water Quality Streams and Water Quality Lakes layers (expand Water Quality and Quantity) and the Distance tool to determine if there is a water quality-limited water body or stream reach located identified within 1 mile downhill or downstream from the AA's edge. To determine the reason for the listing, use the Identify tool (Find tab). The results will show in the left-side window. Select all the parameters that apply.

OF31 Duration of Connection Between AA & Water Quality Problem Area
Use the National Hydrography Dataset- Flowline and Waterbody layers (expand Hydrology), and the Persistent, Seasonal, or Saturated Non-tidal layers (expand National Wetlands Inventory) to determine the duration of connection between the AA and the downhill or downstream problem area identified in OF30. This may need to be verified in the field.

OF32 Drinking Water Source
Use the Surface Water Drinking Water Source Areas and Ground Water Drinking Water Source Areas layers (expand Water Quality and Quantity) to determine the source area that the AA is within.

OF33 Groundwater Risk Designations
Use the DEQ Groundwater Management Areas layer and the Sole Source Aquifer layer (expand Water Quality and Quantity) to determine if the AA is within a designated groundwater management area or sole source aquifer area.

OF34 Relative Elevation in Watershed
Use the 4th Level 8 Digit HUC layer (expand Hydrology/Watershed Boundary Dataset) 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 National Hydrography Dataset- Flowline layer (expand Hydrology) and both Floodplain layers, 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*

Answer the following indicator questions using the RCA created in section 4.1

Indicator questions OF35 through OF38

OF35 Runoff Contributing Area (RCA) – Wetland as % RCA
Obtain the area of the RCA from the previously delineated RCA boundaries and the ORWAP Report's AA acreage to determine what percent of the RCA the area of the AA encompasses.

OF36 Unvegetated % in the RCA
Use an Aerial layer (expand Basemaps) 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 Transport from Upslope
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:

a. RCA slopes are steep – use the Topo layer (expand Basemaps) – and/or
b. Upslope wetlands historically present have been filled or drained extensively – use the Hydric Soils layers (expand Soils) as an indicator and consider human disturbance and management – and/or
c. Land cover is mostly non-forest – use an Aerial layer (expand Basemaps) – and/or
d. Most RCA soils are shallow and/or have high runoff coefficients.
Use the Oregon Soils SSURGO/STATSGO Map Units layer (expand Soils) and the Identify tool to obtain soil unit names within the RCA. The map unit name will be displayed in the left-side window.

Tip 1 : The soils layer takes longer than other layers to load and process data so be patient.

Tip 2 : If you only need one map unit name, use the Identify tool and right click on the unit. If you need several map unit names, left click on the map and drag a rectangle to highlight and identify soils within an area.

Then, open the 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. Soils that are shallow should be evaluated for this question. Scroll down to “Drainage and Permeability” where information about runoff is found (i.e. Well drained; moderate permeability). Soils that are poorly drained or have low permeability should be evaluated for this question.

OF38 Upslope Soil Erodibility Risk
Use the Topo layer (expand Basemaps) and the Distance tool (Analysis tab) to determine the area 200 ft. away and upslope of the AA. If the soil unit is the same as the AA, use the Erosion Hazard from the ORWAP Report’s Soil Information section. If the soil unit is different than the AA, use the Oregon Soils layer to identify which soil map unit occupies the largest percentage of the area within 200 ft. upslope. Use the Identify tool to view the soil unit name, which will be displayed in the left-side window. Click on the arrow that is located after the map unit name to look at additional data. Scroll down to “FOR – Potential Erosion Hazard (Road/Trail)” for the erosion potential.

Answer the indicator questions OF39 and OF40 using the SCA created in section 4.1

Indicator questions OF39 through OF40

OF39 Streamflow Contributing Area (SCA) – Wetland as % of SCA
Obtain the area of the SCA from the previously delineated SCA boundaries and the ORWAP Report’s AA acreage to determine what percent of the SCA the area of the AA encompasses.

OF40 Unvegetated % in the SCA
Use an Aerial layer (expand Basemaps) and the Area tool (Analysis tab) to determine what percentage of the SCA is unvegetated at the time of the peak annual runoff.

Answer the following indicator questions using the figure provided and information from the ORWAP Map Viewer

Indicator questions OF41 through OF43

OF41 Upland Edge Shape Complexity
To determine the AA’s upland edge shape complexity, compare the wetland to the types of boundaries illustrated in Figure 4.10.

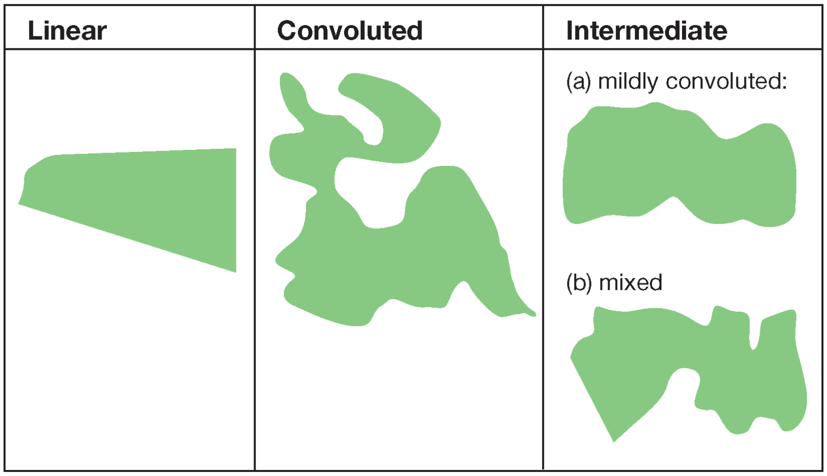


Figure 4.10. Upland Edge Shape Complexity

OF42 Zoning
Use an Aerial layer (expand Basemaps) and the Zoning layer (expand Land Classification) to determine the zoning of undeveloped parcels upslope from the AA and within 300 ft. of the AA's edge.

OF43 Growing Degree Days
Use the Growing Degree Days layer (expand Land Classification) and the Identify tool to determine the category for the AA. Click on the AA with the Identify tool, then in the left-side window that appears, click on the arrow. Use the number that appears under "Pixel Value" to answer the question.

5.0 Field Component Instructions

The Field Component of an ORWAP Assessment uses direct observations to generate scores for the ecological functions provided by the site. The Field Component of the assessment involves visiting as much of the AA (and the entire wetland if practicable) as is safely and legally possible, and then filling out the appropriate two field forms (Form F or Form T and Form S) and verifying, as needed, answers on the office Form OF. If you cannot access all the assessment area, you must rely more on the aerial imagery, maps, other office information, field indicators, and discussions with the landowner and other knowledgeable sources.

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.

5.1 Site Visit Preparation

Schedule the field visit at a time best suited for data collection. The wet season is the recommended time to conduct an assessment. However, the assessment may be conducted at any time of year. If possible, visit the AA during both the wettest and driest times of year. If you cannot, again you must rely more on other sources. If assessing a tidal wetland, try to assess the AA during the daytime high tide on a given day, and preferably also during the day's low tide.

Download and Print Documents:

Take the following documents 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)
- Wetland delineation map (if any, to verify AA and use as a base map)
- 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 is available)
  - Aerial image of the 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)
  - PDF versions of the plant worksheets from the *ORWAP_SuppInfo* file, as needed, to help answer specific questions and for reference:
    - Invasive Plants (P_Invasive worksheet)
    - Plants Not Native to Oregon (P_Exotic worksheet)
    - Wetland Plants Uncommon in Oregon (RareWetPlants worksheet)
    - Salt-tolerant and Low Tidal Marsh Plants (P_SALT worksheet)
    - Plants Reputed to Support Nitrogen Fixation (NFIX worksheet)

- The current US Army Corps of Engineers *State of Oregon Wetland Plant List* that can be downloaded from http://wetland-plants.usace.army.mil/nwpl_static/v33/home/home.html.

Field Equipment and Gear:

Equipment and gear for field work includes:

- Clip board, pencil, rag to clean hands and other items you'd normally take in the field
- Shovel
- Water (for texturing soil)
- The explanatory illustrations in **Appendix B** that includes the flow chart for texturing soils in the field
- GPS (optional)

5.2 Preliminary Reconnaissance

Step 1. Review
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.

Tip: Series of 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 specific wetland type or setting (like open water wetlands), or similar themes (like outlet conditions), or allowed "skips" in a block of questions.

Step 2. Identify boundaries and walk the site
Identify and confirm boundaries delineated on the site maps and explore any concerns you have about site accessibility. Before answering questions on the data forms, walk as much of the AA and wetland as is safely and legally possible. While walking the AA and wetland:

- Look for Inlets and outlets to the AA and inlets and outlets for the entire wetland.
- 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).
- 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 RareWetPlants worksheet), and other indicators described on the field forms.

Step 3. Create a base map
For your own use, it is suggested that you create or revise a base map to show the verified AA boundaries, 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.

5.3 Collect Field Data and Answer Assessment Questions

Step 1. Fill out data forms
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 Column E of the data forms, as well as referring to graphics in the Explanatory Illustrations appendix to this manual (**Appendix B**).

As you answer the questions dealing with "percent of the area," pay attention to the spatial context (area) which the question is addressing. For example, regarding 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

For the soil indicator (question F58), refer to the soil map you made of the AA's soil map units to determine the location of the predominant unit. The examined soil should be in the currently unflooded part of the AA and within the AA's predominant soil map unit. You will need to determine the composition of the soil in the uppermost layer. Do not use the mapped soil unit texture class without verifying it with your own determination.

> 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).
>
> Exclude living roots and duff, which are fresh leaf, needle, twig, moss, dead roots and lichens that have not undergone observable decomposition. 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 B**. After you determine the soil composition in the surface layer, compare it with the mapped soil units within the AA.

Most map unit names indicate the texture of the surface layer [1] (e.g., Omahaling fine sandy loam). If the composition differs from that of all the listed soil map units, examine soil from a *second* location in the wetland. The intent is to characterize the soil that comprises most of the AA. Be aware that the mapaped soil units do include small areas of other soil series and that soil surveys are not intended to be used at a point/site scale. You may need 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.

Step 2. Verify the RCA
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 3. Visitation Notes
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.

6.0 Instructions for Entering, Interpreting, and Reporting the Data

6.1 ORWAP_Calculator Data Entry

Enter data for lines 19 – 21 on the CoverPg and correct lines 13 and 17, if needed. Enter the 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.

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.

[1] 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).

6.2 Interpret Outputs

When all inputs have been entered to the Calculator worksheets, the scores for the functions and values will calculate automatically and appear in the Scores Tab. ORWAP produces several different outputs, which are described in Table 6.1.

Table 6.1. ORWAP Outputs

Primary Outputs	**Function Score**	Numerical normalized score between 0.0 and 10.0. A score of 0.0 indicates that the level of function being provided by the wetland is equal to or less than the lowest score found among the wetlands in our statistical sample of 200 other Oregon wetlands, whereas a score of 10.0 indicates that the level of function being provided by the wetland is equal to or greater than the highest score found among the wetlands in that sample.
	Value Score	Numerical normalized score between 0.0 and 10.0. A score of 0.0 indicates that there is relatively low opportunity for the site to provide a specific ecological function and that, even if it did, the specific function would not be of significance given the context of the site. Conversely, a value score or 10.0 indicates that a site has relatively high opportunity to provide a specific function and/or that it would be highly significant in that location.
	Ratings	Numerical normalized scores are translated into ratings of Lower, Moderate, or Higher to convey the relative meaning of the numeric score and to allow for comparison across different functions and values. See the ORWAP Technical Supplement for explanation of how numerical scores were converted to these ratings.
	Rating Break Proximity	Alerts the user when a score and associated rating lies within the repeatability error of ORWAP. "LM" is displayed when the score could be assigned either a lower or moderate rating; "MH" is displayed when the score could be assigned either a moderate or higher rating.
	Group Ratings	Each specific function, and its associated value, is included in one of the five functional groups: hydrologic, water quality support, fish habitat, aquatic habitat, and ecosystem support functions. Group ratings provide a summary of the degree to which each group of processes is present at a site. Groups are represented by the highest-scoring function with the highest-scoring associated value among the functions that comprise each group. The score sheet in the ORWAP Calculator is programmed to select the highest-rated function with the highest-rated associated value within each group. This hierarchical selection system ensures that thematic functional groups are represented by the highest performing and highest valued ecological function. If there are multiple functions are equally ranked in the selection hierarchy, the first function on the list is selected.

Other Attribute Outputs	**Wetland Ecological Condition**	The integrity or health of a wetland, as defined operationally by its vegetation composition. More broadly, the similarity of a wetland's structure, composition, and function with that of a reference wetland of the same type and landscape setting, operating within the bounds of natural or historical disturbance regimes.
	Wetland Stressors	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 the performance level of one or more of its functions.
	Wetland Sensitivity	A wetland's lack of intrinsic resistance and resilience to human and natural stressors. A higher score represents higher sensitivity.

6.3 Evaluate 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 C** (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 2.2).

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 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. An ORWAP assessment that reflects this "predicted" state of the wetland may be required for permitting associated with partial wetland impacts or enhancement of an existing wetland as compensatory mitigation. See section 7.1.

6.4 ORWAP Products

A completed ORWAP assessment should include these products:

- Scores worksheet (computed by ORWAP)

- Completed forms on Excel worksheets (CoverPg, OF, F or T, S)
- Aerial photograph(s) showing boundaries you drew for the AA, RCA, SCA, and the entire wetland boundaries, if different from the AA
- Topographic map showing boundaries you drew for the AA, RCA, SCA, and the entire wetland boundary, if different from the AA
- Soils map showing soil units in the AA
- ORWAP Report generated by the ORWAP and SFAM Map Viewer
- Base map created or revised during the field assessment (section 4.1)

6.5 Trouble Shooting ORWAP

If the Scores worksheet cells contain error messages such as "#DIV/0!" or "#VALUE", there is likely an error or blank in an input cell that needs to be corrected.

For difficulties with the ORWAP and SFAM Map Viewer, there is a "Feedback" link at the bottom right corner of the Map Viewer from which an email can be directly sent to the Oregon Explorer technical support staff.

7.0 Using ORWAP

7.1 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, the Department of State Lands (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* (**Appendix F**) 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). Elements from the guide are important to understand when assessing a wetland using ORWAP for purposes of a state or federal permit application.

7.2 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 4.1.

The Department of State Lands (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, upon written approval by DSL, in place of the Oregon Freshwater Wetland Assessment Methodology (1996) or it's replacement the Wetland Assessment for Planning in Oregon (WAPO), which is currently in development. All portions of ORWAP must be completed.

Local Wetland Inventories (LWIs) 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 LWI inventory and assessment work must be completed without benefit of onsite access to all wetlands or all portions of a wetland. For planning purposes, 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 3.4) 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 should 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.

7.3 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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9.0 Appendices

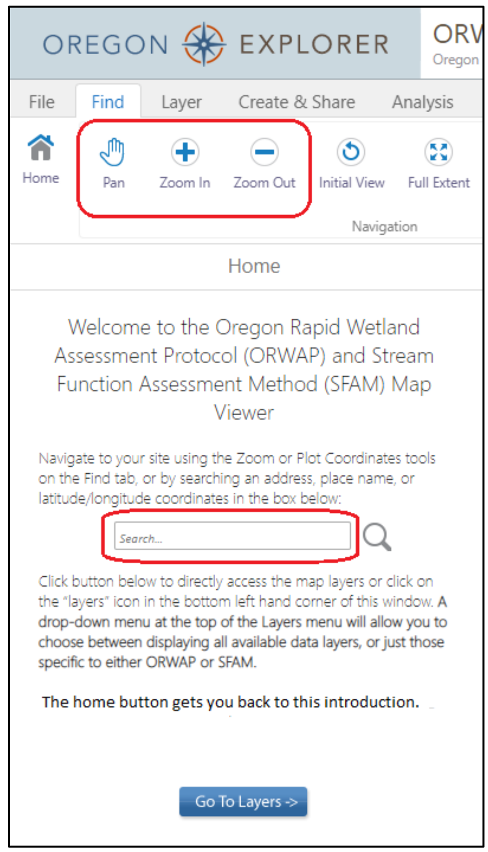
Appendix A: Instruction for Common ORWAP and SFAM Map Viewer Functions and Tasks

The ORWAP map viewer is available at
https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam
Note – The Map Viewer works with all (updated) internet browsers.

Navigate to a Site

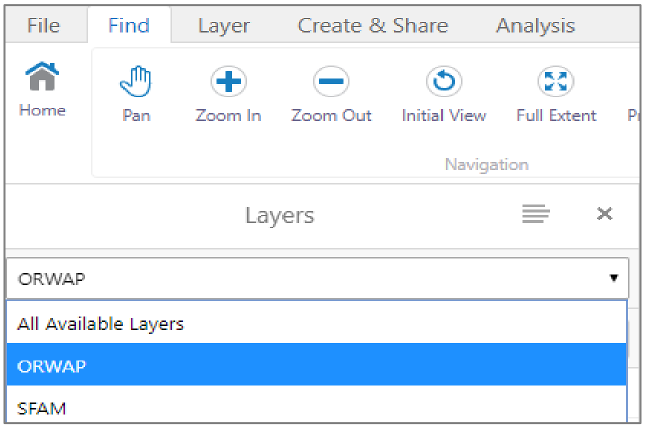
Users can navigate to a known location in the ORWAP Map Viewer using three different methods:

1. **Plot Coordinates:** Enter the latitude and longitude of a site (e.g. 44.930, -123.033) in the Search box on the Home screen
2. **Search Tool:** Enter an address (e.g. 123 River Road, City, State) or place name (e.g. Willamette University) in the Search box on the Home screen.
3. **Zoom/Pan Tools:** Use the Zoom In (+) or Zoom Out (-) functions on the map or on the Find tab to change the scale of the map. Use the Pan function or click and drag map to where it displays the area of interest.



Manage Layers

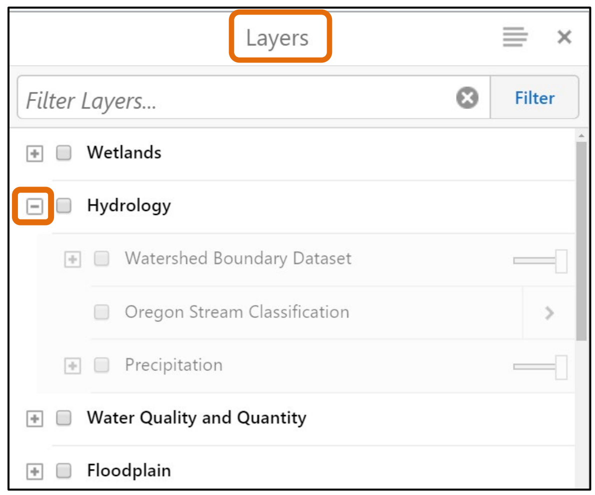
The ORWAP and SFAM Map Viewer contains three sets of layers (All Available Layers, ORWAP, and SFAM).



Choose **ORWAP** for completing an ORWAP assessment.

Datasets available in the ORWAP Map Viewer are listed in the Layers table of contents window. Layers are grouped by category (e.g. Wetlands, Hydrology, Water Quality and Quantity, Floodplain, etc.).

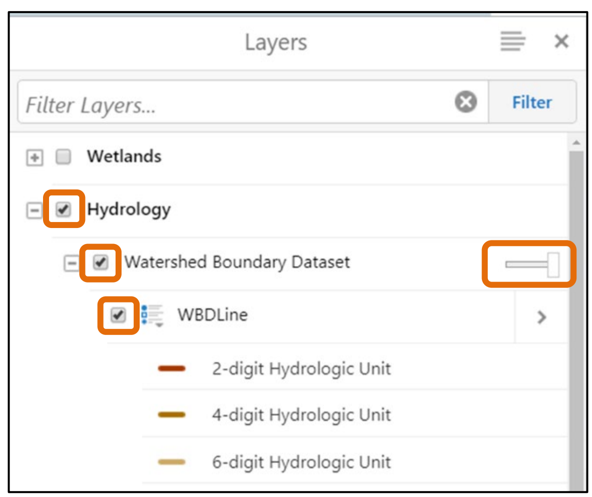
To view the specific data layers available in each group, select the **+** symbol to the left of the group name to expand the list, or the **–** symbol to collapse the list.



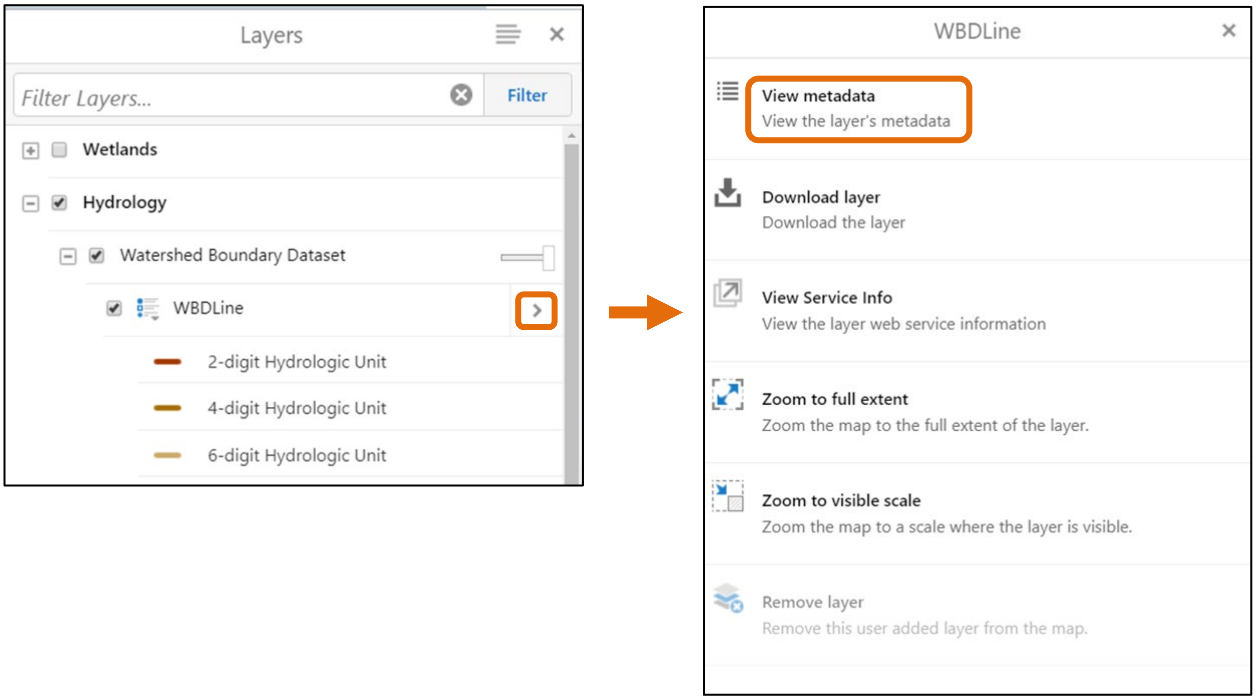
Check the box to the left of a layer name to display the layer in the ORWAP map viewer (i.e. to activate the layer).

Note - In order to display a specific layer, you must first select the group or subgroup that the layer belongs to. That will activate all layers within the group so that they can be turned on or off individually.

Slider symbols to the right of a group name or layer name can be used to adjust the transparency of the layer(s).



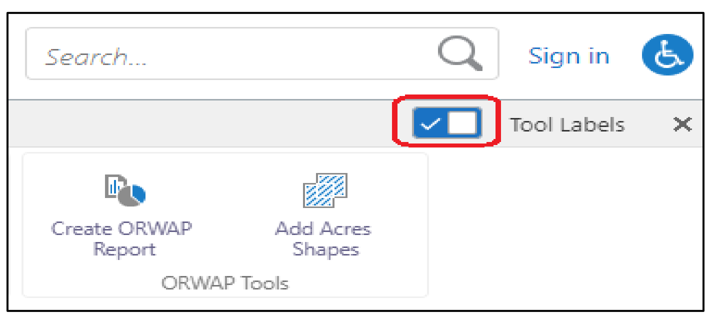
The **>** symbol to the right of a layer name displays a menu with a link to the metadata available for that layer, as well as options to zoom the display relative to the layer.



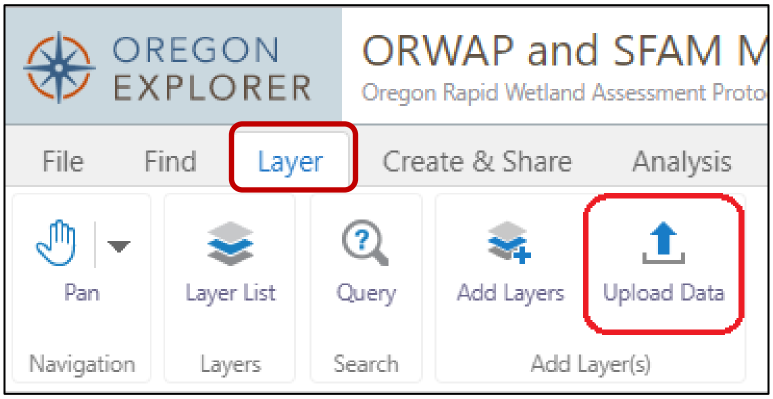
Tip: Many layers are visible only at certain spatial scales. If a layer is greyed out even when checked (activated), zoom in or out until the layer appears, or use the "Zoom to Visible Scale" tool in the Layer menu.

Tip: If you find that it is becoming difficult to view the basemap or individual lines or polygons associated with each layer, you may need to deselect layers that are not part of your current analysis.

Tip: The map area can be expanded by unselecting the Tool Labels box located in the upper right corner of the map viewer.



Upload Data

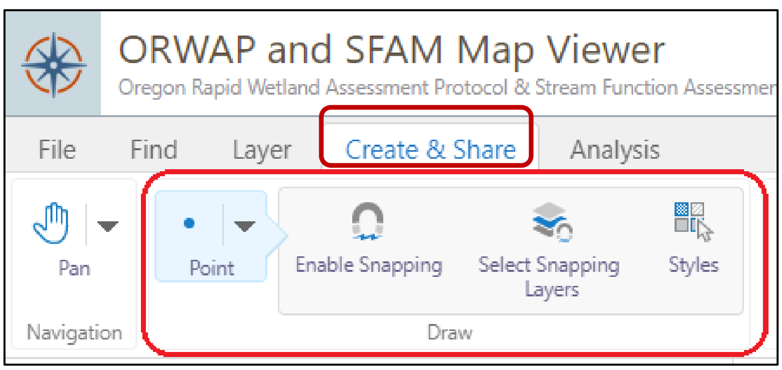


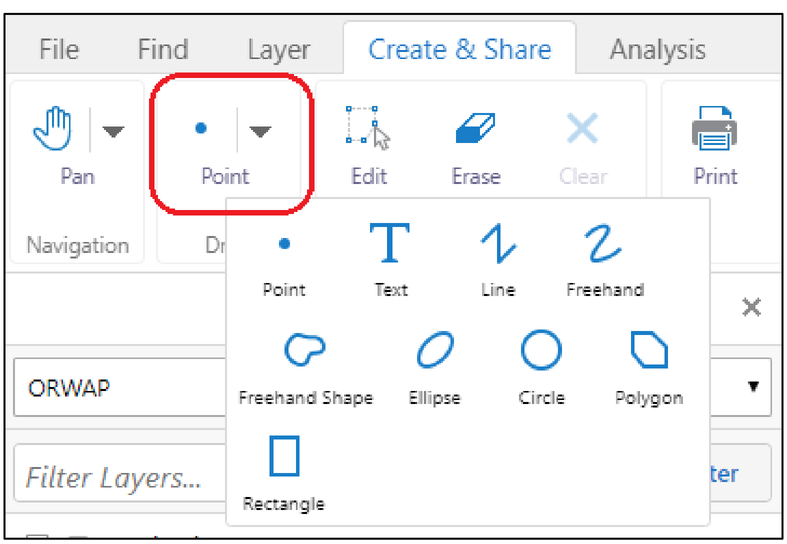
Users can upload data such as a shapefile to the ORWAP Map Viewer using the Upload Data tool under the Layer tab, browsing to the location of the files, and selecting the file to upload. **Supported file types include** *.csv, .xlsx, .kml, .shp, .gpx, or a .zip containing a FileGDB or shapefiles*.

Users can upload shapefiles of the Runoff Contributing Area (RCA) and the Stream Contributing Area (SCA) for their site as part of the ORWAP assessment.

Draw

The Draw tools in the ORWAP Map Viewer allow users to add features such as rectangles, circles, polygons or lines to base maps. Draw tools are found under the Create and Share tab.





Draw a polygon - select the Polygon tool, place the cursor over the starting point and drag the mouse or trackpad along the boundaries of the shape you are delineating. Click to make waypoints (endpoints of a line segment). Double click to finish the polygon.

Draw ellipses, circles or rectangles - select the shape, place the cursor on the map and use the mouse/trackpad to create the shape.

Add another drawn object - select the shape from the toolbar and add it to the map.

Edit an object - select the Edit tool, then click the object you wish to edit and use the cursor to move the boundaries of the object.

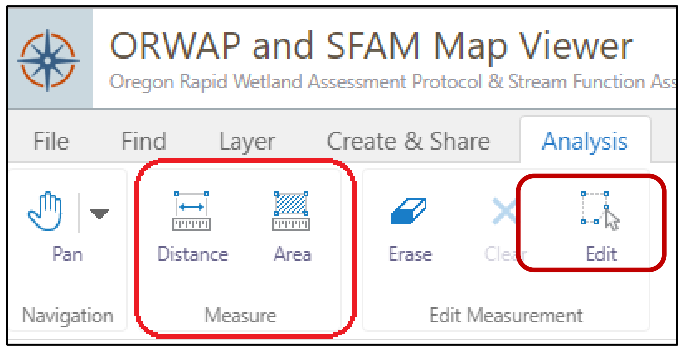
Delete an object - select the Erase tool and click the object you wish to remove. Note - the object will be immediately deleted; this action cannot be undone.

Remove all objects from the map - use the Clear tool. This action cannot be undone.

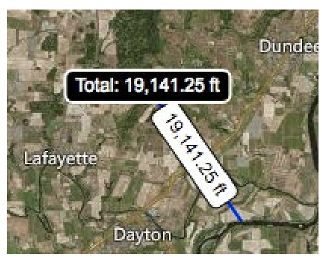
Measure Distance and Area

Users can measure both distance and area on a map using the Measure tools located on the Analysis tab.

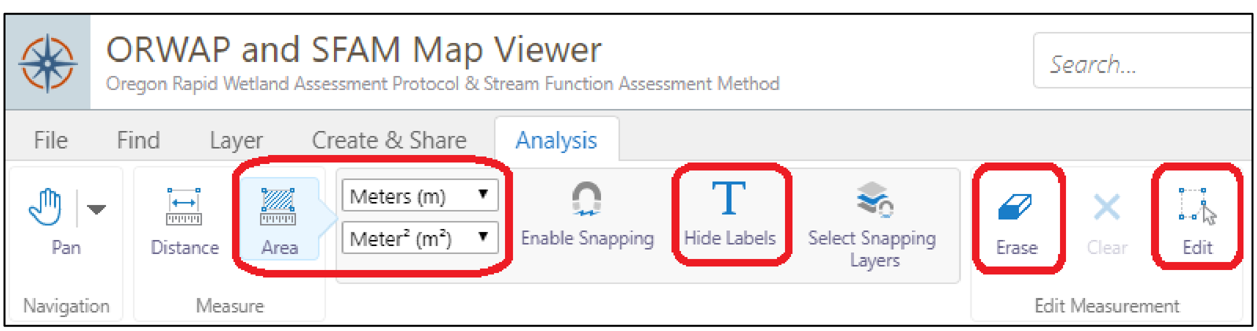
Select either the **Distance** or **Area** measurement tool. Then select the units for your straight line (distance) or polygon (area).



Click the map to start a measurement and click additional locations to add vertices to your line or polygon. Double click to finish a measurement. The total length or area will appear.



To modify an **Area shape**, select the Edit tool, left click on the new polygon and drag the vertices to the desired locations, then click again on the Edit tool to stop modifying.

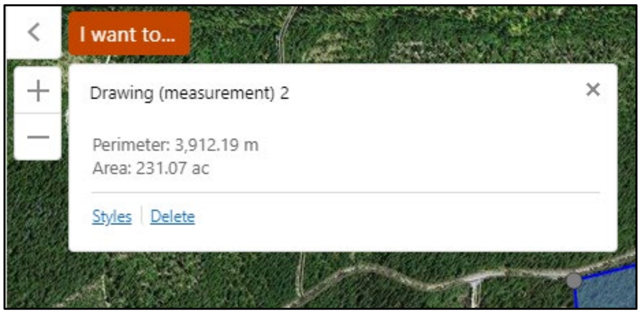


Labels - Can be removed (hidden) by using the Hide Labels tool. If this tool is no longer displayed, click on Area tool again and the Hide Labels tool once the tool bar expands.

To erase an area drawing, select the Erase tool then click on the drawing or left click on the drawing and select Delete in the popup box.

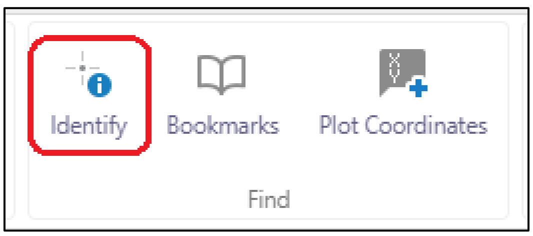
Warning: Using the <u>Clear</u> tool will eliminate all drawings made on the map.

Shading - If you want to remove the colored shading from an area shape, left click on the polygon and a popup box will appear. It may take several tries. If the popup does not appear, try left clicking on different areas of the polygon.



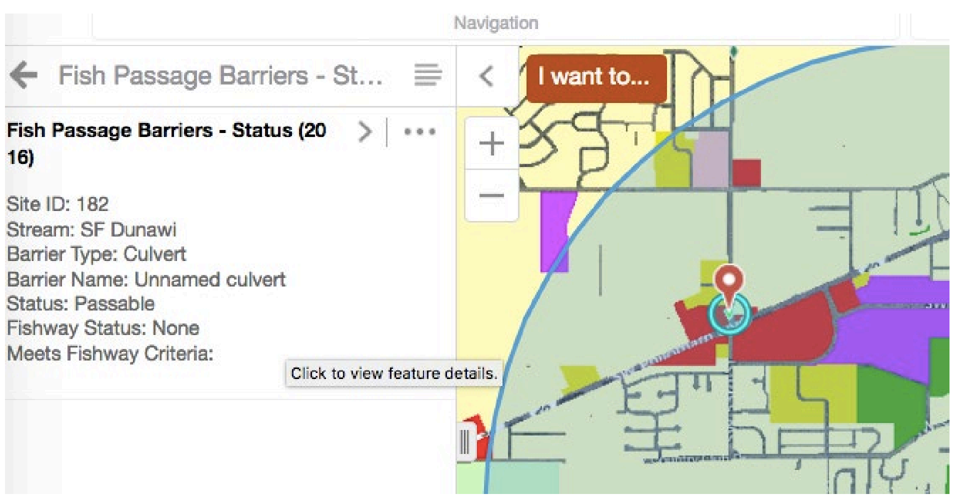
Once the popup box appears, click on Styles. In the left popup column, choose Color. Slide the bottom scale all the way to the left (0), which will be transparent.

Identify Feature



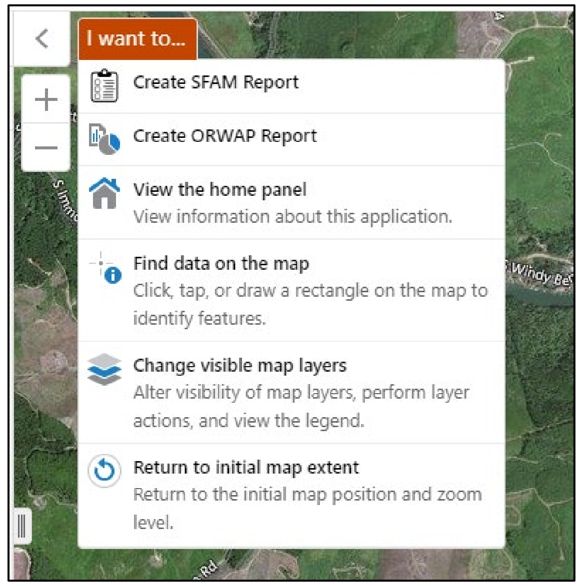
The Identify tool under the Find Tab allows users to obtain information about specific features in the map. For example, if the map is displaying a layer of point features or polygons, click on an individual point or polygon feature.

Available information or data associated with that location will appear in the left panel.



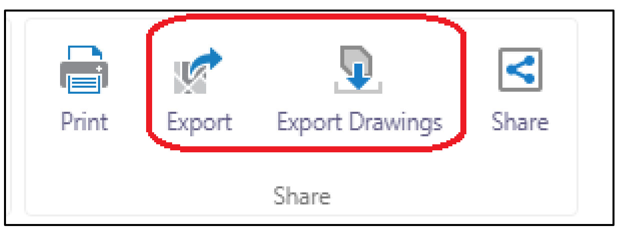
Map Viewer Shortcuts

The "I want to" Tool gives users the option to select from a suite of commonly performed tasks in the ORWAP Map Viewer such as create an ORWAP Report, identify features on the map, and return to original map extent.



Export

Users can export images (including basemaps and maps with drawn objects) from ORWAP Map Viewer using the Export and Export Drawing tools under the Create and Share tab.



Export files:

1. Click the Export button and select the preferred format for your exported file (e.g. PNG, JPEG, PDF).
2. Click "View Image" and a new tab will open in your browser. Right click the image displayed in the new tab and save it to your computer.
3. Note – the exported image will be what is currently shown in the map viewer; there is no option to outline or select the print area.

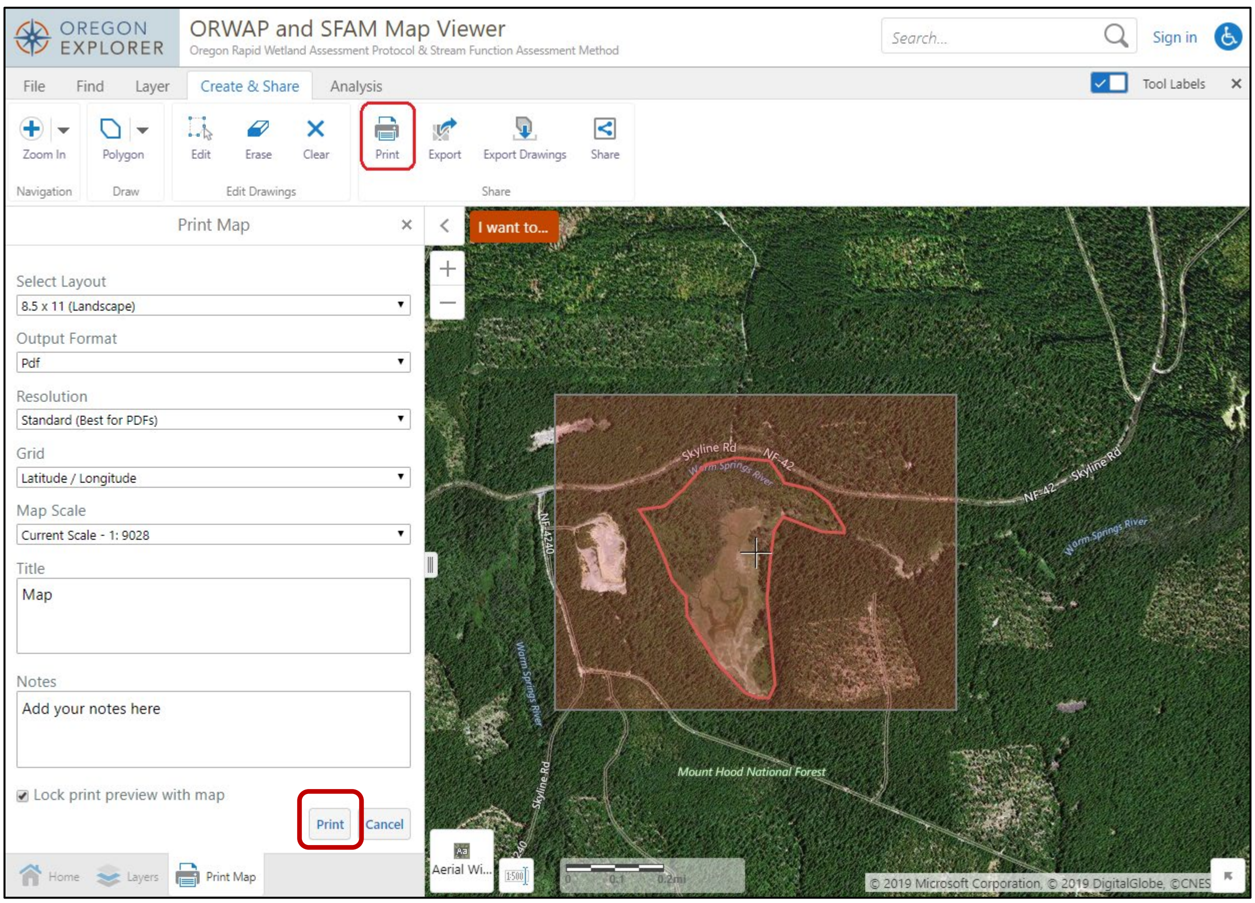
Export drawings: to export drawings as shapefiles, select the Export Drawing tool and save the .SHP file to your computer.

Print

Users can print images (including basemaps and maps with drawn objects) from the ORWAP Map Viewer using the Print tool under the Create and Share tab.

Directions:

1. Click the Print tool located under the Create and Share tab. A “print box” (transparent orange box) appears on the map viewer that previews what portion of the map will be printed. There are two ways the print box can be relocated: (1) choose a map center, right click on the chosen point, and click “Center the Map Here” on the pop-up box, or (2) uncheck the box in the sidebar labeled “Lock print preview with map.” This option locks the print box to its initial scale and location. Now the map area behind the print box can be moved by left clicking and dragging.
2. A sidebar will provide options for selecting output size, format, and resolution. Users can set the scale of the map from this sidebar, separate from the scale of the viewer.
3. Users can also add a title, latitude and longitude gridlines, and any notes about the site. This information will be included on the printed version of the map.
4. Once your selections are made, click the “Print” button located at the lower right side of the sidebar. The printable map will open in a new browser. You can download the file and print it from your computer.



Tips:

• Selecting “current extent” under Map Scale if you want to print everything shown in the current map view. You may increase the extent of the map view by narrowing the sidebar on the left.

• The printed map will include a legend for any ORWAP data layers that are selected at the time you create your map. You may want to minimize the number of layers selected so as not to have unnecessary items in the legend.

Appendix B: Additional Explanatory Indicator 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.
Arid or Semi-arid hydrologic unit	See the ORWAP Report's Hydrologic Landscape Class (under Location Information).
Bare ground	Includes unvegetated soil, rock, sand, or mud between stems if any.
Brackish or saline	Conductance of >5000 µS/cm, or >3200 ppm TDS.
Contiguous	Abutting, with no major physical separation that prohibits free exchange or flow of surface water, if any is present (i.e. not separated by roads or channels that create gaps wider than 150 ft.).
Convoluted 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.
DBH	The diameter of the tree measured at 4.5 ft above the ground.
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.
Driest time of a normal year	When the AA's surface water is at its lowest annual level.
Duff	Loose organic surface material, e.g., dead plant leaves and stems). Organic soils are much less common in floodplains.
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.
Fresh	Conductance of <500 µS/cm, or <320 ppm TDS.
Herbaceous open land	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.
Permanent	Usually having significant groundwater input, higher conductivity, and less annual water level fluctuation. No woody vegetation in most persistently flooded parts. Often with extensive open water and subsurface aquatic plants.
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.
Slightly brackish	Conductance of 500-5000 μS/cm, or 320-3200 ppm TDS.
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/Vegetated wetland	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 the Office and Field instructions in 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

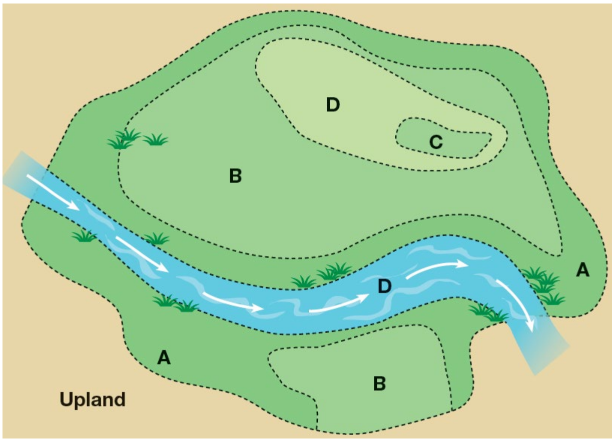
OF11 Herbaceous Open Land

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.

Field F Data Form Illustrations

F5 F6 Depth Class Predominant and 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 SubmergedAquatic 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

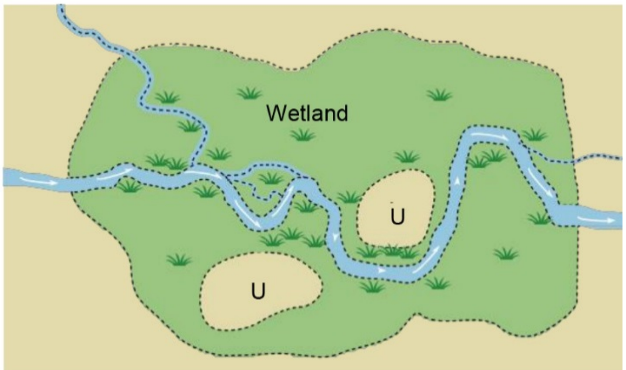
For brief periods during spring or early fall recently plowed or flooded soils in farmed wetlands provide important feeding opportunities for migratory shorebirds. Coburg, Oregon.

F31 Outflow Duration

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

A small outlet channel that carries water only seasonally.

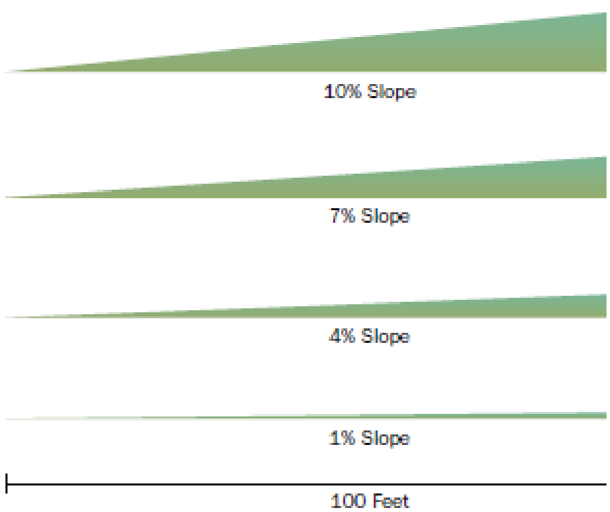
F35 Throughflow Complexity



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

F36 Internal Gradient

Assessment Area Cross Sections



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.

F48 Above water 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.

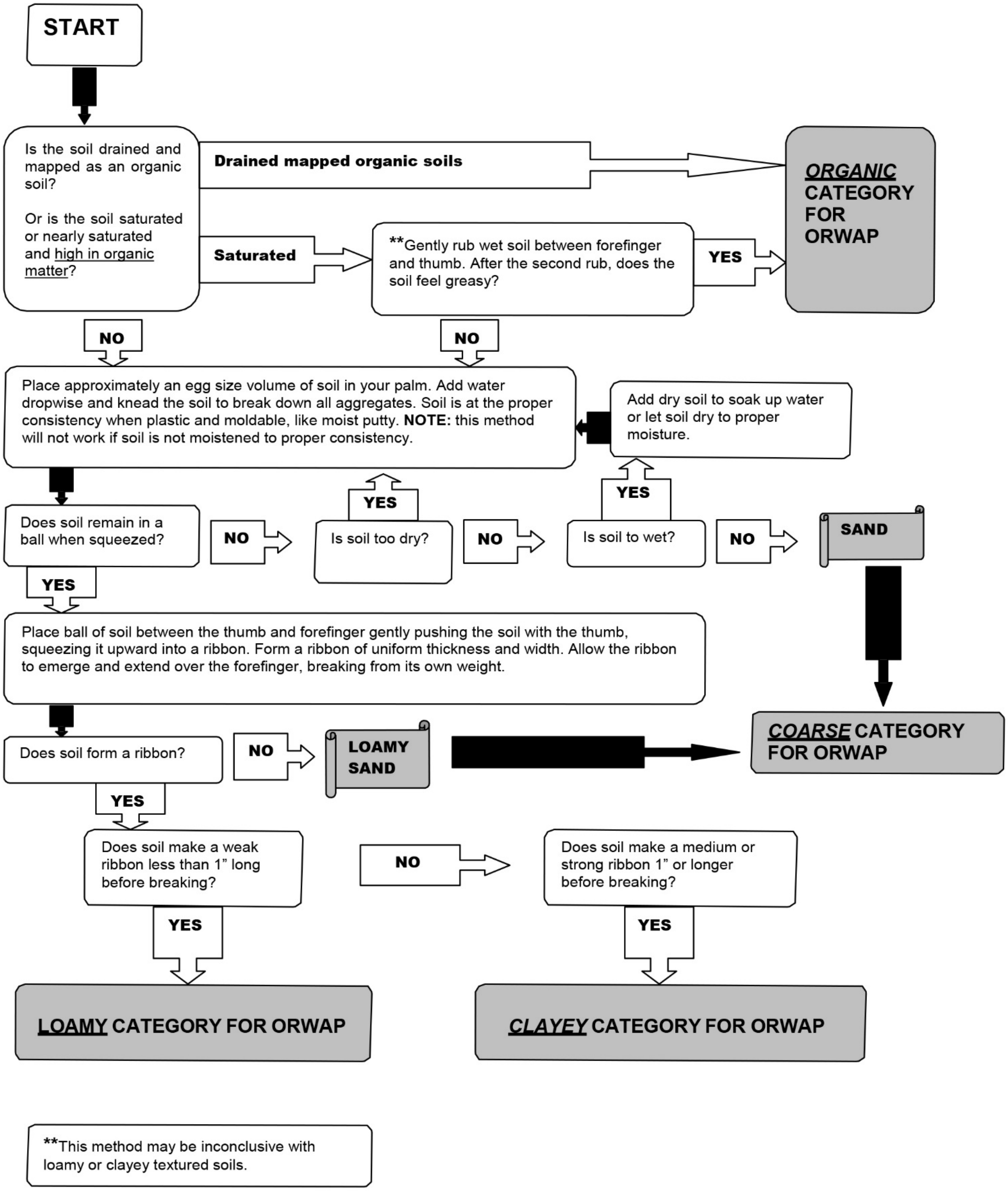
F56 Bare Ground Accumulated Plant Liner

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

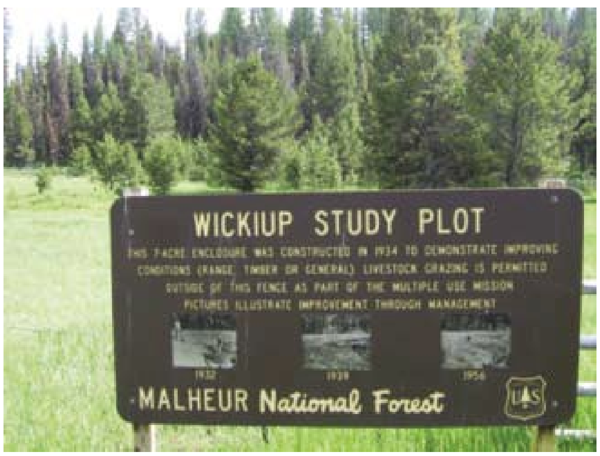
Use this flow chart to estimate the soil composition in your soil pit. Also read the explanation in Section 5.3 of this Manual.



F59 Cliffs, Banks, or Beaver

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

F65 Cliffs, Banks, or Beaver



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

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

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...

Ultramafic soil wetland

Darlintonia californica wetlands on ultramafic soil occur in northern California and southwest Oregon.

Interdunal wetland, Coos Bay, Oregon.

Interdunal Wetlands

Interdunal wetland. South Jetty, Florence, Oregon.

Interdunal wetland. Newport-South Beach, Oregon.

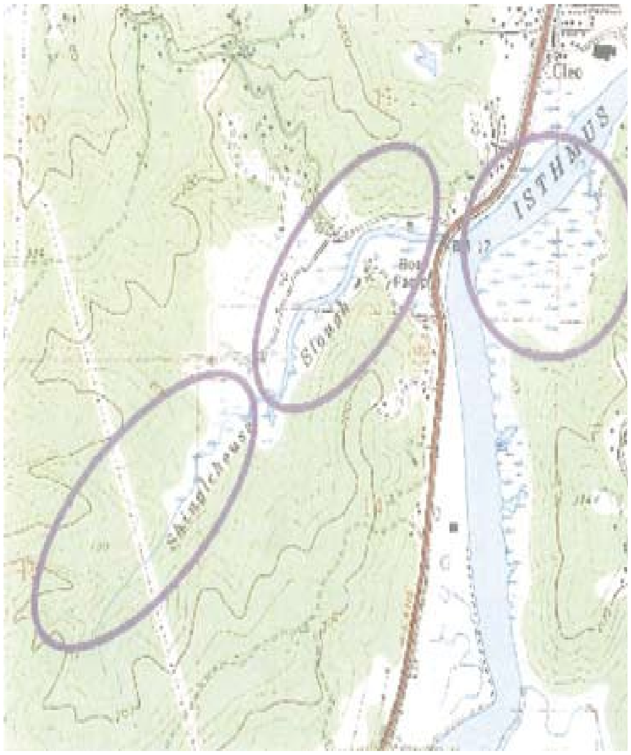
Field T Data Form Illustrations

T3 Low Marsh

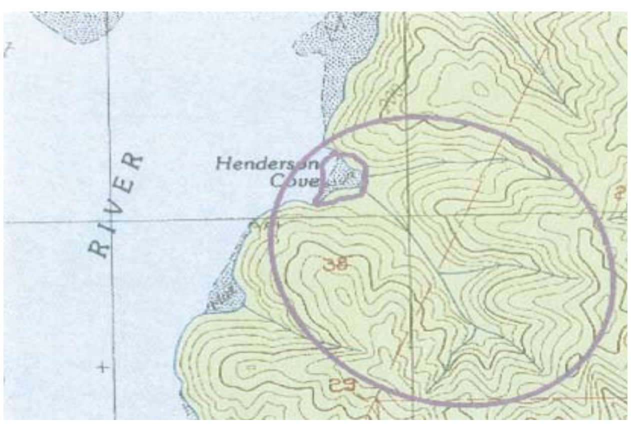
Along Siuslaw River, Cushman, Oregon.

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 questionT10, 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 sewered, 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 C: Narrative Descriptions of the ORWAP Scoring Models

WATER STORAGE AND DELAY (WS)

<u>Function Definition:</u> 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.

<u>Scientific Support for This Function in Wetlands Generally</u>: Moderate to High. Being flat areas located low in the watershed; many wetlands can slow 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

<u>Full model structure</u>: 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.

<u>Submodel structures</u>:

- *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.

<u>Approach for Future Validation</u>: 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 and 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_2O 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 interspersion 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 or if the value of Phosphorus Retention is high. 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 partly submerged large 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.

<u>Approach for Future Validation</u>: 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

<u>Structure</u>: 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)

<u>Function Definition</u>: 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.

<u>Scientific Support for This Function in Wetlands Generally</u>: 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

<u>Full model structure:</u> 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 interspersion 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 interspersion between 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 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. If the wetland is tidal, the Value score is automatically set at "0".

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 interspersion between 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 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. In tidal wetlands, visibility does not contribute to the score.

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 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 interspersion of

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 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 account 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. In tidal wetlands, visibility does not contribute to the score.

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 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 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. In tidal wetlands, the Value is automatically set to "0".

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 interspersion 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 unconstricted 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., Frolking 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. In tidal wetlands, visibility does not contribute to the score.

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Appendix D: ORWAP Relevant Map Layers and Data in the ORWAP and SFAM Map Viewer

Relevant map layers and data used to complete an ORWAP assessment are described below and are listed in alphabetical order.

DEQ Groundwater Management Areas

Data source: Oregon Department of Environmental Quality (DEQ). **Description excerpted from:** http://www.oregon.gov/deq/wq/programs/Pages/GWP-Management-Areas.aspx

This coverage displays groundwater management areas (GWMA) in Oregon, as designated by DEQ as of June 2018. GWMAs are designated when groundwater in an area has elevated contaminant concentrations resulting, at least in part, from nonpoint sources. Once the GWMA is declared, a local groundwater management committee comprised of affected and interested parties is formed. The committee then works with and advises the state agencies that are required to develop an action plan that will reduce groundwater contamination in the area. Oregon has designated three GWMAs because of elevated nitrate concentrations in groundwater. These include the Lower Umatilla Basin GWMA, the Northern Malheur County GWMA, and the Southern Willamette Valley GWMA. Each one has developed a voluntary action plan to reduce nitrate concentrations in groundwater.

Element of Occurrence Records (Rare Species)

Data source: Oregon Biodiversity Information Center (ORBIC). **Description excerpted from:** https://inr.oregonstate.edu/orbic/data-requests and Department of State Lands

INR's ORBIC maintains Oregon's most comprehensive database of rare, threatened and endangered species. This database includes site-specific information on the occurrences, biology, and status of over 2,000 species throughout Oregon. It includes the state's only database of natural vegetation, with descriptions and information on the occurrences and protected locations of all known ecosystem types.

The occurrence records are tallied using information from ORBIC's database. The ORWAP Report has 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 HUC12 watershed. A list of all wildlife species predicted to occur in the HUC12 can be viewed by clicking on the "View wildlife list" link. 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.

Essential Salmonid Habitat

Data source: Oregon Department of State Lands (DSL). **Description excerpted from:** http://chetco-new.dsl.state.or.us/esh2017/.

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 DSL, 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.

Fish Passage Barriers

Data source: Oregon Department of Fish & Wildlife (ODFW). **Description excerpted from:** https://nrimp.dfw.state.or.us/DataClearinghouse/default.aspx?p=202&XMLname=44.xml

The Oregon Fish Passage Barrier Data Standard (OFPBDS) dataset contains the locations of barriers to fish passage in Oregon watercourses. Barriers include the following types of natural or artificial structures: bridges, cascades, culverts, dams, debris jams, fords, natural falls, tide gates, and weirs. The OFPBDS dataset does not include structures which are not associated with in-stream features (such as dikes, levees or berms). Barriers are structures which do, or potentially may, impede fish movement and migration. Barriers can be known to cause complete or partial blockage to fish passage, or they can be completely passable, or they may have an unknown passage status. The OFPBDS dataset now contains over 40,000 barrier features from 19 separate sources including: ODFW, Oregon Department of Transportation, Oregon Department of Water Resources, Oregon Department of Forestry, Oregon Watershed Enhancement Board , Oregon Department of Land Conservation and Development, U.S. Bureau of Land Management, U.S. Forest Service, Nez Perce Tribe, Benton Soil and Water Conservation District, Washington County, Lower Columbia River Estuary Partnership and watershed councils representing the Rogue, Umpqua, Siuslaw, Santiam, Calapooia, Clackamas and Scappoose basins.

The OFPBDS database is the most comprehensive compilation of fish passage barrier information in Oregon however, it does NOT represent a complete and current record of every fish passage barrier within the state. Efforts to address deficiencies in data currency, completeness and accuracy are ongoing and are often limited by lack of sufficient resources. Attributes (including key attributes such as fish passage status) are often unknown or incomplete. Consistency in attribution also varies among data originators. Field verification of barrier features and their attributes will be an important component to making this dataset current, comprehensive and accurate. Fish passage status is a key attribute. Many barrier features have an unknown passage status.

Floodplain

100-year Floodplain

Data source: Oregon Department of Geology and Mineral Industries. **Description excerpted from:**
http://spatialdata.oregonexplorer.info/geoportal/details;id=f2cc36de1f0a42d29b8dfdd71721a7d3
This coverage uses a feature class called the Federal Emergency Management Agency (FEMA) Flood Insurance Study inundation zones, which were derived from Digital Flood Insurance Rate Maps and georeferenced paper Flood Insurance Rate Maps. The originator of the data for Oregon is the Oregon Department of Land Conservation and Development and Oregon Department of Geology and Mineral Industries.

Non-Regulatory Floodplain - 100-year Flood Preliminary
Data source: Federal Emergency Management Agency (FEMA). **Description excerpted from:** https://www.fema.gov/view-your-communitys-preliminary-flood-hazard-data

Preliminary data is presented as the best information available at this time and include new or revised Flood Insurance Rate Maps (FIRMs), Flood Insurance Study (FIS) reports and FIRM Databases:

Non-Regulatory Floodplain - 100-year Flood Digitized
Data source: Oregon Department of Land Conservation and Development (DLCD).
Description excerpted from:
https://oe.oregonexplorer.info/externalcontent/metadata/FEMA_FLD_HAZ_digitzed.xml

Digital representation of flood zones currently shown on FEMA paper maps with minor modifications added by DLCD in order to more accurately reflect current topography and stream reaches. This data cannot be used for regulatory purposes. The FEMA Q3 data is a digital version of existing FEMA FI RM maps. However, it is generally inaccurate because it was created on poor topography source data and needs revision because of the overall age of the data. The digital Q3 flood data are designed to provide guidance and a general proximity of the location of 100 -year floodplain. (DOGAMI, 2016)

HUC Best
Data source: Oregon Biodiversity Information Center (ORBIC). **Description excerpted from:** https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam ORWAP Report tool.

Oregon Watersheds (HUC8, HUC10, HUC12) with greatest type diversity, proportional area, or density of wetlands according to available National Wetland Inventory Maps.
The three metrics listed below can be strongly correlated with watershed size and with each other. To minimize that bias, the rankings of the residuals from a regression analysis were used, rather than simply the top-ranking watersheds, to identify the most "important" watersheds for each metric at each scale. That is, the watersheds were identified that were in the top 5% in terms of variety of mapped wetland types for watersheds of that size, the largest area of mapped wetlands as a proportion of the watershed area for watersheds of that size, and/or the greatest number of mapped wetland polygons for watersheds with that much wetland area. The digital maps used to determine this do not show many wetlands or cover the entire state. Data were compiled only from watersheds that have been at least 90% mapped by NWI (see worksheets for HUC8, 10, and 12). Data were received in November 2008 from ORBIC.

- "Type diversity" is the number of unique NWI codes in the watershed (e.g., PEMA, PEMC, PEMCx) and excluded types that have no vegetation component (e.g., PUBH, R3US2).
- "Density" is the number of vegetated NWI polygons divided by the acreage of the watershed; many of these polygons may be contiguous with each other, forming a single wetland.
- "Proportional Area" is the proportion of the watershed's total area occupied by vegetated wetlands as mapped by NWI.

Hydric Soils
Data source: Department of State Lands. **Description excerpted from:** https://www.arcgis.com/home/item.html?id=26b203bf50d141ab8eac611b1c59ad80.

Predominately Hydric Soil Map Units: This layer was created from STASTGO soil layer, and only consist of approximately 22 000 records from the entire 350,000 record dataset. This dataset is only interested in those percent hydric soils values of > 50 %.
Agate-Winlo Soil, Jackson County: The Agate-Winlo complex is about 55% Agate soils and 35% Winlo soil. The soils occur as patterned land with the areas of Winlo soil (somewhat poorly drained and shallow to a hardpan) between and around areas of the Agate soil (well drained and moderately deep to a hardpan), which are on circular mounds. In the Winlo soil, depth to hardpan is 7 to 15 inches, permeability is slow, and effective rooting depth is only down to the hardpan. Runoff is ponded and the water table fluctuates between 0.5 foot above and 0.5 foot below the surface from December through April.

Hydrologic Landscapes

Data source: U.S. EPA Office of Research and Development (ORD**). Description excerpted from:** https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=orwap_sfam and https://lib-gis2.library.oregonstate.edu/arcgis/rest/services/sfam_orwap/sfam_and_orwap/MapServer/48

The five-letter hydrologic landscape code representing five indices of hydrologic form that are related to hydrologic function: climate, seasonality, aquifer permeability, terrain, and soil permeability. Each hydrologic assessment unit is classified by one of the 81 different five-letter codes representing these indices. Polygon features in this dataset were created by aggregating (dissolving boundaries between) adjacent, similarly coded hydrologic assessment units. Climate Classes: V-Very wet, W-Wet, M-Moist, D-Dry, S-Semiarid, A-Arid. Seasonality Sub-Classes: w-Fall or winter, s-Spring. Aquifer Permeability Classes: H-High, L-Low. Terrain Classes: M-Mountain, T-Transitional, F-Flat. Soil Permeability Classes: H-High, L-Low.

This dataset updates the Wigington et al. (2013) hydrologic landscape (HL) approach for Oregon to make it more broadly applicable and applies the revised approach to the Pacific Northwest (PNW) (i.e., Oregon, Washington, and Idaho). Specific changes incorporated are the use of assessment units based on National Hydrography Dataset Plus V2 catchments, a modified snowmelt model validated over a broader area, an aquifer permeability index that does not require preexisting aquifer permeability maps, and aquifer and soil permeability classes based on uniform criteria. Polygon features in this dataset were created by aggregating (dissolving boundaries between) adjacent, similarly coded hydrologic assessment units.

HUC12 Functional Deficit

Data source: Department of State Lands. **Description excerpted from:**
https://www.oregon.gov/dsl/WW/Documents/ORWAP_Technical_Supplement_v3_2.pdf

The HUC12 Functional Deficit data in the ORWAP report is pulled from a worksheet in the ORWAP3.2_SuppInfo file that ORWAP's author used to identify -- for every Oregon watershed (12-digit HUC) -- the wetland functions that appear to be deficient in that watershed. If a watershed is considered “deficient” in a given function, the ORWAP spreadsheet potentially increases the *value* score for any wetland in that watershed which ORWAP determines may have that function. See ORWAP Technical Supplement V.3.2, section 1.2.4 to read how "Deficient" was determined.

Important Bird Areas

Data source: Audubon Society of Portland. **Description excerpted from:** http://audubonportland.org/local-birding/iba and http://oe.oregonexplorer.info/ExternalContent/ORWAP/metadata/IBA_2013_metadata.xml
This coverage contains boundaries and associated attributes for Important Bird Areas (IBA) identified as of May 2013. An IBA is a site that has been selected for its outstanding habitat value and imperative role it plays in hosting birds, whether for breeding, migrating, or over-wintering. The IBA designation is internationally recognized. State-level IBAs are nominated through a public process and reviewed by a Technical Advisory Committee. The boundaries should not be perceived as absolute, definitive boundaries. Rather, the boundaries should be considered approximates of the critical habitat areas. There are four specific scientific criteria to be considered as a guideline for the IBA program (in-depth descriptions can be found at http://audubonportland.org/local-birding/iba/selection-criteria):

1. Sites important to endangered/threatened species or species of special concern.
2. Sites important to species of high conservation priority (which includes species identified as high conservation priorities by Partners in Flight and identified in any bird conservation plan or agency list relative to the area in question).
3. Sites that are representative of rare or threatened natural communities.
4. Sites where significant numbers of birds concentrate for breeding, during migration, or in the non-breeding season.

Local Wetlands Inventory Subset

Data source: Oregon Department of State Lands. **Description excerpted from:** The Local Wetlands Inventory Subset data description.

The Local Wetland Inventory Subset (2019) is a dataset pulled from the Local Wetlands Inventory (LWI) geodatabase developed in 2019 by the Department of State Lands (DSL), Institute for Natural Resources (INR), and Oregon State University Libraries and Press. The LWI geodatabase is a standardized dataset comprised of Local Wetlands Inventories received and approved by DSL dating from 1992. The geodatabase was developed for inclusion into the Statewide Wetlands Inventory (SWI) geospatial database compiled and maintained by DSL.

National Hydrography Dataset

Data source: U.S. Geological Survey (USGS). **Description excerpted from:** https://nhd.usgs.gov/NHD_High_Resolution.html.

The National Hydrography Dataset (NHD) represents the nation's drainage networks and related features, including rivers, streams, canals, lakes, ponds, glaciers, coastlines, dams, and stream gages. The NHD High Resolution, at 1:24,000 scale or better, is the most up-to-date and detailed hydrography dataset for the nation.

Oregon's Greatest Wetlands

Data source: The Wetlands Conservancy. **Description excerpted from:** https://spatialdata.oregonexplorer.info/osdl-geoportal/rest/document?id=%7B1D70E066-8A80-4B5F-A4A4-C5492A05168A%7D

Identifies the most biologically and ecologically significant wetlands in the State of Oregon. Oregon's Greatest Wetlands (2015) refined the OGW 2005 database. Geometries were improved to better identify the targets. Attributes were added, including a succinct narrative describing the wetland's significance. Several wetlands were removed, and several were added based on information gained since 2005.Oregon's Greatest Wetlands were identified in a top-down manner, with wetland experts from throughout Oregon identifying the most significant wetlands.

Presettlement Vegetation Class

Data source: Oregon Biodiversity Information Center (ORBIC). **Description excerpted from:** https://lib-gis1.library.oregonstate.edu/arcgis/rest/services/oreall/oreall_hab_veg/MapServer/18.

A grid presenting the historical (pre-settlement) distribution of ecological systems, as defined by NatureServe.

Rare Species Scores

Data source: Institute for Natural Resources and the Oregon Biodiversity Information Center (ORBIC). **Description excerpted from:** Institute of Natural Resources, 2018 and https://inr.oregonstate.edu/orbic/rare-species/ranking-systems.

Rare species scores and ratings are determined for seven categories of species (non-anadromous fish, amphibians and reptiles, feeding waterbirds, nesting waterbirds, songbirds/raptors/mammals, invertebrates, and plants). Rare species scores take into account several factors for each rare species record contained in the official database of the ORBIC: (a) the regional rarity of the species, (b) their proximity to the point of interest, and (c) the “certainty” that ORBIC assigns to each of those records.

The formula for determining a score is C * [(U + D)/2] where:

- C= conservation status of the Element of Occurrence (EO) species with points assigned as follows: S1= 1.0, S2= 0.6, S3= 0.4, Oregon Department of Fish and Wildlife Strategy Species = 0.1
- U= uncertainty of the particular record’s location with points assigned as follows: High Certainty = 1.0, Moderate = 0.5, Low = 0.1
- D= zonal distance of the Element of Occurrence (EO) from the entered coordinates within 100m or within the same mapped wetland that the coordinates hit = 1.0within 1 mile = 0.5within same HUC6 but not within 1 mile = 0.1

Within each rare species category, this formula is applied to each EO record “on the fly” at the project area defined by the user, and then the sum, mean, and maximum for all EO records in that group around that point are reported (Institute for Natural Resources, 2018).

Maximum and sum scores are then used to assign the rankings for each group. ORBIC participates in an international system for ranking rare, threatened and endangered species throughout the world. The system was developed by The Nature Conservancy and is now maintained by NatureServe in cooperation with Heritage Programs or Conservation Data Centers (CDCs) in all 50 states.

The ranking is a 1-5 scale and is primarily based on the number of known occurrences, but also including threats, sensitivity, area occupied, and other biological factors. State rankings begin with the letter “S.” The rankings are summarized as follows:

> 1 = Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences.

2 = Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6-20 occurrences.

3 = Rare, uncommon or threatened, but not immediately imperiled, typically with 21-100 occurrences.

4 = Not rare and apparently secure, but with cause for long-term concern, usually with more than 100 occurrences.

5 = Demonstrably widespread, abundant, and secure.

H = Historical Occurrence, formerly part of the native biota with the implied expectation that it may be rediscovered.

X = Presumed extirpated or extinct.

U = Unknown rank.

? = Not yet ranked or assigned rank is uncertain.

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 be present.

Special Protected Area
Data source: US Geological Survey (USGS). **Description excerpted from:** https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/protected-areas and https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/pad-us-data-web-services?qt-science_center_objects=0#qt-science_center_objects.

The Protected Areas Database of the United States (PAD-US 2.0) is a geodatabase, managed by USGS Gap Analysis Project (GAP). PAD-US is the nation's inventory of protected areas, including public land and voluntarily provided private protected areas, identified as an A-16 National Geospatial Data Asset in the Cadastre Theme. The PAD-US is an ongoing project with several published versions of a spatial database including areas dedicated to the preservation of biological diversity, and other natural (including extraction), recreational, or cultural uses, managed for these purposes through legal or other effective means. The database was originally designed to support biodiversity assessments; however, its scope expanded in recent years to include all public and nonprofit lands and waters.

Protection Status by GAP Status Code indicates a measure of management intent to permanently protect biodiversity. GAP Status 1 & 2 areas are primarily managed for biodiversity, GAP Status 3 areas are managed for multiple uses including conservation and extraction, and GAP Status 4 areas have no known mandate for biodiversity protection. The ORWAP Report only draws information from GAP Status Code 1 and 2.

Surface Water & Groundwater Drinking Water Source Areas
Data source: Oregon Department of Environmental Quality (DEQ) and Oregon Health Authority (OHA). **Description excerpted from:** http://spatialdata.oregonexplorer.info/osdl-geoportal/rest/document?id=%7BBD6FD933-A183-4A4C-8314-AF1FC4613CB7%7D and

http://spatialdata.oregonexplorer.info/osdl-geoportal/rest/document?id=%7B6A1EC8DD-8B68-4483-8CC5-01C57B6A2C27%7D.

Surface Water: This map includes DEQ and OHA Drinking Water Program Source Water Assessment results for community and non-transient non-community public water systems for surface water systems that were active in June 1999 (when Oregon's Source Water Assessment Plan was approved by EPA). Subsequently, post-1999 systems have been added including some non-community systems. This layer was developed in order to spatially reference the watersheds that supply drinking water to surface water intakes for Public Water Systems (PWS) within the state of Oregon. Source water assessments were completed for these PWS's in accordance with the 1996 Amendments to the Safe Drinking Water Act and Oregon's 1999 Source Water Assessment Plan. The original list of PWSs was generated in 1999, however additional PWSs may be added in the future. These source areas should be used in conjunction with the locations of potential contaminant source threats as well as mapped sensitive areas to provide an overall picture of the susceptibility of the drinking water system.

These data are for community (C) and non-transient non-community (NTNC) public water systems only. Data were compiled in a cooperative effort between DEQ/Water Quality Division, Drinking Water Protection Program and OHA/Drinking Water Program. A community PWS regularly serves at least 25 year-round residents or serves at least 15 service connections used by year-round residents. A non-transient non-community PWS is not a community PWS and regularly serves at least 25 of the same people over 6 months per year (for example, work sites and schools). Source Water Assessment results for 1,100 public water systems serving approximately 2,360,000 Oregonians are included in this data set. Source Water Assessment results for transient non-community systems (NC) (a PWS that does not regularly serve at least 25 of the same people over 6 months per year (i.e. rest areas, campgrounds) are not included in these data. Information on private water supplies was not collected as part of the Source Water Assessment project. For surface water, the drinking water source area is defined as the geographic area (watershed) that supplies the water body where the intake is located. Surface water source areas were delineated intake to intake. For watersheds with more than one intake, Oregon reported source water assessments results by watershed segment representing the area from the public water system's intake to the next intake upstream. All source areas upstream of a specific water system's intake are included in the drinking water source area for that water system and PWSs are encouraged to work with other water providers and other entities within the subbasin as they move forward with developing protection strategies.

Groundwater: These polygons were developed to spatially reference source areas that supply drinking water to groundwater wells or springs for PWSs within the state of Oregon. Source water assessments were completed for these PWS's in accordance with the 1996 Amendments to the Safe Drinking Water Act and Oregon's 1999 Source Water Assessment Plan. The original list of PWSs was generated in 1999, however additional PWSs will be added in the future. PWSs whose status changed to community or non-transient non-community since the 1999 list was generated may not be included or may be added as updates are performed; PWSs that have become inactive may be deleted. These source areas are to be used in conjunction with the locations of potential contaminant source threats as well as mapped sensitive areas to provide an overall picture of the susceptibility of the drinking water system.

Sole Source Aquifers

Data source: U.S. Environmental Protection Agency (EPA). **Description excerpted from:** https://catalog.data.gov/harvest/object/05efabd4-ee92-43b2-b51f-f45d666cba4b/html.

This coverage displays sole source aquifers in Oregon, as designated under the National Environmental Policy Act as of October 2016. The Sole Source Aquifer protection program is authorized by section 1424(e) of the Safe Drinking Water Act of 1974 (Public Law 93-523, 42 U.S.C. 300 et seq.). This program is designed to protect drinking water supplies in areas with few or no alternative sources to the ground water resource, and where, if contamination occurred, using an alternative source would be extremely expensive. EPA defines a sole or principal source aquifer as an aquifer that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. These areas may have no alternative drinking water source(s) that could physically, legally and economically supply all those who depend on the aquifer for drinking water. For convenience, all designated sole or principal source aquifers are referred to as "sole source aquifers. The designation protects an area's ground water resource by requiring EPA to review certain proposed projects within the designated area.

Springs

Data source: Geographic Names Information System (GNIS) and the National Hydrography Dataset (NHD). **Description excerpted from:** https://lib-gis2.library.oregonstate.edu/arcgis/rest/services/sfam_orwap/sfam_and_orwap/MapServer/10 and https://lib-gis2.library.oregonstate.edu/arcgis/rest/services/sfam_orwap/sfam_and_orwap/MapServer/9.

GNIS: The dataset was modified from a GNIS dataset by PSU-CSAR for inclusion in the OR-IRIS geodatabase. The GNIS source data were filtered to include only named springs that do not also appear in the National Hydrography Dataset (NHD) NHDPoint feature class.

NHD: The National Hydrography Dataset (NHD) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. This high-resolution NHD, generally developed at 1:24,000/1:12,000 scale, adds detail to the original 1:100,000-scale NHD. (Data for Alaska, Puerto Rico and the Virgin Islands was developed at high-resolution, not 1:100,000 scale.) Local resolution NHD is being developed where partners and data exist. The NHD contains reach codes for networked features, flow direction, names, and centerline representations for areal water bodies. Reaches are also defined on waterbodies and the approximate shorelines of the Great Lakes, the Atlantic and Pacific Oceans and the Gulf of Mexico. The NHD also incorporates the National Spatial Data Infrastructure framework criteria established by the Federal Geographic Data Committee.

Watershed Boundary Dataset

Data source: U.S. Geological Survey (USGS). **Description excerpted from:** https://nhd.usgs.gov/wbd.html.

The Watershed Boundary Dataset (WBD) defines the areal extent of surface water drainage to a point, accounting for all land and surface areas. Watershed boundaries are determined solely upon science-based hydrologic principles, not favoring any administrative boundaries or special projects, nor any program or agency. The intent of defining Hydrologic Units (HU) for the WBD is to establish a base-line drainage boundary framework, accounting for all land and surface areas. At a minimum, the WBD is being delineated and georeferenced to the USGS 1:24,000 scale topographic base map meeting National Map Accuracy Standards. HUs are given a Hydrologic Unit Code.

A HU is a drainage area delineated to nest in a multi-level, hierarchical drainage system. Its boundaries are defined by hydrographic and topographic criteria that delineate an area of land upstream from a specific point on a river, stream, or on similar surface waters. A HU can accept surface water directly from upstream drainage areas, and indirectly from associated surface areas such as remnant, non-contributing, and diversions to form a drainage area with single or multiple outlet points. HUs are only synonymous with classic watersheds when their boundaries include all the source area contributing surface water to a single defined outlet point.

Water Quality (Lakes & Streams)

Data source: Oregon Department of Environmental Quality (DEQ). **Description excerpted from:** http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp.

This feature contains a spatial representation of streams and stream segments with water quality information from Oregon's 2012 Integrated Report Assessment Database and 303(d) List. The Integrated Report Assessment Database contains information on water quality in Oregon's surface waters and includes waters identified as water quality limited that need Total Maximum Daily Loads (Category 5: Section 303(d) List). A water body may have assessment information for multiple pollutants or conditions and may have multiple data records associated with the spatial representation of the water body or segment of the water body. Oregon's 2012 Integrated Report Assessment Database and 303(d) List are available on-line at http://www.deq.state.or.us/wq/assessment/rpt2012/search.asp. The on-line searchable database is the reference source to verify all attribute information about water quality and to obtain assessment information about water bodies that do not have georeferenced locations.

Zoning

Data source: Oregon Department of Land Conservation and Development (DLCD).
Description excerpted from:
http://spatialdata.oregonexplorer.info/geoportal/details;id=9966f34d71e74bd5a91e0d2757c91ebf.

As of April 28, 2017, this feature class contains zoning data from 198 local jurisdictions. DLCD plans to continue adding to and updating this statewide zoning dataset as they receive zoning information from the local jurisdictions. Jurisdictions included in the latest version of the statewide zoning geodatabase:

> **Cities:** Adams, Adrian, Albany, Amity, Antelope, Ashland, Astoria, Athena, Banks, Barlow, Bay City, Beaverton, Bend, Bonanza, Brookings, Brownsville, Burns, Butte Falls, Canby, Cannon Beach, Carlton, Cascade Locks, Cave Junction, Central Point, Chiloquin, Coburg, Columbia City, Coos Bay, Cornelius, Corvallis, Cottage Grove, Creswell, Culver, Damascus, Dayton, Detroit, Donald, Dufur, Dundee, Dunes City, Eagle Point, Echo, Estacada, Eugene, Fairview, Falls City, Florence, Forest Grove, Garibaldi, Gates, Gearhart, Gervais, Gladstone, Gold Beach, Gold Hill, Grants Pass, Grass Valley, Halsey, Happy Valley, Harrisburg, Helix, Hermiston, Hillsboro, Hines, Hood River, Hubbard, Idanha, Independence, Jacksonville, Jefferson, Johnson City, Jordan Valley, Junction City, Keizer, King City, Klamath Falls, La Pine, Lafayette, Lake Oswego, Lebanon, Lincoln City, Lowell, Lyons, Madras, Malin, Manzanita, Maupin, Maywood Park, McMinnville, Medford, Merrill, Metolius, Mill City, Millersburg, Milton-Freewater, Milwaukie, Molalla, Monmouth, Moro, Mosier, Mt. Angel, Myrtle Creek, Nehalem,

Newberg, Newport, North Bend, North Plains, Nyssa, Oakridge, Ontario, Oregon City, Philomath, Phoenix, Pilot Rock, Portland, Port Orford, Prineville, Redmond, Reedsport, Rivergrove, Rockaway Beach, Rogue River, Rufus, Salem, Scappoose, Scio, Scotts Mills, Seaside, Shady Cove, Shaniko, Sheridan, Sherwood, Silverton, Sisters, Sodaville, Springfield, Stanfield, St. Helens, Stayton, Sublimity, Sweet Home, Talent, Tangent, The Dalles, Tigard, Tillamook, Troutdale, Tualatin, Turner, Ukiha, Umatilla, Vale, Veneta, Vernonia, Warrenton, Wasco, Waterloo, West Linn, Westfir, Weston, Wheeler, Willamina, Wilsonville, Winston, Wood Village, Woodburn, Yamhill.
Counties: Baker County, Benton County, Clackamas County, Clatsop County, Columbia County, Coos County, Crook County, Curry County, Deschutes County, Douglas County, Harney County, Hood River County, Jackson County, Jefferson County, Josephine County, Klamath County, Lane County, Lincoln County, Linn County, Malheur County, Marion County, Multnomah County, Polk County, Sherman County, Tillamook County, Umatilla County, Union County, Wasco County, Washington County, Wheeler County, Yamhill County.

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Appendix F: Guidance for Using ORWAP V.3.2 in the State and Federal Permit Programs

Guidance for Using the Oregon Rapid Wetland Assessment Protocol (ORWAP) in the State and Federal Permit Programs

Updated April 2020
For use with ORWAP version 3.2

OREGON DEPARTMENT OF STATE LANDS

US Army Corps of Engineers® Portland District

Table of Contents

1. Using This Guide

The purpose of this guide is to provide guidance to Oregon removal-fill permit and Department of the Army permit applicants, consultants and regulatory staff for using the Oregon Rapid Wetland Assessment Protocol (ORWAP) v3.2 to further state and federal wetland regulatory objectives. 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, eligibility, and accounting; and, 3) presenting assessment results in the Joint Permit Application (JPA). This document is not intended to supplant Oregon Revised Statutes, Oregon Administrative Law, Clean Water Act (33 USC 1251 et seq.), or the Rivers and Harbors Act (33 USC 403); all applicable laws and rules still apply.

> **User Note**: In several places throughout this document, it is stated that DSL requires the submittal of specific information or the use of specific methodologies per Oregon Administrative Rules. The Corps of Engineers does not require the use of a specific assessment method; however, the use of ORWAP is recommended and may be requested to aid in application review. Specific mitigation-related requirements can be obtained at 33 CFR Part 332. http://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/Federal-Regulation/

This guide cannot anticipate every situation or contingency that may arise in the wetland regulatory programs; therefore, users are encouraged to consult with a Department of State Lands' (DSL) aquatic resource coordinator and U.S. Army Corps of Engineers' (Corps) regulatory project manager if there are any questions. The reader is cautioned to consult agencies' regulations first, and to rely on this guidance only as a guide to understanding those regulations. This guide should be used in conjunction with:

- "Manual for the Oregon Rapid Wetland Assessment Protocol V.3.2" (ORWAP Manual) and accompanying electronic files (wetland calculator spreadsheet)
- Technical Supplement: Procedures Used to Refine, Re-calibrate and Test ORWAP version 3.2
- Oregon Administrative Rule (OAR) 141-085-0680, *et seq*. (Compensatory Mitigation for Wetlands and Tidal Waters)
- Oregon Revised Statute (ORS), 196.800 *et seq.*
- Section 404 of the Clean Water Act
- Section 10 of the Rivers and Harbors Act
- U.S. Army Corps of Engineers, 33 CFR Part 332, U.S. Environmental Protection Agency, 40 CFR 230 (Compensatory Mitigation for Losses of Aquatic Resources; Final Rule)

2. Delimiting the Assessment Area for Regulatory Uses of ORWAP

Repeatable assessment of a wetland using ORWAP depends greatly upon correctly delimiting the assessment area. The ORWAP Manual generally instructs users to include the entirety of the wetland when determining the assessment area. However, in the regulatory setting, it may not be possible or practical to do so for reasons such as: the proposed impact[3] area may only be a small part of a large wetland, the characteristics of the proposed impact site may not be representative of the whole wetland (e.g., be of substantially different condition), or large portions of the wetland may be inaccessible. Therefore, for regulatory uses of ORWAP, the following additional guidance is offered:

- **If the proposed project impact or mitigation area is the entirety of the wetland**, then the assessment area should be defined as the whole wetland using the standard assessment area delimiting guidance provided in the ORWAP Manual. Normally, only one set of scores should be calculated for the entire wetland, regardless of the number of vegetation types, HGM classes, tax lots, or other factors.

- **If the proposed project impact or mitigation area is less than the entire wetland**, then the assessment area may be defined based on the study area boundary identified in the wetland delineation report. However, if any additional wetland area, whether in or out of the study area, could be adversely affected by the proposed project (for example, any off-site wetland area that may be hydrologically altered by the proposed project), then that additional area should be included as part of the wetland assessment. Most ORWAP indicator questions can be answered considering a limited assessment area. However, the following ORWAP indicator questions (Table 1) must still be answered considering the entire wetland using the standard assessment area delimiting guidance provided in the ORWAP Manual. These indicator questions are denoted in the ORWAP office form "OF" and field forms "F" and "T" with a "**W**" in column D.

Table 1. Indicators That Must be Applied Considering Entire Wetland

Office Form "OF"		Field Form "F" or "T"	
OF35	Runoff Contributing Area (RCA) - wetland as % of RCA	F7/T21	Emergent Plants - Area
OF36	Unvegetated % in the RCA	F13	Ponded Open Water Area - Wettest
OF37	Transport from Upslope	F17	Ponded Open Water Area - Driest
OF39	Streamflow Contributing Area (SCA)- wetland as % of SCA	F31/T7	Outflow Duration
OF40	Unvegetated % in the SCA	F32/T8	Outflow Confinement
OF41	Upland Edge Shape Complexity	F72	Wetland Type of Conservation Concern

[3] As used herein, the term "impact" means any reasonably expected adverse effect at the project site or mitigation site.

- **If the proposed project impact or mitigation area includes more than one wetland**, then all wetlands may be included in a single assessment area or multiple assessment areas, if all the following are true for each assessment area:

    1) they have the same predominant hydrology source;
    2) they have a similar degree of disturbance;
    3) they contain the same predominant mapped soil series; and,
    4) they have similar abutting land uses.

    There are limits to this approach for very large projects and linear projects; DSL and Corps staff should be consulted on assessment area determinations in these cases. If all the above are not true, a separate assessment of each affected wetland will be necessary.

In all other regards, ORWAP practitioners should defer to the ORWAP Manual for instructions on how to complete the office and field portions of the assessment. DSL and Corps staff should be consulted if there is any question regarding selection of the proper assessment area. DSL and the Corps retain final decision authority for assessment area determination for their respective permitting authorities.

3. Regulatory Uses of ORWAP

ORWAP can inform many aspects of the wetland regulatory programs. Table 2 provides a summary of which ORWAP outputs are generally the most relevant to which elements of the wetland regulatory programs. Each regulatory use is described, in turn, thereafter.

Table 2. Regulatory Uses of ORWAP Outputs

<table>
<tr><th colspan="2">Regulatory Use</th><th>Function</th><th>Value</th><th>Ecological Condition</th><th>Stressors</th><th>Sensitivity</th></tr>
<tr><td colspan="2">3.1. Alternatives analysis for avoidance & minimization</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td></tr>
<tr><td rowspan="2">3.2. CWM scoping</td><td>3.2.1 Site selection</td><td>X</td><td>X</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>3.2.2 Site design</td><td>X</td><td>X</td><td></td><td>X</td><td></td></tr>
<tr><td colspan="2">3.3. CWM Eligibility and Accounting</td><td>X</td><td>X</td><td></td><td></td><td></td></tr>
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<tr><td colspan="2">Verify replacement</td><td>X</td><td>X</td><td></td><td></td><td></td></tr>
</table>

3.1 The Alternatives Analysis

Assessment of wetlands on alternative sites and/or all wetlands within the proposed project site, while not mandatory in the regulatory setting, can provide valuable information for the alternatives analysis. ORWAP allows us to consider factors beyond just acreage when determining where and to what extent alternatives with lesser, or no, wetland impact should be pursued.

- **Consider function and value**. Greater emphasis should be placed on minimizing impact to wetlands that have both "higher" function and associated "higher" value ratings. Such wetlands are relatively effective in performing the given function in a location that has the opportunity to do so and where that function has local significance. This can be a good indicator of the local importance of the wetland.

- **Consider the ecological condition.** Greater emphasis should be placed on minimizing impacts to wetlands with a "higher" condition rating (that is, wetlands of relatively good health and/or intactness, as indicated most commonly by their dominantly native plant communities).

- **Consider sensitivity**. Greater emphasis should be placed on avoidance and minimization opportunities for wetlands that have a "higher" sensitivity rating in conjunction with "higher" function and associated value ratings. These wetlands may suffer adverse effects to functions disproportionately large to the scale of the impact. This consideration generally applies when the wetland extends beyond, and may be adversely affected by, the proposed project.

3.2 Scoping Compensatory Wetland Mitigation (CWM)

The following considerations should be made when the applicant may be evaluating multiple CWM sites and may also be useful to prospective bankers and in-lieu fee project proponents. The use of ORWAP in this capacity is not required. However, when being used in this capacity, it may not be necessary to perform the entire ORWAP assessment. Familiarity with the ORWAP indicators for functions and values may be sufficient to allow for a quick review of various CWM sites' characteristics to determine which option provides the best opportunity to replace functions and values lost at the proposed impact site.

3.2.1 Site Selection Assistance

- **Consider functions.** Is the proposed CWM site in a landscape position appropriate to restore, create or enhance the functions sought? Refer to the indicators for the sought functions and assess whether the site and its landscape position have the potential to sustainably improve or create those characteristics.

- **Consider values.** Wetland values at the proposed impact site can be used to help guide CWM site selection. For example, consideration of on-site or near-site mitigation opportunities should be emphasized where there are highly valued wetland functions being impacted. Also, the opportunity for a wetland to provide functions depends largely on spatial context, i.e., the wetland's landscape position. For example:

  - If water storage is a target function, then replacing or maintaining this function is more likely to be successful if mitigation sites are located upgradient of (or higher in the watershed than) the impact site.
  - If nitrate removal is a target function, then replacing or maintaining this function at a mitigation site with no upgradient nitrate inputs or downgradient beneficiaries will not achieve this.

- **Consider the ecological condition.** Enhancement of a wetland with a high-rated ecological condition probably doesn't make sense since the opportunity for additional ecological "lift" is probably very limited. Wetland creation or restoration contiguous to high condition wetlands may be more appropriate.

- **Consider the stressors.** The "stressors" output evaluates the degree to which a wetland has been recently altered or exposed to risk. As such, the "stressors" assessment can help determine the appropriateness of a wetland for CWM particularly when enhancement is proposed. Are there stressors that will continue to impair the functioning of this wetland as a mitigation site?

- **Consider sensitivity**. This provides some indication of the degree to which the wetland's functions will respond to the removal (or addition) of stressors.

3.2.2 Site Design Assistance

- **Consider functions.** Functions with higher ratings at the impact site (or reference wetland for CWM planning) should be used to inform the design at the mitigation site. Look at the indicators for these functions – can the wetland characteristics of those indicators be reasonably incorporated into mitigation site design? In considering this, it is important to understand the natural limitations of the site, its landscape position and the wetland classes present there. Trying to create wetlands customized to address a specific suite of functions without considering the natural limitations of the land will likely result in non-sustainable CWM.

- **Consider values.** Higher value ratings at the mitigation site suggest that mitigation design elements that can create or enhance the associated functions will better improve watershed health.

- **Consider stressors.** Can mitigation design elements sustainably reduce or reverse existing stressors? By rule (OAR 141-085-0694), DSL requires that CWM plans involving wetland enhancement identify the causes of

> **User Note:** For the Corps, stressors should be considered when developing the mitigation plan, in particular site selection, baseline information, and the work plan (33 CFR 332.4(c)).

degradation and how they will be reversed. Using ORWAP data form “S,” have stressors been identified that could be sustainably reversed to enhance the functions or condition at the CWM site? Have stressors been identified that cannot be reasonably reversed that will continue to constrain the site after treatment?

3.3 Mitigation Eligibility and Accounting

DSL requires a two-step process for determining mitigation eligibility and accounting.

Step 1: demonstrate that a proposed mitigation site is eligible to offset the proposed impacts.
Step 2: quantify mitigation requirements (in acres for wetlands) using an accounting worksheet.

The ORWAP function and values ratings will be used to inform the decision-making at both the eligibility and mitigation accounting steps. To determine if a proposed mitigation project is eligible to compensate impacts it must be demonstrated that the group-level functions and values at the impacts site match (or exceed) those at the mitigation site (predicted scores). A rating break proximity output on the score sheet can also indicate replacement even if the ratings do not explicitly match but the scores are within the repeatability error of a break between categories

Table 3 provides an example showing when function and value replacement would and would not be meet the eligibility requirements using two of the groups.

Table 3. Comparison of Function and Value Rating for Mitigation Eligibility

Groups		Impact Site			CWM Site- Predicted State			Function match	Value Match
		Specific Function	Rating	Rating Break Proximity	Specific Function	Rating	Rating Break Proximity		
Hydrologic Function	Function	Water Storage & Delay	Moderate		Water Storage & Delay	Moderate		Yes	Yes
	Value		Moderate	LM		Lower			
Water Quality Support	Function	Phosphorus Retention	Higher		Sediment Retention & Stabilization	Moderate		No	No
	Value		Moderate			Lower			

Conclusion:

- Hydrologic function and value ratings match and meet the mitigation eligibility requirements. The predicted rating of “Moderate” at the CWM site offsets the expected loss of “Moderate” functioning at the impact site. The value rating of the Hydrologic Function predicted at the CWM site is less than the impact site; however, replacement is otherwise achieved because the Rating Break Proximity display of “LM” indicates that the impact site rating can be considered “Lower” based on the repeatability error in ORWAP.

- Water Quality Support function and value ratings do not match and do not meet the mitigation eligibility requirements. The ratings for function and value at the CWM site are less than those at the impact site and, therefore, do not provide a sufficient offset.

During the calculation of the mitigation requirements (mitigation accounting) the ORWAP function and value scores are used to increase and decrease mitigation requirements. An increase factor will be applied to the mitigation calculation when fewer than 13 specific function and values from the impact site are replaced at the mitigation site (Table 4). This increase factor will range from 10% for 11-12 function and value matches to 50% for less than 5 matches. A decrease factor of 20% will be applied when 13 or more of the predicted specific function scores at the mitigation site exceed (replace beyond an overlapping rating break proximity) the scores at the impact site.

Table 4. Mitigation Accounting - Function and Value Replacement

Number of specific function and value matches between the impact and mitigation site	Increase factor associated with the specific function and value replacement
≥13	0%
11-12	10%
9-10	20%
7-8	30%
5-6	40%
<5 matches	50%

3.4 Reporting Assessment Results for the Joint Permit Application (JPA)

DSL requires a functions and values assessment on wetlands or tidal waters proposed for impact (OAR 141-085-0685(4)), regardless of CWM method proposed. In the JPA, applicants must report results of an ORWAP function assessment at the Group level, and include copies of the ORWAP answer pages, score sheet, and assessment area maps in the application package. DSL also requires a digital copy of each completed ORWAP excel workbook for review and verification.

Table 5 has an example for a JPA with multiple wetlands on a project site. In this example, the project site has three wetlands. Wetlands B and C met the criteria to be combined into a single assessment area (Section 2) while Wetland A did not.

Table 5. Example Format for JPA Reporting for Multiple Wetlands on a Project Site

Groups		Impact Wetland A			Impact Wetland B/C		
		Specific Function	Rating	Rating Break Proximity	Specific Function	Rating	Rating Break Proximity
Hydrologic Function	Function						
	Value						
Water Quality Support	Function						
	Value						
Fish Habitat	Function						
	Value						
Aquatic Support	Function						
	Value						
Ecosystem Support	Function						
	Value						
Additional Outputs							
Carbon Sequestration	Function						
Public Use & Recognition	Value						
Sensitivity	Value						
Ecological Condition	Value						
Stressors	Value						

3.5 Replacement Assessment in the Joint Permit Application (JPA)

This section applies specifically to applicants proposing permittee-responsible CWM, either on-site or off-site. An assessment of the proposed CWM is not required when CWM is proposed by means of purchasing legacy bank credits, in-lieu fee program credits not associated with a Department-approved project, payment-in-lieu program credits, or if the project is limited to 0.2 acres or less or permanent wetland impacts and mitigation bank or in-lieu fee credits are proposed (OAR 141-085-0685(3).

> **User Note**: DSL's payment-in-lieu program is not approved by the Corps and will not satisfy Federal mitigation requirements.

3.5.1 Replacement at the Group Level

Generally, replacement of the function and value ratings of the groups described in section 3.3 must be demonstrated, as these are considered the primary groups for the regulatory program in Oregon. However, there may be circumstances where an individual function or value is identified as being of critical importance within the given setting. In such cases, specific replacement of that particular function may be sought.

Carbon sequestration and public use and recognition will, in most cases, be considered of secondary importance for which less than full replacement may be acceptable. Exceptions to this might include coastal wetlands with a “higher” function rating for carbon sequestration, and wetlands with documented high public use. In such cases, carbon sequestration, and public use and recognition may be elevated to primary status.

3.5.2 Formatting the Outputs

Group ratings and rating proximity breaks for the impact site should be compared side-by-side to the predicted group ratings and rating proximity breaks for the CWM site (Table 6). If multiple wetlands are proposed to be mitigated at a single CWM site, represent each “impact” group using the highest rating recorded among all the impacted wetlands. Alternatively, prepare a separate table to compare each impacted wetland to the mitigation site.

As detailed below, CWM using restoration or creation requires one function assessment of the mitigation site (predicted state) while CWM using enhancement requires two function assessment of the mitigation site (existing state and predicted state). Table 6 provides an example format for reporting the comparison of functions and values between impact and mitigation sites.

A. Formatting outputs for CWM using restoration or creation

For CWM using restoration or creation, the function and value ratings for the predicted state should be reported for comparison with function and value ratings of the impact site. It may be assumed that the existing (baseline) wetland function and value scores of the CWM site are 0, eliminating the need for an assessment of the existing state.

B. Formatting outputs for CWM using enhancement

For CWM using enhancement, two ORWAP assessments of the mitigation site must be completed and reported in the JPA for comparison with an assessment of the impact site. The first assessment should evaluate the existing wetland prior to any improvements. The second should assess the predicted state that would follow from the use of enhancement measures. This information will assist the agencies in evaluating the proposed enhancement project. In most cases, a change in the value rating for a given group should not be expected between the current state and the predicted state of existing wetland(s) for CWM-by-enhancement proposals. This is because value is driven primarily by conditions offsite from the CWM (i.e., in the contributing area and downslope area). Therefore, unless there is reason for the contrary, the current and predicted ratings for a wetland’s group values at a CWM-by-enhancement site will usually be reported as the same rating. Possible exceptions to this include: 1) changes to the function rating results in the selection of a different specific function to represent the group; 2) where a project or CWM action eliminates or introduces an ESA-listed species at an assessment area; or 3) where a project or CWM action eliminates or introduces public accessibility.

Table 6. Example Format for JPA Reporting

Groups		Impact Site			CWM Site- Existing State (for enhancement only)			CWM Site- Predicted State		
		Specific Function	Rating	Rating Break Proximity	Specific Function	Rating	Rating Break Proximity	Specific Function	Rating	Rating Break Proximity
Hydrologic Function	Function									
	Value									
Water Quality Support	Function									
	Value									
Fish Habitat	Function									
	Value									
Aquatic Habitat	Function									
	Value									
Ecosystem Support	Function									
	Value									
Additional Outputs										
Carbon Sequestration	Function									
Public Use & Recognition	Value									
Sensitivity	Value									
Ecological Condition	Value									
Stressors	Value									

3.5.3 Making Future Predictions

This format requires that the applicant make some predictions about the future, post-treatment state of the CWM site. Because many of the ORWAP indicator questions are of a detailed nature, it may be difficult to accurately apply ORWAP to a conceptual, future state. Therefore, users may wish to select a reference wetland site (that is, an existing wetland of the same HGM and Cowardin class(es) and preferably within the watershed of the same 8-digit hydrologic unit code (HUC)) that reasonably and realistically represents the envisioned future state of the proposed CWM site. Users then would run the ORWAP assessment on the reference site as a means to calculate the predicted (post-treatment) CWM site function scores. If this approach is used, the value ratings of the reference site should be disregarded. Value ratings should be calculated only for the actual CWM site.

3.6 Inform Performance Standards

Establishing performance standards is an important part of the CWM planning and development process because it is the means by which the success of the mitigation effort will be measured. At the most basic level, performance measures are typically established for the vegetation condition (e.g., percent cover, survival rate, extent of invasive species) and hydrology (e.g., depth, duration). Such standards are, in some cases, assumed to be a proxy for the measurement of a wetland's functions, which can otherwise be time- and labor-intensive.

Using the specific function tabs in the ORWAP calculator spreadsheet, the user can create a more refined set of performance standards compared to the measures mentioned above. ORWAP allows the user to estimate a wetland's relative effectiveness in providing selected functions and thereby provide more informed conclusions regarding CWM success or failure.

Each indicator question on forms "OF," "F" and "T" includes an "Explanation, Definitions" column that includes a list of functions the question is using for scoring. With this, the user can look for those indicators that most commonly represent the key functions sought for replacement and then incorporate those indicators, as appropriate, as performance standards for the CWM site. For example, indicator F25 (Water Fluctuation Range - Maximum) is a significant consideration for ten functions. Therefore, it may be appropriate to establish a performance standard that establishes the most desirable annual change in surface water level between the driest and wettest time of year. Using this example, it must be cautioned that while a greater fluctuation benefits the water storage, sediment retention and nitrate removal, and organic material export functions, it simultaneously degrades several other functions. Therefore, it is important to consider what the optimal standard is that balances all the functions that the indicator influences.

As a caution, ORWAP indicators should not be used as the **sole** basis for performance standards, because: 1) not all of the numbers used to demarcate answers to ORWAP questions have been scientifically validated for the function(s) they address; 2) ORWAP users estimate rather than use a direct measure for most indicators, as was necessary for ORWAP to be configured as a rapid method; and, 3) many indicators were chosen because they *correlate* with a given function, but this does not necessarily mean they *drive* the function, in a causal sense.

3.7 Verify Replacement through Mitigation Site Monitoring

DSL requires (OAR 141-085-0710 (4)), by the fifth monitoring year, a comparison of actual functions and values attained at the CWM site to the predicted functions and values identified in the CWM plan. If ORWAP was used in the original CWM plan, the permittee will run a fifth monitoring year ORWAP assessment on the CWM site and include the following in the monitoring report:

- Completed ORWAP data forms: "CoverPg," "OF," "F," "S" and "Scores." If the wetland is tidal, form "T" substitutes for form "F."
- Side-by-side comparison of actual scores to predicted scores as originally included in the approved CWM plan.
- Discussion of the results, including identification of any shortfalls in Group replacement.
- Likely reasons for the shortfall and proposed remedial actions, as appropriate, to address that shortfall should be included.

If another assessment method or an earlier version of ORWAP was used for the original CWM plan, then that same method/version must be used for the fifth-year monitoring report assessment. DSL will maintain earlier versions of ORWAP and make them available on the web or available by request.

4. ORWAP Assessment Documentation to be Included in the JPA

When using ORWAP to meet assessment documentation requirements, the following materials must be included in the JPA:

- Within the body of the CWM plan:
    - Completed ORWAP forms: "CoverPg" and "Scores" for the impact site and the proposed CWM site.
    - Side-by-side comparison of impact and mitigation sites as described in Section 3.3.3 above.
    - Documentation and discussion of "other considerations" (Section 3.4.7) used where function or value replacement for a group is not anticipated.

- As an appendix to the JPA:
    - Completed ORWAP forms: "OF," "F," and "S" for impact site and proposed CWM site.
        - If both the impact site and proposed CWM site are tidal wetlands, form "T" substitutes for form "F."

        - If the CWM is enhancement, two sets of ORWAP forms must be submitted: one for the existing state (baseline) and a second for the predicted state.
    - 7.5' topo map, soils map, and aerial photo illustrating the assessment area and contributing areas (runoff and/or streamflow).
    - Photographs of the assessment area, while helpful, are not mandatory.

The following materials may be included in the JPA to the extent ORWAP was used for these aspects:

- In the Alternatives Analysis: A summary of the ORWAP assessment results for all wetlands on the project site discussed as part of the alternatives analysis process.
- As an Appendix to the JPA: ORWAP assessment results used as part of the alternatives analysis or CWM scoping process.

Users are also asked to submit electronic ORWAP results as they are needed for review and verification of the ORWAP results

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