SEALASKA TECHNICAL

Manual for the Idaho Wetland Ecosystem Services Protocol

Submitted by
Sealaska Technical Services, LLC

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Executive Summary

WESP-ID is a standardized method for rapidly assessing some of the important natural functions of individual wetlands throughout Idaho.

WESP-ID consists of this manual and its appendices and an Excel® spreadsheet calculator containing data forms and models (formulas). It is a regionalized adaptation of WESP (Wetland Ecosystem Services Protocol, Adamus et al. 2016 and updates) whose template for North American wetland assessments had previously been customized by resource agencies in Alaska, Oregon, Alberta, and the Maritime Provinces of Canada (Dorney et al. 2018).

WESP-ID generates scores (0 to 10 scale) and ratings (Lower, Moderate, Higher) for each of the following wetland attributes: Water Storage & Delay; Stream Flow & Temperature Support; Sediment Retention & Stabilization; Phosphorus Retention; Nitrate Removal; Organic Nutrient Export; Aquatic Primary Productivity; Fish Habitat; Amphibian & Turtle Habitat; Waterbird Habitat; Raptor & Songbird Habitat; Keystone Mammal Habitat; Native Plant Diversity; Pollinator Habitat; Wildfire Resistance; Carbon Stock; Cultural or Recreational Use; Wetland Stressors. For each attribute, the scores and ratings represent a particular wetland's standing relative to those in a systematically-chosen sample of wetlands previously assessed by this study throughout Idaho.

The scores and ratings are intended to inform decisions about wetland avoidance, minimization, and replacement. WESP-ID can also be used with other tools and measurements to monitor wetland restoration projects and to help assure that wetland restoration efforts offset the unavoidable loss of specific functions and benefits in other wetlands, not just loss of their area.

After being trained in the use of this WESP-ID, users initially answer a series of multiple-choice questions about a wetland by consulting aerial imagery (e.g., the free Google Earth Pro) and visiting specified web sites. The wetland is then visited and an additional set of questions are answered based on field observations and, if necessary and possible, on conversations with the person on whose property the wetland exists. Completing the on-site part of WESP-ID typically takes 1-3 hours depending on wetland size, access, and the user's prior experience applying the tool and familiarity with the area. Although most data form questions (indicators) are applied to estimate several wetland attributes, users need only enter the data for each indicator in one place on the data form. In most cases, not all questions need to be answered because the data form allows many to be skipped if a wetland has specified characteristics. In its calculations, the spreadsheet accounts for differences among wetland types by ignoring, rather than scoring 0, the responses to questions that are not relevant to the type of wetland being assessed.

WESP-ID's scoring is based on logic models programmed into the calculator 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 the open architecture of the Excel™ spreadsheet as well as by detailed explanations, viewable in the spreadsheet, of the assumptions and mathematics of each scoring model. The spreadsheet contains a rationale for use of each metric or indicator in every model, often with citation of supporting scientific literature.

WESP-ID is a refinement of the first wetland assessment method peer-reviewed and widely used throughout the U.S. (Wetland Evaluation Technique, WET; Adamus 1983, Adamus et al. 1987) and a similar protocol (ORWAP) developed, peer-reviewed, and adopted for routine use by Oregon Department of State Lands with funding from the US Environmental Protection Agency (EPA; Adamus et al. 2009, 2016). WESP-ID also incorporates elements of the Hydrogeomorphic (HGM) Approach (Brinson 1983, Smith et al. 1985). Most components of WESP-ID or its predecessors have been peer-reviewed by scientists in the various disciplines that its models cover. Although users sometimes differ in their interpretation of particular WESP-ID questions, the overall repeatability of the scores and ratings has been shown to be quite high where regionalized versions of WESP were independently tested (mean confidence interval of ±0.60 around function scores on a 0-10 scale).

For technical questions about WESP-ID, the primary author (Dr. Paul Adamus) may be contacted at: adamus7@comcast.net

1.0 Introduction

1.1 General Description

A need has existed for a tool that can be applied rapidly by one trained person during a single visit to a wetland, that standardizes the data collected and the way it is interpreted to indirectly yield relative estimates of a wide variety of important wetland functions and their associated potential or actual values. This need exists because measuring the natural functions of wetlands directly is expensive and may require years of data. Alternatively, a team of multidisciplinary experts could visit a wetland and render opinions about each of its functions. However, few project applicants can afford this, and many do not have access to personnel who are knowledgeable of wetland biogeochemistry as well as hydrology, botany, aquatic biology, and wildlife, as would be necessary to properly assess all important wetland functions. Agencies responsible for managing and protecting wetlands do not have the unlimited staff to provide such services and expertise, either.

Nature is complex, and varies enormously from place to place. As natural systems, wetlands are no exception. Thus, the use of one word or phrase describing a wetland's type (e.g., bog, swamp, fen) or a short list of its characteristics cannot meaningfully predict what a particular wetland does and how it may benefit people and ecosystems. The roles of dozens of factors and their interactions must be considered and addressed systematically. Otherwise, assessments of what wetlands do-- and therefore decisions based on those assessments—may be less reliable.

Fortunately, there is a growing capacity to illustrate and encode some of nature's complexity in computer models such as those that take the form of formulas in the WESP-ID spreadsheet. This, along with the commonplace availability of personal computers and software that make those models quick and easy to use, has made WESP-ID relatively simple to apply in the support of decisions and policies, while at the same time reassuring users and decision-makers that assumptions are transparent.

Table 1. Values of wetland functions scored by WESP-ID.

Function	Definition	Potential Values
HYDROLOGIC FUNCTIONS:		
Water Storage & Delay	The effectiveness for storing runoff or delaying the downslope movement of surface water for long or short periods.	Flood control, maintain ecological systems
WATER QUALITY & CLIMATE MAINTENANCE FUNCTIONS:		
Stream Flow & Temperature Support	The effectiveness for contributing water to streams especially during the driest part of a growing season, and for maintaining or reducing temperature of downslope waters.	Support fish and other aquatic life
Sediment Retention & Stabilization	The effectiveness for intercepting and filtering suspended inorganic sediments, thus allowing their deposition along with some associated contaminants. Also the effectiveness for reducing energy of waves and currents, resisting excessive erosion, and stabilizing underlying sediments or soil for long periods of time.	Maintain quality of receiving waters. Protect shoreline structures from erosion.
Phosphorus Retention	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 resistant to physical or chemical remobilization of phosphorus into the water column.	Maintain quality of receiving waters.
Nitrate Removal & Retention	The effectiveness for retaining particulate nitrate and converting soluble nitrate and ammonium to nitrogen gas while generating little or no nitrous oxide (a potent greenhouse gas).	Maintain quality of receiving waters.
Carbon Stock	The inferred amount of carbon stored within a wetland per unit area, after discounting the potential for carbon loss via methane emissions.	Maintain global climate.
Organic Nutrient Export	The effectiveness for exporting organic matter, either particulate or dissolved, along with associated nutrients and ecologically-important elements such as iron.	Support food chains in receiving waters.
ECOLOGICAL (HABITAT) FUNCTIONS:		
Fish Habitat	The capacity to support an abundance and diversity of native fish (both anadromous and resident species)	Support recreational and ecological benefits.
Aquatic Primary Productivity	The effectiveness, on a net annual basis, for supporting high production of benthic, epiphytic, and/or planktonic algae and other plants essential to food chains and their component species.	Support salmon and other aquatic life. Maintain regional biodiversity.

Function	Definition	Potential Values
Amphibian & Turtle Habitat	The capacity to support or contribute to an abundance or diversity of native frogs, toads, salamanders, and turtles.	Maintain regional biodiversity.
Waterbird Habitat	The capacity to support or contribute to an abundance or diversity of waterbirds that breed in or migrate through the region.	Support hunting and ecological benefits. Maintain regional biodiversity.
Raptor & Songbird Habitat	The capacity to support or contribute to an abundance or diversity of native songbird, raptor, and mammal species and functional groups, especially those that are most dependent on wetlands or water.	Maintain regional biodiversity.
Keystone Mammal Habitat	The capacity to support an abundance of wetland-associated mammals that are ecological keystones and/or are of recognized importance as game or for subsistence in this region. Primarily: beaver, moose, muskrat.	Maintain regional biodiversity and hunting/ trapping opportunities.
Native Plant Habitat, Pollinator Habitat	The capacity to support or contribute to a diversity of native, hydrophytic, vascular plant species, communities, and/or functional groups, as well as the pollinating insects linked to them.	Maintain regional biodiversity and food chains.
Wildfire Resistance	The capacity to resist ignition by wildfire, thus potentially limiting wildfire spread.	Protect vulnerable infrastructure.
Cultural or Recreational Importance*	Prior designation of the wetland by a natural resource or environmental protection agency as some type of special protected area. Also, the potential or actual use of a wetland for low-intensity outdoor recreation, education, or research.	Commercial and social benefits of recreation. Protection of prior public investments.

* a benefit or value rather than a function of wetlands

As a standardized approach WESP-ID provides consistency and comparability when using wetland functions as a way to prioritize wetlands. It also can be used to assess the consequences of wetland alterations in terms of the wetland functions that may be affected and the relative magnitude of the effect. For example, if it is expected that a proposed wetland alteration (e.g., placement of fill or removal of invasive vegetation cover) will increase annual fluctuation of a wetland's water levels, actual or hypothesized changes in the wetland's WESP-ID scores before and after the alteration can show the likely result of that water fluctuation change on Nitrate Removal and some other functions.

WESP-ID uses visual assessments of weighted ecological characteristics (indicators) to generate the scores and ratings for a wetland's functions and values. The number of indicators that is applied to estimate a particular wetland function depends on which function is being assessed.

The number may range from a few to as many as 38. However, not all indicators need to be assessed in every wetland. The indicators are combined in a spreadsheet using mathematical formulas (models) to generate the score and rating for each wetland function and its potential or actual values. The models are logic-based rather than deterministic. Together they provide a profile of "what a wetland does." WESP-ID indicators and models attempt to incorporate the best and most recent scientific knowledge available on what determines the levels of functions provided by individual wetlands.

Each indicator has a suite of *conditions,* e.g., different categories of percent-slope. For each wetland function, weights were pre-assigned to all conditions potentially associated with each indicator used to predict the level of that function or its value. The weights can be viewed in column E of the individual worksheets (worksheets are the tabs at bottom of the calculator spreadsheet).

For most models of wetland functions, the indicators in the worksheets were grouped by the underlying *processes* they inform. Indicator and process selection was based on the author's experience and review of much of the literature compiled initially in an indexed bibliography of science relevant to functions of the Idaho landscape.

1.2 Conceptual Basis

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). In particular, the frequency, duration, magnitude and timing of these processes and disturbances shapes a given wetland's functions (Smith et al. 2008). Climate, geology, topographic position, and land use strongly influence all of these. Well-functioning wetlands with certain characteristics can reduce the need for humans to construct and maintain some types of expensive infrastructure at other locations that would otherwise be necessary to perform the same services, such as reducing regional flood damages or treating stormwater (Costanza et al. 1987, Finlayson et al. 2005, Russi et al. 2013, Pendleton et al. 2020, Vermaat et al. 2021).

Despite popular perceptions, high-functioning wetlands are not always healthy and intact, and healthy wetlands are not always high-functioning. This is true for at least two reasons: (1) There exists no widely-accepted scientific definition of wetland "health" (or integrity, or ecological condition, or "intactness") or accepted protocols for measuring any of those concepts comprehensively, and (2) No single wetland, regardless of how intact, pristine, or biodiverse it may be, can provide all functions at a high level because many wetland functions operate naturally in opposing directions. No research has yet confirmed that maintaining biodiversity alone will preserve all or perhaps even most wetland functions that are important at local, watershed, or region-wide scales. Thus, it is inappropriate to describe a wetland as having “high function” or being “highly functional” without specifying the function or combination of functions to which one is referring and how they are being weighted.

2.0 Procedures for Using WESP-ID

2.1 Overview

Completing a WESP-ID assessment requires answering questions on three data forms. Two of the data forms (F and S) contain questions you answer based on your observations made during at least one visit to the wetland during the growing season and the third data form (OF) contains questions you answer at your computer using aerial imagery (Google Earth or other online sources), the Idaho Wetland Data Viewer (https://idfg.idaho.gov/conservation/wetlands), and if available, GIS (Geographic Information Systems). The three data forms are available as worksheets (tabs at the bottom) of the WESP-ID spreadsheet (Table 2). Purposes of tabs (worksheets) at bottom of WESP-ID spreadsheet). Note that the spreadsheet also contains an important worksheet called *Instructions*.

Table 2. Purposes of tabs (worksheets) at bottom of WESP-ID spreadsheet

Tab	**Purpose**
Instructions	Basic steps and definitions
CovPg	Cover page. Include when submitting results.
OF	"Office" form with 41 questions to be answered using sources described in section 2.3 of this manual.
F	"Field" form with 61 questions to answer based on observations made during one or more visits to a wetland during the growing season.
S	"Stressor" form with 6 questions to answer based mainly on observations made during one or more visits to a wetland during the growing season
Scores	Scores and ratings for functions and other attributes of the subject wetland. Calculates automatically once all data required by forms OF, F, and S are entered.
WS through STR	Full names of these tabs are shown in the Scores worksheet, e.g., WS= Water Storage. Each contains formulas used to calculate function and/or value scores and provides the rationale for inclusion.
Rare Animals through Towns	Tables with information necessary to answer some of the questions in forms OF and S.
How It Works	Description of the spreadsheet's mechanics.

Note: If some tabs are not visible, click on the [...] symbol at bottom right or left.

2.2 General Procedures

1. If training in the use of WESP-ID is offered by a qualified trainer, attending that training (which generally lasts 2 or 3 days) is highly recommended. In any case you must have read this manual as well as any definitions or other sidenotes in the last column of data forms OF and F.
2. Obtain the most recent version of this manual, the WESP-ID calculator spreadsheet, and supporting files from the US Army Corps of Engineers, Walla Walla District.
3. Draw the Assessment Area (AA) on an enlarged aerial image of the wetland. For detailed rules regarding this essential step, read the Instructions worksheet of the WESP-ID calculator. Basically, the AA includes all or part of a wetland. It must never include non-wetland habitat except, in some cases, unvegetated open water and possibly some small inclusions ("islands") of non-wetland vegetation. Part of its boundary will likely be the same as the wetland boundary, but depending on the assessment objective it may comprise only a portion of the entire wetland. For example, if a project area has been defined, include the part of the wetland where alteration/conservation/mitigation is anticipated, including its secondary impacts. If alternative sites or alignments are being assessed, include a wetland area large enough to encompass each reasonable alternative along with its secondary impacts.
4. Open the Excel calculator spreadsheet, click on the tab labeled "OF" (for office or off-site) and answer all questions, then give the file a name that describes it uniquely, e.g., Beaver_23. You do not need to print this worksheet beforehand if you will be answering the questions directly on a computer. However, once you've answered them, print a copy to take along when you visit the wetland.
5. If you cannot differentiate this region's major invasive plant species (see calculator worksheet Noxious Plants) from its native species, memorize photos of the invasives before visiting the wetland or use a field guide. A useful illustrated reference is the University of Idaho Extension Service's "Idaho's Noxious Weeds": https://invasivespecies.idaho.gov/plants
6. Print Forms F and S as well as the CovPg worksheet from the spreadsheet or load them onto a field computer. Then visit the wetland during the growing season and do the following:

    a. Evaluate soil, water, and vegetation to digitally delineate the boundary between wetland and upland according to agency guidance. Or, obtain a digital file with that boundary from a reliable source who determined it recently.

    b. If necessary, adjust your drawing of the AA (assessment area) boundary.

c. Fill out a printed copy of form F and form S during your visit, following the field protocol described in the *Instructions* worksheet of the calculator. Also fill out the Cover Page (**CovPg**) worksheet of the calculator.

d. If possible, conduct surveys for rare plants and animals. Do so at an appropriate time of the season and using approved survey protocols if those are available.

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

f. Review the answers you earlier provided on form OF, and change any responses which observations during the subsequent on-site visit suggested were inaccurate. Note: While it is recommended that you fill out form OF before going afield, under some circumstances that may not be practical and in those cases the field work (form F and S) may be completed first.

2.3 Instructions for Office Component

Field data alone are insufficient to accurately assess a wetland's functions. Additional data must be obtained and interpreted from aerial images and existing databases and entered on Form OF of the spreadsheet to complete the assessment.

First, write down the coordinates of your AA as determined either in the field using GPS or by using Google Earth or another source of georeferenced aerial imagery to zoom into the AA. If using Google Earth, place the cursor near the center of the AA and then note the coordinates (lat lon) shown in the lower right part of the image. The free Google Earth Pro can be downloaded from: http://www.google.com/earth/download/gep/agree.html

2.3.1 Streamflow and Runoff Contributing Areas

To answer form OF questions 23 through 27, it is first necessary to consider a wetland's Streamflow Contributing Area (SCA) and Runoff Contributing Area (RCA). The SCA includes all lands that drain into streams or channels that flow into the AA's wetland during a year of average precipitation, as well as any rivers or lakes whose surface or subsurface waters influence the water levels within the AA's wetland. The RCA includes lands that contribute surface runoff or subsurface seepage directly to the AA without first passing through a stream or river. *It is not necessary to delineate either type of contributing area (CA) with a high degree of precision*.

As shown in Figure 1, both types of CA include areas uphill from the AA until a ridge or topographic rise is reached, often many miles away, beyond which water would travel in a direction that would not take it to the AA. The water does not need to travel on the land surface; it may reach the AA slowly as shallow subsurface seepage[1]. The lowest part of a CA is usually the perimeter (upland-wetland edge) of the AA's wetland. The CA's highest point is often along a ridgeline or topographic rim or mound located in the uplands. Although it is possible that roads, tile drains, and other diversions that run across 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 CA 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, dike, or large elevated road adjoins all of a wetland's uphill perimeter. The CA may include other wetlands and ponds, even those without outlets, if they're at a higher elevation. Normally, the boundary of a CA will *cross a stream at only one point*— at the CA's and AA's outlet, if it has one. Include bordering perennial waters at the same elevation (such as a pond, lake, river). Especially in urban areas and areas of flat terrain, the CA boundaries can be somewhat subjective and estimation in the field may be preferable. Although the amount of runoff received by an AA may vary annually as wetlands and streams farther upslope connect or disconnect in response to varying precipitation, the size of the CA you draw will remain constant because it is based on topography rather than on presence of surface connections.

[1] There are often situations where subsurface flow (especially deep groundwater) that potentially feeds a wetland ignores such topographic divides. However, due to the limitations imposed by rapid assessment, no attempt should be made to account for that process.

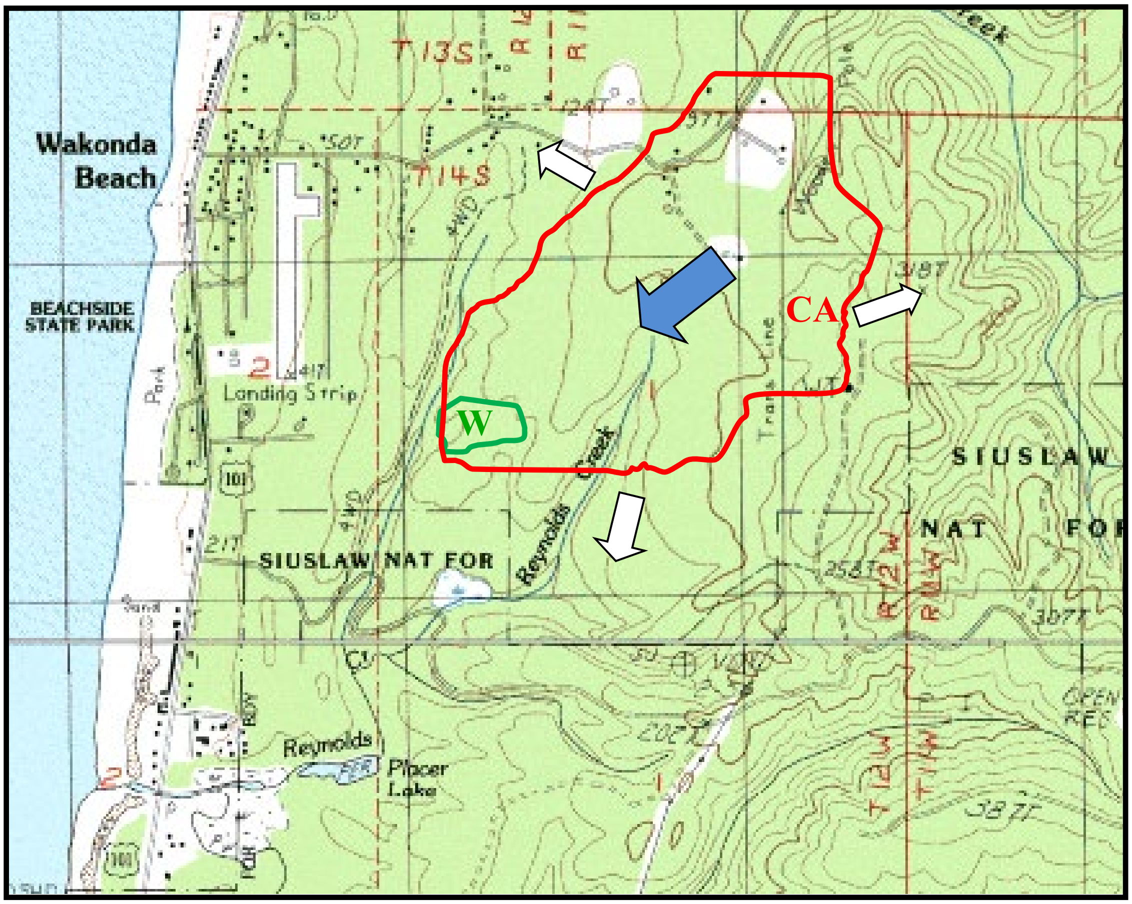


Figure 1. Approximating a wetland's contributing area (CA).

Wetland (to the right of the "W") is fed by runoff and/or stream flow from areas whose boundary is represented by the red line. The dark arrow denotes flow of water downgradient within the CA. The light arrows denote the likely path of water away from the CA and into adjoining drainages, as interpreted from the topography. Note that the CA boundary never crosses a stream except at the outlet (if any) of the wetland (Adamus et al. 2016).

2.3.2 IDFG Wetland Data Viewer

For many questions, you will use the IDFG Wetland Data Viewer here: https://idfg.idaho.gov/conservation/wetlands

Click on View Application, check the disclaimer box and press "OK". When the viewer appears, exit the Wetland Mitigation Select Area Tool on the left side of the opening screen by clicking on the "x". Figure 2 shows the main features you'll use in the Viewer's opening screen.

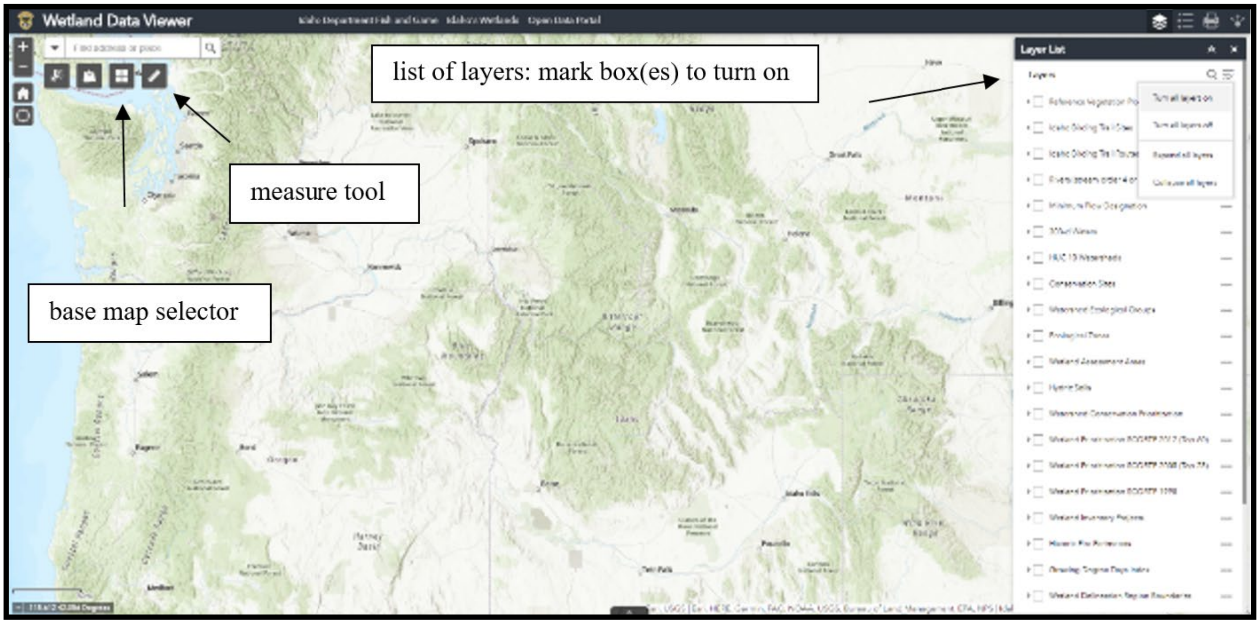


Figure 2. Main features of the Idaho Wetland Data Viewer

For some form OF questions you may wish to use the *base map* selector to enable topographic maps or aerial images, and for many questions you'll use the *measure tool* to estimate area of a polygon or distance. The primary focus, however, will be the spatial data layers in the menu on the right. A few things to note:

1. It is best not to mark all layers at once -- only the layer addressed by the form OF question you're answering. The Viewer contains several layers not used by WESP-ID.
2. Clicking on the small arrow to the left of each check box shows the map legend. For a few layers (e.g., Wetland Condition and Occurrence) it also reveals sub-themes of the layer's main theme that also have check boxes.
3. If a layer's features aren't visible zoom in until they are, or click the *Zoom To* choice after clicking on the three dots to the right of the layer title.
4. Transparency of a layer can be adjusted by clicking on the three dots to the right of the layer title. This is useful, for example, if you wish to overlay a topographic map with the HUC 10 Watersheds layer.

The following screenshot (Figure 3) from the Wetland Data Viewer associates the relevant data layers with their numbered form OF questions.

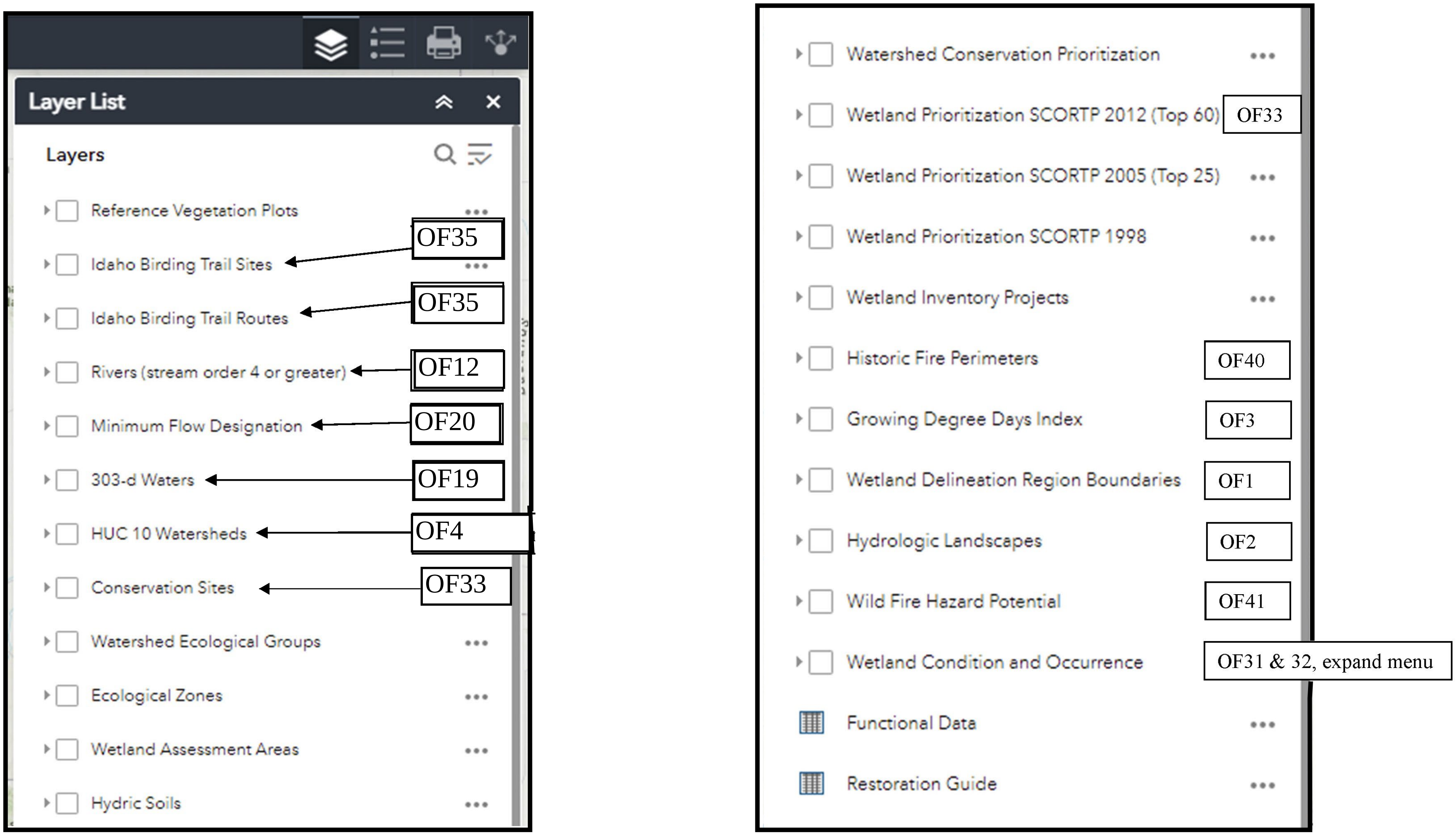


Figure 3. Form OF questions associated with layers in IDFG Wetland Data Viewer

2.3.3 NWI Wetlands Mapper

The IDFG Wetland Data Viewer does not show boundaries of wetland polygons, so unless you've completed a formal delineation of your wetland in the field, to answer some form OF questions you may need to rely on approximate boundaries of your wetland as shown in the National Wetland Inventory's online NWI Wetlands Mapper:

https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper

You can zoom to your wetland manually or input its coordinates in the Find Location box in the upper right of the Wetlands Mapper (Figure 4). Note that many "wetlands" shown in the Wetlands Mapper are actually complexes of various abutting wetland cover types, e.g., Freshwater Emergent Wetland + Freshwater Forested/Shrub Wetland. Click on Legend in the upper right of the Wetlands Mapper to see cover type names associated with map colors of the component polygons. For purposes of answering form OF questions that ask about size and distance to other features, all such NWI polygons that *abut* each other should normally be considered to comprise a *single* wetland except as described in the *Instructions* worksheet of the WESP-ID calculator. By clicking on each polygon comprising a wetland, you can see its area and a code that describes its overall hydroperiod (the likely duration of surface water presence or saturation). However, be aware that not all wetlands have been mapped by the NWI and some of the information is outdated, having been based almost entirely on 1980s aerial photographs rather than field inspection or high-resolution imagery.

Figure 4. Example from NWI Wetlands Mapper

The right-ward dark green and light green polygons should be counted as a single wetland because they abut each other while apparently being completely separated from the polygon on the left by upland (non-wetland). The white abbreviation on each polygon is explained by clicking on the polygon, and describes the likely water regime of that polygon overall.

2.3.4 Nearby Land Cover

As shown in Figure 5 below, spatial data useful for answering questions OF13 and OF14 can be accessed via the USGS National Map website:

https://apps.nationalmap.gov/viewer/

Enter your wetland's coordinates in the box in the upper left and press the magnifier icon to zoom to that wetland. Then, in the menu bar click on the third icon from the left to see available layers and mark the box next to the most recent NLCD Land Cover. Finally, when you click on the Range Ring icon in the middle of the menu bar, a pop-up appears. Press Activate and enter the buffer distance (0.5 or 2 miles) specified in OF14 or OF13 respectively. Then press Draw Rings and a circle of that distance will appear around the point you specified. From this, visually determine the most prevalent land cover type within the ring. To interpret the map colors, click on the Legend icon (fourth icon from the left). However, it is prudent to compare this coarse categorization with your field observations and with aerial imagery. The imagery can be seen on the same map by clicking on Basemap Gallery (second icon from left), selecting USGS Imagery, and then temporarily making the land cover more transparent by clicking on the three dots to the right of the "NLCD Land Cover" label in the Layer List.

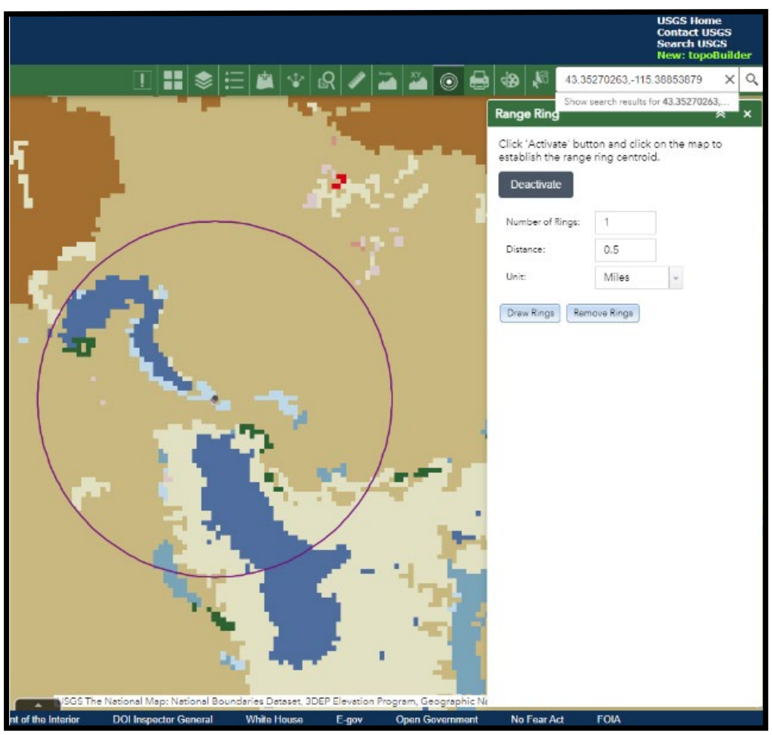
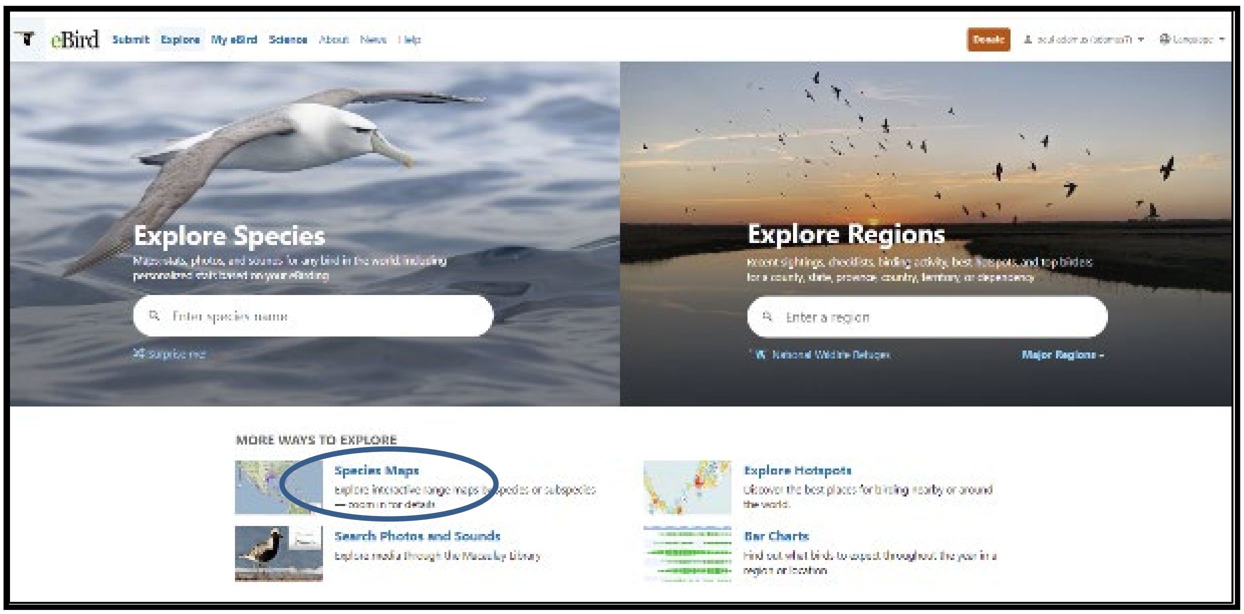


Figure 5. Land cover layer accessed via online USGS National Map, showing Range Ring pop-up menu

2.3.5 eBird

Part of question OF30 asks about waterbirds of greatest conservation need and migratory wetland-associated songbirds or raptors of greatest conservation need. Species belonging to those groups are shown in the calculator's RareAnimals worksheet. Although IDFG maintains a database of fairly precise locations where each of those species has been documented, that database is not publicly available. For all but the rarest species, the next best source for relatively precise locations from which a species has been reported is the global database updated daily by the Cornell Laboratory of Ornithology with careful review of reported observations: https://ebird.org/home. As shown in Figure 6, click on Explore in the toolbar at the top, then in the next screen click on Species Maps (not Explore Species) and enter a species' name. On the next screen in the top right enter the county or a major city closest to your wetland and a map will appear showing locations.



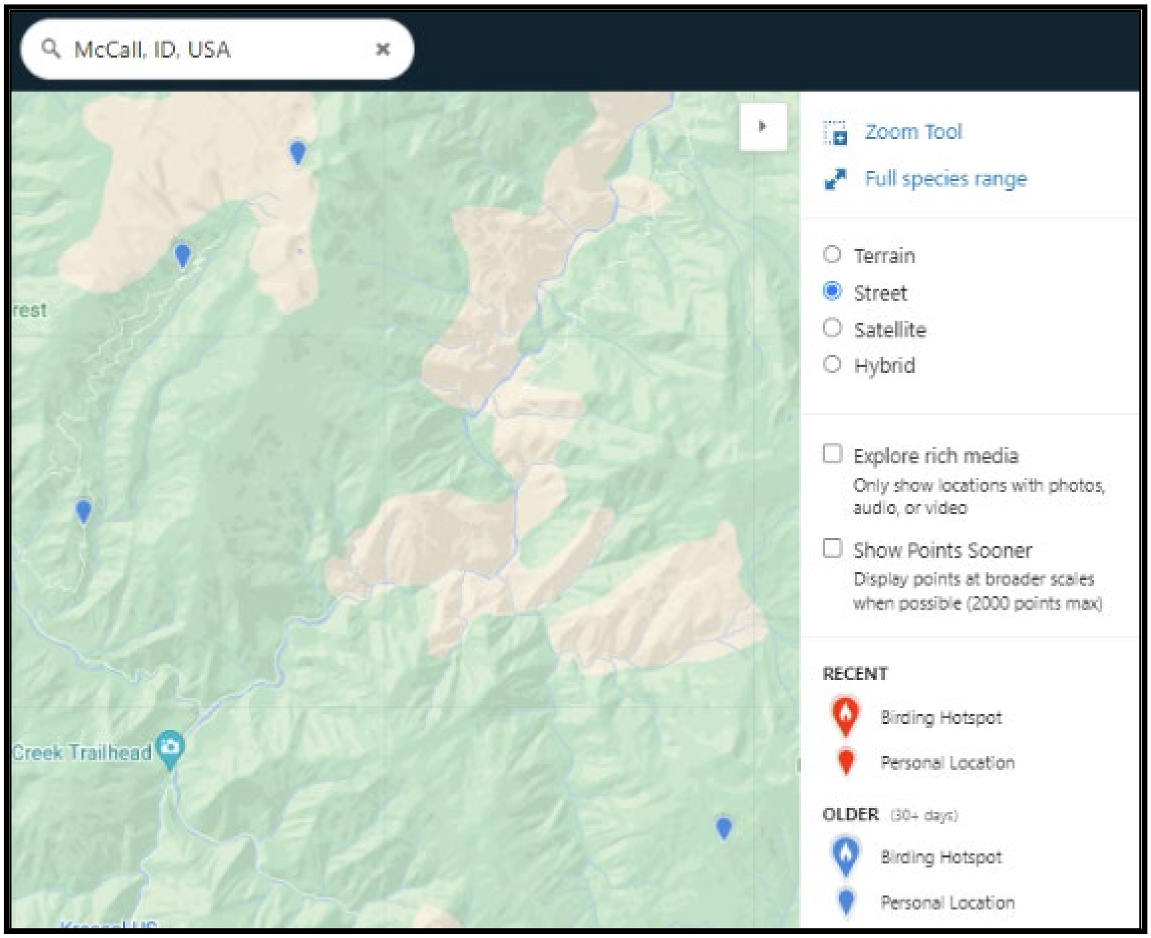


Figure 6. eBird main page (first image) and example of species map for Olive-sided Flycatcher (above)

2.3.6 USEPA 303(d) Waters

To address questions OF18 and OF19 utilize the Idaho Department of Fish and Game Wetland Viewer (https://idfg.idaho.gov/conservation/wetlands) zoom into streams and lakes within 1 mile of the AA that have a surface connection to the AA's wetland and are indicated as being 303(d) streams or lakes. Then click on the line to enable the pop-up as shown in Figure 7. Scroll down and click on More info to bring up the Waterbody Quality Assessment Report and click on Causes of Impairment and TMDLs That Apply to This Waterbody to see which substances are believed responsible for causing the impairment.

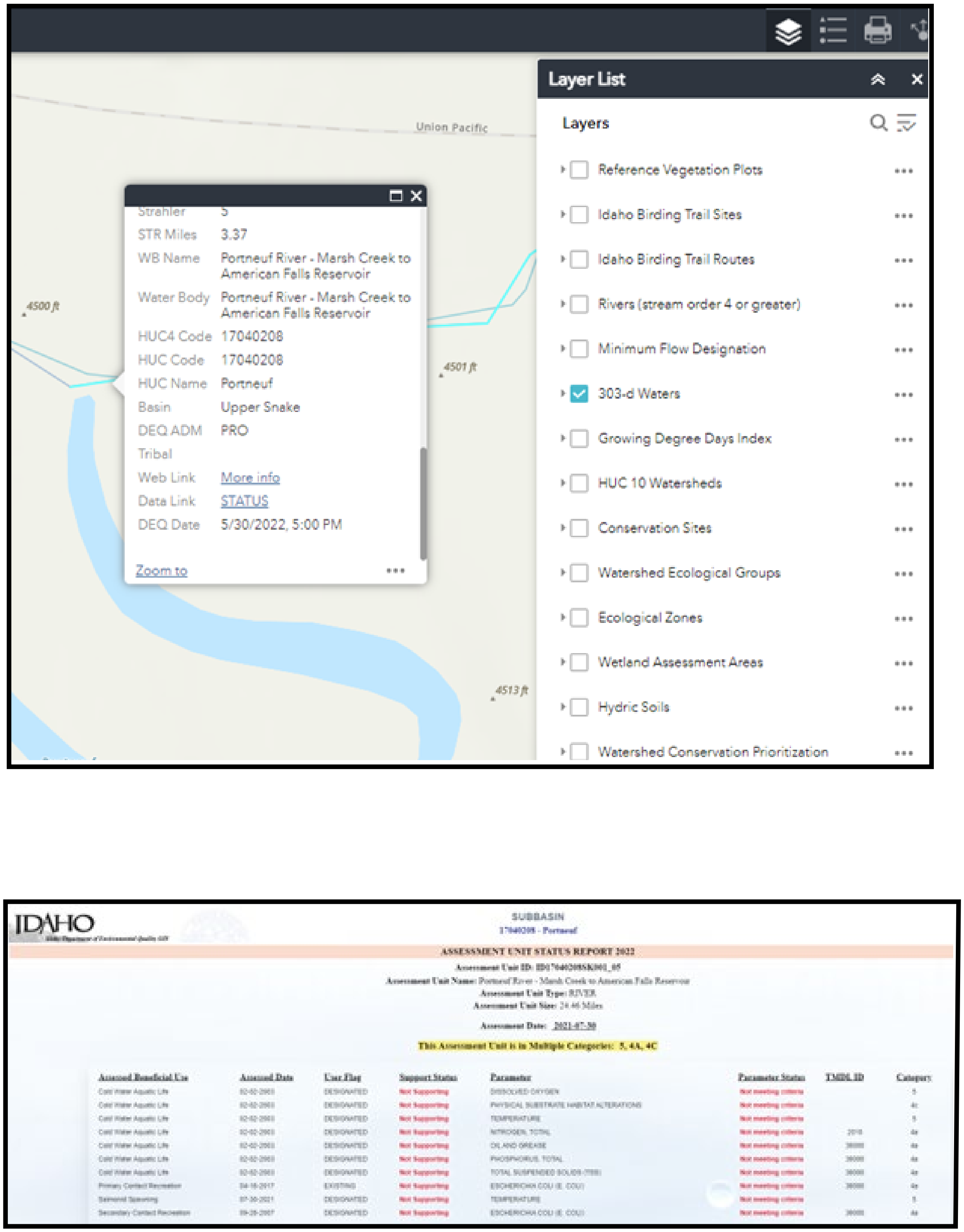


Figure 7. Pop-up menu (top) with *More Info* that links to causes of water quality impairment (below)

2.4 Instructions for Field Component

For the method overall, the essential instructions are presented in the **Instructions** worksheet of the WESP-ID calculator so are not repeated here. Also, important tips for answering specific form F questions are provided, sometimes with illustrations, in Appendix A of this manual.

In addition it is important to understand distinctions between some terms in the ways that WESP-ID uses them. *Water* can be characterized as either **ground water** or **surface water**. Groundwater is water that is present in soil pores and aquifers below the land surface, whereas surface water is visible to an observer at some time of an average year. Surface water can be categorized is several ways. One way is *ponded vs. flowing*. As used in WESP-ID, **flowing** water is surface water that moves at a sufficient rate that most suspended sediment particles would normally remain in suspension as they pass through a wetland, whereas in **ponded** water most such particles would be deposited. Wetlands with outlets can have areas of both ponded and flowing water, while wetlands that lack outlets only have ponded water. A second way of characterizing surface water is *open vs. vegetated*. As used in WESP-ID, **open water** is water that, in aerial view, either lacks vegetation entirely or contains only vegetation that has no foliage projecting above the water surface, e.g., most floating-leaved vegetation and vegetation that remains entirely submerged. In contrast, **vegetated** water is water that in aerial view is mostly obscured by vegetation within the wetland, whether that be herbaceous plants such as sedges or cat-tail, or tree canopies or moss islands. A third way of characterizing surface water is by its *hydroperiod*, meaning the length of time during which it is present during an average year. Typical descriptors (defined in form F) are persistent vs. seasonal-only (which includes ephemeral, temporary, and similar terms). Note that terms can be combined, e.g., a wetland can be described as having predominantly-ponded open water that is seasonal-only. *Vegetation* also can be characterized in several ways, the broadest being *woody vs. herbaceous*. Herbaceous vegetation generally includes all non-woody vegetation but note that some questions on form F explicitly exclude moss and/or aquatic vegetation that does not normally protrude above the water surface.

When answering questions on the data forms, pay special attention to the *context* of the conditions you're asked to select from. Is the question asking you to estimate the percent of some attribute relative to the entire wetland? Or just its assessment area (AA) as you've delimited it? Or just the *vegetated* part of the AA or wetland? Comparing to the wrong reference will likely cause you to choose the wrong condition.

As you answer the questions, you may wonder, "What is this question getting at?" Abbreviations of the functions and/or values each question addresses are shown in column B of form F, and those abbreviations are decoded at the end of the *Instructions* worksheet as well as in the *Scores* worksheet. But even knowing the wetland function or value the question addresses will not tell you whether answering it a particular way will potentially increase or decrease the score of that function or value. To know that, you will need to click on the worksheet for that function, e.g., FH for Fish Habitat, scroll down to the question, and notice in the Weight column how that question's various condition choices are weighted relative to each other. Note that in some instances choosing a different condition will have no effect on the function score. That is because other indicators (questions) in that particular type of wetland are known to have an overriding influence.

2.5 Reviewing the Output, Limitations

Before accepting the scores and rating provided by the calculator, think carefully about those results. From your knowledge of wetland functions, do they make sense for this wetland? If not, review the worksheet for that function, particularly the descriptions in column J of each worksheet, as well as Appendix C (Modeling Principles) to see how the score was generated. If you still have reservations about one or more of the scores, check for data entry errors. Also, consider the possibility that the scores differ from your impression because you weren't able to see part of the AA or view it during a preferred time of year. If you still disagree with the scores, write a few sentences explaining your reasoning. Remember, WESP-ID 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.

Perhaps 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. In that case you may try changing responses to questions based on the ways you anticipate particular conditions to change, e.g., by reconnecting a wetland to its watershed after being isolated by road construction. Note that WESP-ID is not intended to *predict changes* to a wetland, e.g., that if a particular type of road is constructed it will reduce local fish populations by 10 percent. Instead, WESP-ID only estimate the likely direction and relative magnitude of shifts in various functions if specific wetland characteristics such as a wetland's connectivity are altered. Finally, note that if WESP-ID scores suggest that proposed changes to a wetland will not appreciably change any function scores, it cannot be assumed automatically that no impacts will occur. That is because WESP-ID is a fairly coarse tool and no method or model is capable of anticipating all possible changes. WESP-ID is not intended to answer all questions necessary for wetland decisions. Users should understand the following important limitations:

1. WESP-ID 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 WESP-ID 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. Prior training and experience in delineating wetlands accurately will be helpful. For field application of WESP-ID, a multidisciplinary team is encouraged but not required. WESP-ID users must be able to:

   - distinguish the boundary between non-wetland (upland) areas and adjoining wetland, even when the latter have no surface water,
   - recognize the most common wetland plants and invasive plants in this region,
   - determine soil texture broadly (coarse, loamy, peat, other organic, or fine),
   - understand wetland hydrology and local climate,
   - delineate the approximate *contributing area* boundaries of a wetland using a topographic map as explained in this manual.

3. Some of the information WESP-ID requires may not be accurately determinable during a single visit to a wetland, particularly if that visit occurs outside the growing season. That is because 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 able to visit a site during different water conditions, or are at least familiar with the changes in wetland conditions that typically occur locally, or can consult with landowners or others who know that.

4. For the portion of WESP-ID which incorporates existing digital data, it is understood that many of those data were originally created at scales much coarser than represented by the region's 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. Nonetheless, the advantages of judiciously using the existing spatial data, as just one component of each wetland's WESP-ID scores, were determined to outweigh the disadvantages.

5. WESP-ID scores indicate a wetland's functional effectiveness only relative to other wetlands in the applicable region of Idaho (Arid West or Western Mountains & Valleys). Intensive or long-term field measurements might subsequently determine that even the wetlands scored lowest by WESP-ID 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. Thus, the numeric estimates that WESP-ID provides of wetland

functions are not actual measures of those attributes, and WESP-ID does not combine the data using deterministic models of ecosystem processes. Rather, the scores, like those of most rapid assessment methods (Hruby 1989), are estimates arrived at by using standardized criteria (models). The models systematically combine recognized indicators in a logically nuanced manner that attempts to recognize context-specific, functionally contingent relationships among indicators, such as wetland type.

6. WESP-ID's scoring models have not been validated in the sense of comparing their outputs with those from long-term direct measurement of wetland processes 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, WESP-ID's scoring models and their indicators are believed in most cases to adequately describe the relative effectiveness of a wetland for performing particular functions and providing associated values.

7. WESP-ID converts raw scores to estimates of relative wetland function or values, and then standardizes these to the scores of the 120 calibration wetlands that were assessed. This is necessary to facilitate comparisons among levels of functions by spreading out their raw scores to fully encompass a 0 to 10 scale. However, because the statistical distribution of the scores for any given function or its values differs from those of other functions or values (some functions skew low, others high), the scores of different functions are not comparable in the strictest sense. Speaking hypothetically, if 90% of the wetlands in a region had raw scores for the Fish Habitat function of 0 and among the remainder the maximum score was 4, after those raw scores are standardized (i.e., mathematically spread out into a scale of 0 to 1.0), a wetland with a score of 3 would have a standardized score of 9 (because 3 is close to the maximum score of 4 for this function in this region). The high standardized score implies the wetland is functioning very well for Fish Habitat, when in fact it is probably not functioning as low as its score seems to indicate.

8. When using WESP-ID, some of its scores might suggest some Idaho wetlands are functioning at lower levels for some functions than they actually are (Rooney et al. 2022). That is partly because practical considerations (property access, field time limits) required that most calibration sites be located near roads despite road proximity tending to reduce slightly the function scores of calibration wetlands. Thus, the reference data that WESP-ID uses to automatically standardize its raw scores contains some unavoidable bias. See Appendix D for description of the calibration process.

9. It is possible that two WESP-ID users, viewing the same wetland, will interpret some indicator questions differently. This could result in different scores for one or more of the wetland functions. This is true regardless of whether they use WESP-ID, another tool, or their professional judgment. However, when other versions of WESP were tested in different regions (Oregon, Alaska, Alberta) the statistical confidence intervals around the normalized scores, depending on the particular function, averaged ± 0.76 of the score mean on a scale of 0 to 10. That means, for example, that a score of 6.00 could be interpreted as actually being between 5.24 (6.00 - 0.76) and 6.76 (6.00 + 0.76). By most standards this would be considered to be a high level of repeatability. The relative narrowness of the score variance among users stems partly from the fact that some WESP indicators are intentionally redundant, and averaging is often used to combine indicators in the WESP models.

10. WESP-ID may be used to augment the data or interpretations of a subject professional (e.g., a fisheries biologist, plant ecologist, ornithologist, hydrologist, biogeochemist) or tribal elder when such expertise or finer-resolution data are available. WESP-ID outputs, like those of other rapid methods, are not necessarily more accurate than judgments of a subject expert, partly because WESP-ID's 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. WESP-ID outputs should always be screened by the user to see if they "make sense." Nonetheless, WESP-ID's scoring models provide a degree of standardization, balance, and comprehensiveness that seldom is obtainable from a single expert or limited set of measurements.

11. WESP-ID'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 WESP-ID and other rapid methods use to score wetland functions. Because 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. This poses challenges to wetland regulatory programs if necessary revisions to a method create a "moving target".

12. WESP-ID 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 susceptible to estimation 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 function of a few

types of wetland that is not scored because it has no reliable indicators that can be estimated rapidly in this region. Similarly, despite "ecosystem services" in its name, WESP-ID generates only a partial accounting of the values provided by any wetland function. To fully measure values and thus ecosystem services, economists would need to additionally estimate (for example) user-days or damages avoided by the performance of a particular function at a specified level in a particular wetland, and perhaps ultimately convert those to dollar estimates where that may be justified.

13. 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. The sponsors are fully aware of this conflict and its implications. While it has been necessary for WESP-ID to employ some untested assumptions, those assumptions are based on scientific principles and many have been subjected to multiple peer reviews.

14. WESP-ID 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 WESP-ID 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.

15. Understand that the relationship between wetland size and the total level of a service delivered is not necessarily linear. That means that 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 poor habitat for a particular species, then simply increasing its size without changing the wetland's characteristics will usually not make it more effective in supporting that species. 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, WESP-ID has included wetland size as an indicator for that function.

16. In some wetlands, the scores that WESP-ID's models generate may not be sufficiently sensitive to detect, in the short term, mild changes in some functions. For example, it is unknown whether WESP-ID can meaningfully quantify 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, WESP-ID can use information about a project to predict at least the direction of change to all functions as a result of some action. Quantifying the actual change will often require more intensive (not rapid) measurement protocols that are complementary.

17. WESP-ID 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 that other wetlands of its type usually support, e.g., its "site potential?" Although WESP-ID uses many landscape-scale indicators to estimate wetland functions, WESP-ID is less practical for identifying the relative influence of multiple processes that support a single wetland.

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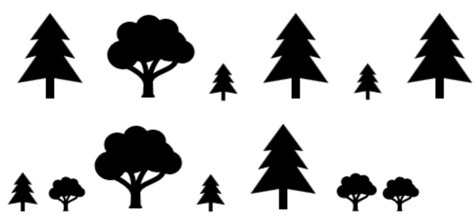
Appendix A. Illustrations for Specific Field Questions

These illustrations are presented in support of selected questions in form F and should be referred to especially while learning the method. Illustrations were not available or necessary for all form F questions. Illustrations are only examples and do not represent all situations of that question that may be encountered.

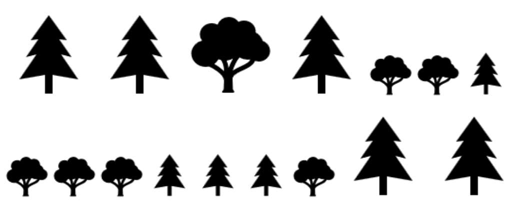
<u>F2. Height Class Interspersion</u>

Condition A. More than 70% of the canopy is comprised of either tall (>5 ft) woody vegetation or shorter (<5 ft) woody or herbaceous vegetation.

A1. The two height classes are scattered and intermixed throughout nearly all of the vegetated AA.



A2 (below). Not A1. The two height classes are mostly in separate zones or bands, or in proportionately large clumps, though some intermixing may occur.



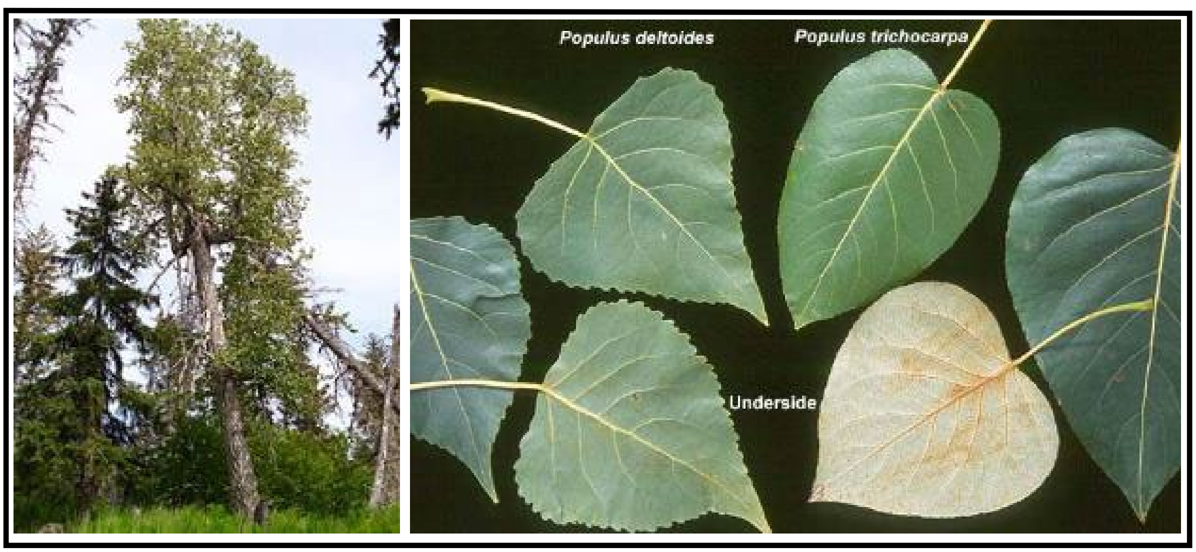
Condition B. Neither tall (>5 ft) nor shorter (<5 ft) woody or herbaceous vegetation exceeds 70% of the canopy of the vegetated AA:

B1 (below). The two height classes are scattered and intermixed throughout nearly all of the vegetated AA.

F3 Tall Willow Cover

For more examples see field guides or https://idfg.idaho.gov/species/taxa

F4 Cottonwood Trees & Regeneration



For more examples see field guides or https://idfg.idaho.gov/species/taxa

F12 Sedge Cover

For more examples see field guides or https://idfg.idaho.gov/species/taxa

F15 Bare Ground & Detached Plant Litter

Although a wetland may have no large patches of bare soil, if there are some parts of the AA that at mid-summer would have bare soil or detached plant litter covering 5-20% of the space between plants such as in this photo, those areas should count towards “bare”.

F17 Flooded Only Seasonally

If visible, flood marks that define the outer limit reached by recent flooding include, for example, litter suspended in shrubs; water lines or ice scour lines on trees, rocks, or structures; bleaching at the bases of tall herbaceous plants; mud cracks in clay soil (below left); filamentous algae suspended in grass (below); matted vegetation.

F29 Interspersion of Inundated Vegetation & Open Water

Examples of vegetation that is scattered (left), Intermediate (middle), Clumped (right) relative to distribution of open water. Note that the condition may vary seasonally depending on water level height, so assess the condition as you presume it to exist for *most* of the growing season during which surface water is present.

F31 Inundated Erect Vegetation

This includes cattail (left), tall bulrush, robust grasses partly submerged but remaining erect for most of the growing season, sedge tussocks (right), or living woody vegetation that remains partially underwater for more than 3 weeks of the growing season annually.

F32 Submerged & Floating-leaved Aquatics

This includes aquatic plants that are always submerged (left), floating-leaved aquatics (right) such as duckweed. Some can cover an entire water surface but are not algae.

F39 Outflow Duration

Seasonal-only outflow is sometimes evidenced by linear paths of matted vegetation or plant debris (below).

F48 Groundwater Probability

There is at least an intermediate probability of groundwater supporting much of a wetland's water budget if most of the wetland has a slope of more than 5% (left), or the wetland is very close to the base of a natural slope longer than the maximum dimension of the wetland and much steeper than the slope of the wetland (right).

Appendix B. Scores and Ratings: Interpreting Functions vs. Values

Your primary focus should be upon the standardized **function** scores in the Scores worksheet of the WESP-ID calculator. In contrast, the standardized **values** score describes the context within which the associated function is being performed. It is largely influenced by current land uses (which can change) and other factors not intrinsic to the particular AA that is being considered. In economic terms, the function score may be thought of as the “supply” of the function and the values score thought of as the “demand” for that function in the specific context. With rare exceptions, each values score is mathematically independent of its associated function score and draws from a different set of indicators.

Solely to make the results more understandable, the calculator assigns a three-level categorical rating (Lower, Moderate, Higher) to each function and values score. A four- or five-level categorization could alternatively have been used. The thresholds used to separate these categories are based on natural breaks in the statistical distribution of the standardized scores among the calibration wetlands for **each** function or value, determined objectively using a statistical procedure known as Jenks Optimization (Jenks 1967). ***Note that different functions and values use different numeric thresholds to define associated ratings***. This leads to a situation where, say, a score of 4.21 gets a rating of Lower for one function but Moderate or Higher for another function. That occurs because each function score and each values score has a different statistical distribution, resulting in different locations of natural breaks in the scores from the series of calibration wetlands. This uneven statistical distribution of scores occurs partly because of unavoidable characteristics of the indicators and the ways the indicators are combined by the models. Thus it is invalid to define a single set of numeric thresholds for Lower, Moderate, and Higher that would apply universally to all functions and values.

When a values rating is greater than its associated function rating, consideration should be given to raising the function rating by one step (e.g., Lower to Moderate, Moderate to Higher) and/or raising the function score by some fixed percentage or by an amount proportional to the difference between the function score and the values score. It is recognized that because the function score and its associated values score have different statistical skews, even for the same function, their mathematical combination in any manner, such as averaging, could contain significant statistical bias.

Appendix C. Principles WESP-ID Uses to Score Indicators and Structure Models

C-1 Introduction

Many models in ecology and especially hydrodynamics are deterministic. That is, rates are first estimated or measured for individual processes that comprise (for example) a river channel function, and then mathematical formulas (e.g., hydraulic or thermodynamic equations) are prescribed to combine variables that determine those processes into an actual rate for a function, e.g., grams of phosphorus retained per square meter per year. However, in the case of wetlands, generally applicable measurements of the processes and the variables that determine them simply do not exist for the types of wetlands occurring in the region. Due to the lack of data involving direct measures of wetland function from a broad array of wetlands, WESP-ID uses a different approach to model the various things that wetlands do naturally. Rather than being deterministic, that approach is at times speculative but logic-based and heuristic. Such approaches are well-regarded as an interim or alternative solution when knowledge of system behavior is scant (e.g., Haas 1991, Starfield et al. 1994).

C-2 Indicators

For most WESP-ID models, physical or biological *processes* that influence a given function were first identified and then *indicators* of those processes were chosen and grouped accordingly. (The term *indicators* is roughly comparable to the term *metrics* used by some other methods). The indicators then were phrased as questions in the data forms. None of WESP-ID's field-level indicators require *measurement*; they all are based on visual estimates. While the *precision* of measurements is typically greater than for visual estimates, their *accuracy* in predicting functions may or may not be. That is because it is often difficult to obtain sufficient measurements of an indicator, in the span of time typically available to wetland regulators or consultants, to create a full representation of any particular indicator of wetland function, let alone all the 129 indicators needed to reasonably assess a common suite of functions and values.

WESP-ID's indicators were mainly drawn from inferences based on scientific literature and the author's experience throughout North America (e.g., Adamus et al. 1987, 2013, Adamus et al. 1992, 2009, 2015, and 2016). Indicators used by other methods for rapidly assessing functions and values of wetlands were also considered. To qualify as an indicator, a variable not only had to be correlated with or determining of the named process or function, but it also had to be rapidly observable during a single visit to a typical wetland during the growing season, or information on the indicator's condition had to be obtainable from aerial imagery, existing spatial data, and/or landowner interview.

When developing models of any kind, the factors that contribute to the output can be categorized in three ways: (1) unknown influencers, (2) known influencers that are difficult to measure within a reasonable span of time, and (3) influencers that can be estimated visually during a single visit and/or from existing spatial data. WESP-ID provides an incomplete estimate of wetland functions because it incorporates only #3. Also, some of the indicator variables it uses may be *correlates* of wetland functions rather than actual influencers. For example, changes in water levels are correlated with changes in nutrient cycling, but it is the difficult-to-measure changes in sediment oxygen and pH that induce the changes in nutrient cycling, not the water level changes themselves (which happen to correlate loosely with those changes in oxygen and pH). These types of limitations apply to all rapid assessment methods.

For regulatory and management applications (e.g., wetland functional enhancement), it's often helpful to understand to which of four categories an indicator belongs:

1. *Onsite modifiable*. These indicators are features that 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 factors 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. 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 maintain or increase 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 (catchment 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.

C-3 Weighting and Scoring

WESP-ID assigns relative weights or scores at three junctures:

1. Scoring of the conditions of an indicator, as they contribute to that indicator's prediction of a given wetland process, function, value, or other metric.
2. Scoring of indicators (metrics) relative to each other, as they together may predict a given wetland process, function, value, or other metric.
3. Scoring of wetland processes, as they together may predict a given wetland function or other attribute.

Each of these is now described here as well as in the "How It Works" worksheet in the WESP-ID calculator. Note that WESP-ID does not assign weights to the functions and values that it scores, e.g., does not assume that Amphibian Habitat is any more or less important than Nitrate Removal.

Weighting of Indicator Conditions

As an example of #1, consider the following conditions of the indicator *Ponded Water* as that indicator is applied with others to estimating the Waterbird Habitat function found in worksheet WB of the calculator:

F34	Ponded Water [WS, SR, PR, NR, SFTS, AM, WB]	During most times when surface water is present, the percentage -- with or without inundated vegetation-- that is ponded (stagnant, or flows so slowly that fine sediment is not held in suspension) is: [Note: ponding is unlikely if the AA's slope from inlet to outlet is more than 2%]				0.00
		<1% of the water. Nearly all the surface water is flowing when it is present. Skip to F38 (Water Color).	0	0	0	
		1 to <5% of the water. Most of the surface water is flowing when it is present.	0	2	0	
		5 to <30% of the water. Most of the surface water is flowing when it is present.	0	3	0	
		30 to <70% of the water. Most of the surface water is ponded when it is present.	0	4	0	
		70-95% of the water. Most of the surface water is ponded when it is present.	0	5	0	
		>95% of the water. Nearly all of the surface water is ponded when it is present.	0	6	0	

Each row following the first describes a possible *condition* of the indicator. WESP-ID users select the one condition that best describes the AA they are assessing (they do so by entering a "1" next to that condition in the column to the right of the text). In the gray column after that, WESP-ID's author previously assigned relative weights (which cannot be altered by WESP-ID users) to each of these conditions as they relate to the function, Waterbird Habitat. In this case, the last condition was considered the most supportive of that function, other factors being equal, and so had been given a weight of 6. This does not necessarily mean it is 6 times more influential than the first condition which has a weight of 0, because this is not a deterministic model. However, available literature seemed to suggest that this condition is better for most waterbirds than the other conditions. When the same indicator is used to score a different function, the weight scheme might be reversed or otherwise differ.

In many instances, considerable scientific uncertainty surrounds the exact relationship between various indicator conditions and a function, and thus which weights should be assigned. However, keep in mind that the above indicator is just one of potentially 33 indicators used to assign a score to the Waterbird Habitat function. To some degree, the use of so many indicators (including several related ones that are averaged together with this one because they probably correlate highly with it) will serve to buffer the uncertainty in our knowledge of exact relationships.

WESP-ID users will also notice that the weighting scale for some indicators ranges from 1 to 8 (especially if there are 8 condition choices) while for others it ranges only from 0 to 2, or some other range. This does not mean that the first indicator is secretly being weighted 4 times that of the second, because before the indicators are combined, their scores are "standardized" to a 0 to 1.00 scale. The Excel spreadsheet accomplishes that by multiplying the "1" signifying a user's choice (here in the second column) by the pre-determined condition weight in the third column, and placing the product in the last column, whereupon a formula in the green cell (not visible here) takes the maximum of the values pertaining to this indicator in that last column and divides it by the maximum weight in the condition weight column. The formula in the green cell could just as easily have taken the only non-zero value in the last column and divided it by the maximum weight pre-assigned to the indicator conditions.

Weighting and Scoring of Indicators of Functions and Values

If one indicator is so important that occurrence of a particular condition of that indicator can solely determine whether a function even exists in a wetland, then conditional ("IF") statements are used in WESP-ID models to show that. For example, if a wetland dries up annually and it never has a surface connection to other water bodies, the Fish Habitat function is automatically scored "0". In this case, "access" (presence/absence of inlets or outlets) is a controlling indicator.

If a few indicators are not individually so controlling but at least one is likely to be strongly limiting in some instances, WESP-ID takes the *maximum* among of the indicators, rather than the average. The latter is applied to situations where indicators are thought to be compensatory, collinear, or redundant. WESP-ID uses averaging as the default operator unless situations can be identified where there is compelling evidence that an indicator is controlling or strongly limiting.

There also are instances where the condition of one indicator (such as wetland type) is used to determine the relevance of others for predicting a wetland function. For example, the effect of vegetation structure within a wetland on the wetland's ability to slow the downslope movement of water in a watershed can be ignored if the wetland has no outlet channel. This has been encoded in the Excel spreadsheet.

Weighting and Scoring of Wetland Processes That Influence Functions

For many functions, dozens of hydrologic (e.g., evapotranspiration) and/or ecological (e.g., juvenile dispersal) processes contribute to its ultimate level of performance. Often, too little is known about the relative importance of these processes in determining a wetland function, and for some processes there are no known indicators that can be estimated visually. Nonetheless, WESP-ID attempted to use processes as an organizing framework for the many indicators it employs to score each function. Processes associated with a given function and indicators associated with each process are named in the ochre-colored cells near the bottom of each worksheet in the WESP-ID calculator file. For most functions, no more than 3 or 4 contributory processes are defined, with each containing a few to a dozen or more indicators. For most functions, the named processes are weighted like indicators and used as a "subscore" when computing the score for a function. For example, for the function Phosphorus Retention, one version of the function model contains these processes:

[3*Adsorb + 2*AVERAGE(Connec, Desorb) + AVERAGE(IntercepWet, IntercepDry)] / 6

That means that Adsorption was given half (3/6) of the weight, the average of Connectivity and Desorption was given one-third (2/6) of the weight, and the average of Dry Interception and Wet Interception was given 1/6 of the weight. They are divided by 6 because that is the sum of their weights (3 + 2 + 1) and the resulting raw function score, for the sake of clear comparisons, is multiplied by 10 to place it close to the 0 to 10 scale used by all functions.

Appendix D. WESP-ID Origins, Evolution, and Regionalization

WESP-ID is a regionalized modification of WESP, the Wetland Ecosystem Services Protocol (Adamus et al. 2010 and updates). WESP and WESP-ID build upon indicator-function relationships first described by the author in the early 1980s and in several agency publications since then (Adamus 1983, Adamus et al. 1987, Adamus et al. 1982, Adamus 1982a, 1982b). WESP and WESP-ID also incorporate elements of the Hydrogeomorphic (HGM) Approach (Brinson 1983, Smith et al. 1985) and the Millennium Ecosystem Assessment (Finlayson et al. 2005). From 2006 to 2009 a regionalization of WESP was conducted in Oregon, resulting in ORWAP[2], the Oregon Rapid Wetland Assessment Protocol (Adamus et al. 2009, 2016). That tool is required for all major wetlands permitting and compensation in Oregon.

The basic steps of the WESP regionalization process are:

1. Identify and review technical literature from the region and other regions as relevant. Use that review to modify or add to the indicator variables that WESP uses to assess wetland functions.
2. Select a set of wetlands to which WESP-ID will be applied in order to (a) calibrate and standardize WESP-ID scores to those of wetlands in the particular region, and (b) identify technical weaknesses in the WESP indicators, assumptions, and models as applied to the region and correct those.
3. Collect WESP-ID data from the calibration wetlands.
4. Modify as needed and then complete the calculator and manual.

Details of the steps to regionalize or develop a wetland rapid assessment method are described in Dorney et al. (2018) and as follows.

<u>Literature Review</u>

To better understand relationships among variables that might indicate functions of Idaho wetlands specifically, it was first necessary to identify and read previously published studies. The author used keyword searches of *Web of Science* and *Google Scholar* to identify those. In addition to using obvious keywords such as Idaho and wetlands, the author expanded the query to include various forms of terms such as lake, pond, stream, river, riparian, groundwater, catchment, watershed, and paired those with keywords describing geographic features within the study area and nearby regions. An indexed database was created that allows the citations to be sorted quickly by any combination of topics. Most of the citations refer to peer-reviewed

[2] http://www.oregon.gov/dsl/WW/Pages/ORWAP.aspx

scientific publications, and the abstracts of all (and sometimes the entire publication) were read. The database was subsequently used to document the reasons behind using particular variables in particular WESP-ID models, as well as to support generally the weights assigned to various conditions of a given indicator.

Selection of Regional Calibration Wetlands

Although each of WESP-ID's scoring models has a *theoretical* minimum score of 0 and a maximum of 10, the *actual* range for any given function is usually narrower, even when WESP-ID is applied to a large number of wetlands. Moreover, in such an application, the resulting range of the raw scores found among all sites will be quite narrow (e.g., 3 to 8) for some functions whereas for others it will be broad (e.g., 0 to 10). Thus, to facilitate rough comparisons among functions, all raw scores were standardized mathematically to the same 0 to 10 scale. For each wetland function or other attribute assessed by WESP-ID, this was done by comparing the raw scores with the range of scores determined from all the wetlands in its region that were visited and assessed. This comparison process is termed "calibration" or "standardization" and the assessed wetlands are termed "calibration wetlands".

The calibration wetlands were not selected randomly. That is because we were not trying to characterize the condition of wetlands in the study area overall. Rather, our aim was to define the likely range of WESP-ID raw score variation with as few wetlands as possible. Visiting and assessing a wide variety of wetlands was essential not only to calibrate the indicators and model scores as described above, but also to clarify the wording of questions on the data forms and streamline them by determining the most efficient order of questions , i.e., which sequencing allows users to skip the most questions in various contexts.

To create the input data for selecting calibration sites, we first used GIS to intersect existing wetlands spatial data layers with spatial data pertaining to hydrography (stream connectivity), watershed position, size, surrounding land cover, and other variables depending on what was functionally relevant and available. Performing those intersects resulted in a large database wherein each row was a different wetland polygon and each column a different characteristic of that wetland or its associated landscape as derived from the overlay.

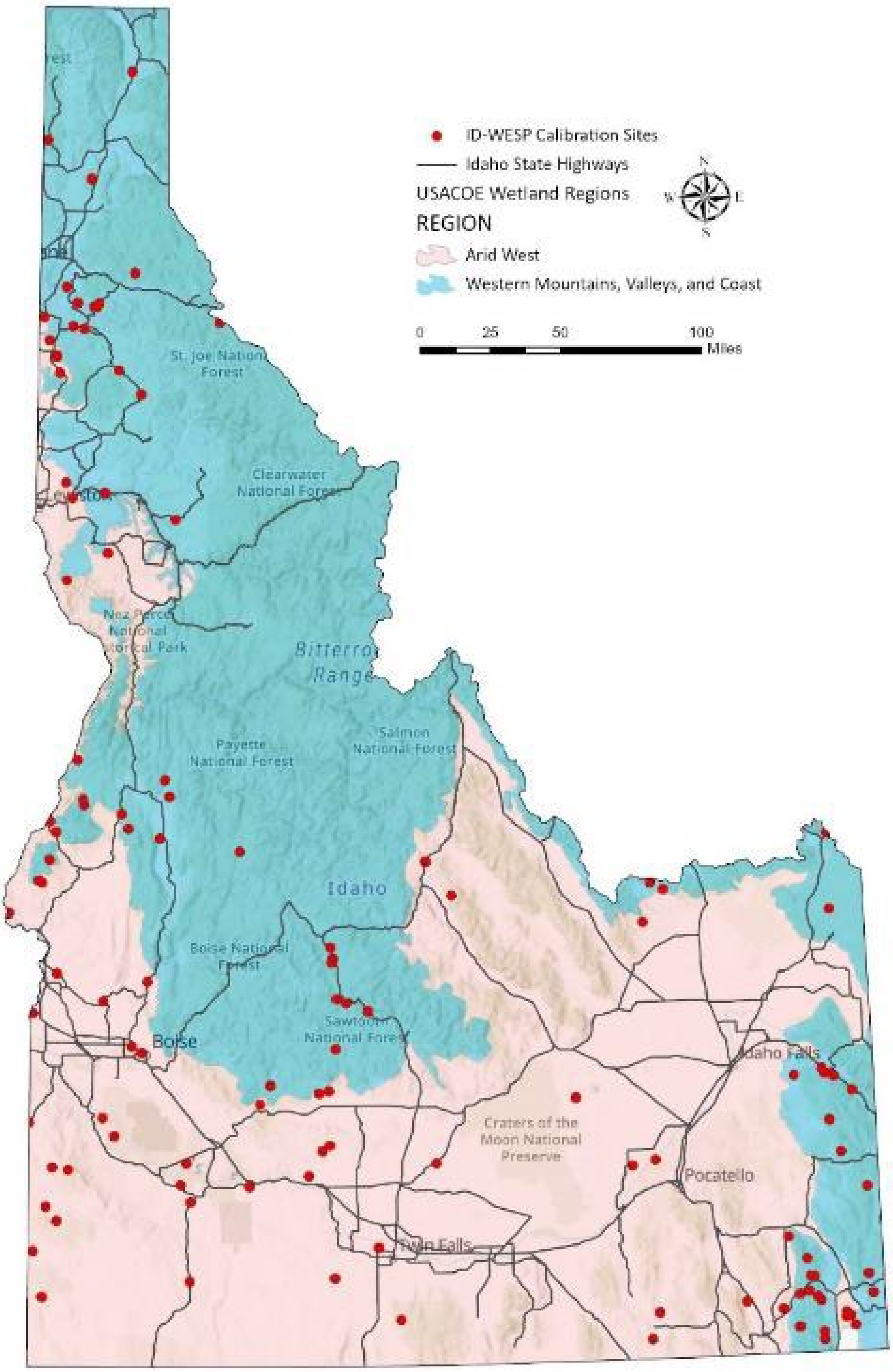


Figure 8. Locations of WESP-ID wetland calibration sites

Future Refinements

Although no further work is contemplated or considered necessary to begin using WESP-ID widely in the study area, it is recommended that efforts be expanded to quantify the repeatability of its ratings among different independent users, as well as efforts to refine the calibration of its scores by comparing with actual measures of wetland functions, as difficult and expensive as those are to make among a statistically significant number and variety of wetland sites.

Assessments of additional wetlands could be added to the existing calibration database to increase the range of variability captured by the calibration database. However, because this could introduce a new regional maximum and/or minimum for the scores of some functions, raw scores from all the existing calibration wetlands would subsequently need to be re-standardized statistically and thresholds for the natural breaks between rating categories would need to be redetermined using the Jenks algorithm. This would not be difficult to do, but unless the scores database was frozen at various points, applicants for wetland approvals and persons monitoring restoration projects would encounter a "moving target" and that would complicate interpretation of WESP-ID outputs.

This project was not tasked with proposing specific procedures or criteria for using WESP-ID outputs to make decisions about individual wetlands. That is rightfully in the realm not of science but of policies recommended by the relevant state and federal agencies. Those participants may wish to give greater weight to some functions than to others depending on local concerns and needs. For a given site, consideration might be given to the number of function-value combinations that scored high and/or the diversity of functions among those scoring high. For wetland restoration or enhancement projects, the function score profiles could be compared before and at successive years after the project to ensure that targeted functions are increasing as planned. In any case, it is likely that decisions about protecting or developing particular wetlands will take into account not only the WESP-ID ratings, but also development costs, biological survey data not accounted for by WESP-ID, the likelihood that the wetland will remain intact if not protected, and other factors. For additional discussion of this topic see Dorney and Adamus (2018).

Appendix E. Acknowledgements

This project was initiated by the Walla Walla District, US Army Corps of Engineers, to help inform the agency's decisions regarding the extent and type of wetland mitigation appropriate for Idaho. Dr. Paul Adamus of Corvallis, Oregon, designed and developed WESP-ID, trained field personnel, and wrote this manual. Ken Israel and Keith Holliday managed the contract for Sealaska Technical Services. Lon Ottosen provided GIS support. Field work was conducted by Scott Clark, Ryan Ramsey, and Keith Holliday. Chris Murphy of Idaho Department of Fish & Game provided helpful comments throughout the project.