Appendix A

Utah Rapid Assessment Procedure User's Manual and Reference Material

UTAH RAPID ASSESSMENT PROCEDURE: Method for Evaluating Ecological Integrity in Utah Wetlands

User's Manual, Version 3.0- DRAFT

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Previous Versions: Edited for formatting in February 2016 and edited to add additional reference cards in May 2016 (overlap and wetland birds). Major changes were made to many of the metrics after one year of field testing in September 15, 2014. Major changes made after field testing in 2017 and additional field work in 2018. Updated some hydrology metrics, functional assessment, and stressor checklist in 2020.

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Introduction and Background

The Utah Geological Survey (UGS) began developing the Utah Rapid Assessment Procedure (URAP) in 2014 as a tool to rapidly assess the condition of Utah's wetland resources. URAP is intended to provide basic inventory information on the status, condition, and potential function of Utah's wetlands and has been implemented in several regions in the state (Menuz and others, 2016a; Menuz and others, 2016b; Menuz and Sempler, 2018, Menuz and McCoy-Sulentic, 2019a). The UGS added metrics to assess habitat for sensitive amphibian species to the protocol in 2015 and 2016 (Menuz and Sempler, 2018), developed draft methods for wildlife habitat in 2017 (Menuz, 2017), and started using Washington State's Wetland Rating System (Hruby, 2014) for evaluating water quality and hydrologic function in 2020, adding some modifications to the Washington protocol in 2020.

Condition and function assessments can be used to identify priority sites for restoration projects (those with lower condition scores or higher function scores) or conservation actions (those with higher condition and function scores). With repeat sampling, URAP can be used to evaluate the success of restoration projects or the effects of new stressors on wetland condition and function. When applied to a random selection of wetlands, URAP can be used to make generalizations about the health and function of all wetlands in an ecoregion, management area, watershed, or other area of interest. This baseline data can be used to identify rare or threatened wetland types and common regional causes of wetland degradation and to inform management and conservation actions. The application of a single wetland assessment protocol across the state of Utah will facilitate the compilation of a large body of standardized data on wetland characteristics that will further our understanding of these important and understudied natural resources.

Environmental Protection Agency Assessment Framework

The Environmental Protection Agency (EPA) has a three-tiered approach to wetland monitoring and assessment (U.S. Environmental Protection Agency, 2006). Level I assessments are generally applied broadly across a landscape and use geographic information systems and remotely sensed data to evaluate wetland abundance and distribution and surrounding land use. These assessments can provide a coarse estimate of wetland condition based on calculated metrics in the surrounding watershed, such as road density, percent agriculture, and presence of point source discharges. Level I assessments are relatively inexpensive and efficient for evaluating wetlands across broad geographic areas but cannot provide specific information about the on-site condition of any particular wetland. Level 2 assessments evaluate wetland condition in the field using a rapid assessment approach. These assessments are intended to take two people no more than four hours of field time, plus up to half a day in the office for preparation and subsequent analysis, and often rely primarily on qualitative evaluation. Level 2 assessments can be used to understand ambient wetland condition, to determine sites appropriate for conservation or restoration, and, in some cases, for regulatory decision-making. Level 3 assessments are detailed, quantitative field evaluations that more comprehensively determine wetland condition using intensive measures such as invertebrate or plant community enumeration or water quality measurements. These assessments require the most professional expertise and sampling time, including, in some cases, repeat visits to a site. Information from Level 3 assessments can be used to develop performance standards for wetland conservation and restoration, support development of water quality standards, determine causes of wetland degradation, and refine rapid assessment methods.

URAP is a Level 2 assessment method designed to require up to two hours of office time to prepare for field sampling and no more than four hours of field survey time per site for a team of two. Office preparation is needed to create survey maps and gather Level I landscape data to assist with evaluation of metrics in the field. URAP surveys typically include the collection detailed plant community data from a timed meander survey, which can be considered quasi-Level III data (see McCoy-Sulentic and Menuz, 2019, for a comparison of different wetland vegetation survey methods) and may also include the collection of water quality samples. Level 3 data can be used to calibrate and validate Level 2 methods, and Level 2 and 3 data can be used to calibrate and validate Level I landscape models. Evaluation of the inter-relatedness of results from all three levels is a helpful first approximation to determine the general soundness of methods. URAP methods were developed in part based on evaluation of inter-relatedness among levels, and the protocol will continue to evolve as more data at all three levels are collected.

Functional Versus Condition Assessments

Wetland assessments are commonly conducted to evaluate the condition, function, or both of wetlands. Condition assessments are designed to evaluate the ecological integrity, or overall soundness, of wetlands. Wetlands with high integrity exhibit species composition, physical structure, and ecological processing within the bounds of states expected for systems operating under natural disturbance regimes (Lemly and Gilligan, 2013). Direct or indirect anthropogenic alteration may lead to changes in these states and a concomitant lowering of the overall integrity of the wetland. Wetlands are evaluated to determine the degree to which they deviate from a reference standard, or anthropogenically unaltered, wetland. Functional assessments, on the other hand, evaluate functional services provided by wetlands, such as the ability to attenuate flood waters or provide wildlife habitat, without regard to the overall naturalness of a site. Functional elements related directly to condition, such as the ability of a wetland to support natural plant species composition, can be components of functional assessments, but are usually not the primary focus. Maximizing some functional elements can require trade-offs with other elements; for example, using a wetland to improve water quality from a wastewater treatment plant may lead to reduced integrity of the plant community (Fennessy and others, 2004).

Functional assessments often evaluate wetlands based on services deemed important to society, whereas condition assessments are intended to be less directly tied to societal values. Functional assessments are useful to directly evaluate potential or actual services lost, to provide recommendations for appropriate mitigation or restoration to replace lost services, and to determine trade-offs when optimizing specific functions. However, it is difficult to reduce all wetland processes to a few functional services, and there may be services provided by naturally functioning wetlands that have not yet been recognized or valued by society. Condition assessments serve as a buffer against the subjectivity of societal valuation of services by evaluating wetlands based on a naturally functioning baseline. Not every wetland should be expected to provide every possible type of service, and even wetlands with few perceived societal functions may be more connected to larger processes than we are able to recognize. The condition and function components of URAP work together to provide a more complete understanding of the state of Utah's wetlands.

Reference Standard

Reference standards are an important component of condition assessments. The reference standard condition is the condition that corresponds with the greatest ecological integrity within the continuum of possible site conditions (Sutula and others, 2006) and is usually specific to a particular class of wetland (e.g., montane meadow, saline depression). The reference standard condition can refer to the expected state prior to any anthropogenic disturbance or at a specified historic point in time, (e.g., pre-settlement of North America by European immigrants), or it can refer to the condition found at the least disturbed sites within the survey area or wetland type (Stoddard and others, 2006). The reference standard condition for URAP is adopted from Colorado Natural Heritage Program's Ecological Integrity Assessment, which rates metrics based on "deviation from the natural range of variability expressed in wetlands over the past ~200–300 years (prior to European settlement)" (Lemly and Gilligan, 2013).

Reference standard conditions are ideally determined from field observations of undisturbed or minimally disturbed wetlands (i.e., reference standard sites). However, it can be difficult to obtain data from enough undisturbed sites to determine the natural range of variability, and in highly altered landscapes, there may be no or too few sites within particular wetland classes to determine the reference standard. Because of this, reference standards for URAP were developed based on field observations from minimally disturbed wetlands, review of relevant literature, and evaluation of conditions described in existing protocols. Reference standards may evolve with the collection of data from additional reference standard sites, particularly for wetland classes that were not visited during initial protocol development.

Wetland Classification

Classification is an important element of successful wetland assessments. The anticipated natural state of a wetland depends in large part on its major defining characteristics, such as whether it is located in an isolated depression or along a river and whether it is found in arid desert or snowy mountains. Effective assessments evaluate wetlands in relation to reference standard conditions in similar types of wetlands. To address the natural variability found in wetlands, metrics or entire assessment protocols can be developed for individual wetland classes or metric scoring can differ between classes. Metrics can also be developed that ask observers to evaluate condition in relation to that expected for the given class. This type of metric requires that observers are able to recognize the wetland type and have experience with or knowledge of similar wetlands.

Classification schemes that minimize variability within classes while avoiding the creation of too many classes or classes that are difficult to distinguish are the most useful. The U.S. Fish and Wildlife Service' s Cowardin classification separates wetlands and deepwater habitat into five systems (marine, estuarine, riverine, lacustrine, and palustrine) that are further divided based on substrate material and flooding regime or predominant vegetative life form (Cowardin and others, 1979). This system is used to classify wetlands for the National Wetlands Inventory, the most comprehensive wetland mapping conducted across the United States. However, the Cowardin system is overly general at higher hierarchical levels (i.e., riverine or palustrine emergent) and contains a very large number of classes at lower levels (over 150 classes at the subclass level).

The International Terrestrial Ecological Systems Classification (Ecological Systems) was developed by NatureServe to provide mid-scale classification of terrestrial ecosystems based on vegetation patterns, abiotic factors, and ecological processes (http://explorer.natureserve.org). There are 15 wetland and riparian Ecological Systems that occur or potentially occur in the state of Utah. Ecological Systems have high degrees of vegetation structure and regional specificity that make them useful for assessments; however, not all wetlands fit easily into a single system, and systems may not yet have been developed for every wetland type. Hydrogeomorphic (HGM) classification was developed from the assumption that wetland function is most closely related to wetland hydrology and geomorphology (Brinson, 1993). Wetlands are classified as one of seven types based on hydrology and geomorphology, though regional subclasses are usually developed for assessments (https://wetlands.el.erdc.dren.mil/class.html HGM classification is particularly useful for assessing site hydrology. Ecoregions are areas with similar ecosystems based on similarity of geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology (Omernik, 1987). Ecoregions can also be useful to determine appropriate expectations for wetland condition. There are seven Level 3 Ecoregions in Utah, including three (Central Basin and Range, Colorado Plateau, and Wasatch and Uinta Mountains) that make up the majority of Utah.

The UGS has typically used Ecological Systems to separate wetland sites into ecologically distinct units for the sake of analysis and comparison, with the goal of having sites classified in a way that is useful for setting the expected condition of structural elements of wetlands, such as the relative cover of woody versus non-woody plant species, as well as expected plant species composition. However, there is considerable overlap between some of the Ecological Systems, and the Ecological Systems tend to be very broad, making them a challenge to use for such analysis (Menuz and others, 2016). The UGS is working on developing a new wetland classification system for wetlands in the Central Basin and Range Level III ecoregion (Menuz and McCoy-Sulentic, 2019a) and has developed a preliminary classification of wetlands in the Wasatch and Uinta Mountains ecoregion that separates Ecological Systems by level IV ecoregions (Menuz and others, 2016a). This new system, called Utah wetland types, will continue to be refined as more data for Utah's wetlands are collected. Keys to the classification systems being used for Utah are provided in appendix A.

URAP Development

URAP was developed as a Level 2 rapid condition assessment method for wetlands in the state of Utah. The initial development of URAP began with field-testing of three previously developed rapid assessment protocols in 2010 and 2013, including the Utah Wetlands Ambient Assessment Method (Hoven and Paul, 2010), Colorado's Ecological Integrity Assessment (Lemly and Gilligan, 2013), and USA-RAM, an assessment protocol used in the EPA's 2011 National Wetland Condition Assessment. At the conclusion of field-testing, we evaluated each tested metric to determine the strength of support for including the metric in a condition assessment (based on literature reviews and best professional judgment) and the degree to which metric states were clear to observers and consistently evaluated in the field. The resulting protocol was field tested in the Weber Watershed in 2014 and additional adjustments were made to the metrics as needed (Menuz and others, 2016a).

The UGS added metrics to assess habitat for sensitive amphibian species to the protocol in 2015 and 2016 (Menuz and Sempler, 2018) and developed draft methods for wildlife habitat and water quality improvement functionality in 2017 (Menuz, 2017). The latter two components were developed as simple checklists of indicators rather than more complex metrics due to feedback from a working group meeting; stakeholders thought more complex approaches would be too difficult to validate and simple approaches would be more repeatable across observers (Menuz, 2017). The UGS conducted a field validation study in 2017 to further evaluate the repeatability of methods across different observers and at different times of the year (Menuz and McCoy-Sulentic, 2019b). Major changes as a result of this testing included a major rewrite of the wildlife indicator checklist and use of the Washington State Wetland Rating System (Hruby, 2014) in lieu of the water quality indicator checklist. Some individual condition and amphibian habitat metrics were also changed, and the UGS developed additional supporting information to help raters. The UGS made some minor changes to the Washington State Rating System in 2020 to remove components that we could not evaluate in Utah and to provide more guidance on the field forms themselves instead of relying solely on guidance in the field manual.

Set-Up and General Site Evaluation

This section describes the guidelines for plot set-up and collection of general site information for URAP. Projects that use URAP may differ in their sample frame and thus guidance on including or excluding sites may differ. For example, some projects may only included vegetated wetlands while others may include sparsely or unvegetated mudflats.

Presurvey Activities

Site Selection and Office Preparation

The process used for site selection for condition assessment surveys will depend on the objectives of the surveys. Targeted surveys may be conducted at subjectively chosen wetlands based on monitoring needs associated with restoration, conservation, or mitigation projects or for other management purposes. If surveys are conducted at wetlands randomly chosen from within an appropriate sample frame (e.g., all mapped wetlands within a watershed, all slope wetlands in a particular ecoregion, etc.), inference about wetland condition can be made to all wetlands within the sample frame.

After initial site selection, several office tasks should be completed before field surveys, including: 1) verification that site is in sample frame; 2) compilation of office evaluation information, including stressor and site hydrology information; and 3) creation of field surveys maps. In brief, first, evaluate randomly selected sites in a geographic information system (GIS) such as ArcGIS or Google Earth using imagery to determine whether they are actually wetlands within the chosen project sample frame. A similar process to that outlined in “Selection of Assessment Area in the Field”, below, should be used in the office to keep, move, or reject randomly selected sites, with sites kept unchanged when the imagery is unclear. Second, use spatial data from state or federal agencies, Utah Automated Geographic Reference Center (AGRC), or other sources to make a preliminary evaluation of those metrics that require an initial office examination. In particular, look for hydrologic stressors on the landscape that may influence the site. There is no maximum up-gradient distance at which stressors should no longer be examined, though the impact of stressors will generally diminish the further they are from a site. Last, prepare site maps for field surveys using the most current and high resolution aerial imagery available. Maps should include a close-up of the site with 100-m buffer and a landscape mapping showing 100-m and 500-m buffers surrounding the site. Additional maps showing the likely contributing basin and information on how to access the site can also be included, depending on need.

Wetland Determination

Surveyors must first determine whether a site is within the target population for the project. For UGS projects, the target population frequently includes all wetlands, as defined by U.S. Fish and Wildlife Service (USFWS), that are less than 1 m deep. The USFWS definition states that wetlands must have indicators of wetland hydrology and should also have hydrophytic plants and hydric soils when vegetation and/or soils are present. Hydrophytic plants are those species that are assigned wetland indicator ratings of FAC (facultative- occurs in wetlands and non-wetlands), FACW (facultative wetland-usually occurs in wetlands), and OBL (almost always occurs in wetlands) by the 2013 National Wetland Plant List (https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html).

Evaluation of each wetland characteristic will loosely follow the Army Corps of Engineers wetland delineation and regional supplement guidelines (U.S. Army Corps of Engineers, 2008; U.S. Army Corps of Engineers, 2010; Environmental Laboratory, 1987). Some indicators only apply to a particular region so first determine which region (Arid West or Western Mountains) your site is located in. It is important to not only look for listed indicators, but to use best professional judgment to determine the likelihood of having false negatives or false positives. Hydrophytic vegetation and hydric soils at recently altered sites can be indicators of past rather than current conditions. Drier-than-normal conditions can lead to an absence of indicators of wetland hydrology at normally wet sites, and wetter-than-normal conditions and recent heavy rainfall events can lead to the presence of indicators of wetland hydrology at sites that are not wetland. Pay attention to seasonal norms, recent precipitation events, and signs of site alteration such as draining.

First, evaluate the site's landscape position. Concave surfaces, floodplains, nearly level areas, the fringe of open water or other wetlands, areas with aquitards within 60 cm of the surface, and areas with groundwater discharge as well as some areas with manipulated hydrology, such as pastures fed from irrigation ditches, are likely to be wetlands. If a site is unlikely to be wetland based on landscape position, you should still look for indicators of wetland hydrology and pull up a few soil samples using a handheld auger to check for hydric soils (ignore vegetation unless most dominant species can be easily identified). Continue to look for indicators within an area 100 m from the original randomly selected sample point, focusing on areas in landscape positions most likely to contain wetland. If an area is in a landscape position that should support wetland but no wetland characteristics are present, make note of this fact, including mention of whether the site appears hydrologically altered and whether the site may have problem soils or other conditions that make it difficult to observe wetland characteristics. If the edge of the wetland must be determined in order to establish the AA, it is probably easiest to use the Dutch auger to determine the approximate boundary where hydric soil indicators are no longer present. *Do not worry about finding the exact jurisdictional boundary of the AA, as long as no more than 10% of the AA is composed of area that is definitely or possibly upland.*

The following is a list of the three wetland characteristics and how they should be evaluated:

1) Wetland Hydrology: Wetland hydrology is present if a site has surface water or a water table ≤30 cm from the soil surface over at least 14 consecutive days during the growing season in 5 out of 10 years (U.S. Army Corps of Engineers, 2008; U.S. Army Corps of Engineers, 2010). The growing season is defined as the portion of the year where the soil temperature is above 41°F (biological zero), but can be estimated as the median dates where the air temperature is ≥28°F in the spring and fall based on nearby meteorological stations (see https://www.nrcs.usda.gov/wps/portal/wcc/home/climateSupport/wetlandsClimateTables/). Using the Indicators of Site Hydrology page in appendix A, determine whether there is at least one primary or two secondary indicators of wetland hydrology present at the site. Permanently flooded areas with water >2 m deep will be considered deepwater habitat, not wetland (Cowardin and others, 1979). For safety reasons, no more than 10% of the AA should be composed of water >1 m deep, even though this area may still be considered wetland.
2) Hydric Soils: Hydric soils are soils that are saturated or inundated long enough during the growing season to develop anaerobic conditions. Dig a quick soil pit to approximately 30 cm using a Dutch auger to look for indicators of hydric soils, using the Hydric Soil Indicators for the Arid West and Western Mountains page in appendix A. If no indicators are found, dig additional pits or a deeper pit (up to 60 cm) to more thoroughly evaluate the area.
3) Hydrophytic Vegetation: Hydrophytic vegetation is composed of plant species that are adapted to grow in anaerobic soil conditions. You only need to assess vegetation if there is at least 5% aerial vegetation cover. Sites where over 50% of dominant plant species have wetland indicator ratings of OBL, FACW, or FAC have hydrophytic vegetation. If most of the dominant plant species at a site can be readily identified in the field, surveyors can evaluate this characteristic. This characteristic is particularly useful when sites are dominated by only a few species. The following steps will be used to determine which species are dominant, though these steps are not as stringent as a thorough U.S. Army Corps of Engineers determination because cover estimates are not made for all species present.
    a. Determine strata (vegetation layers) present in the area (table 1). Strata include trees (DBH ≥7.6 cm), saplings and shrubs (DBH < 7.6 cm), herbaceous plants, and woody vines.
    b. Estimate the percent of the assessment area covered by each stratum. For example, all tree species combined (including trunks and canopy cover) may occupy 25% of the assessed area. If an individual stratum has less than 5% cover, consider species in that strata part of a more abundant strata.
    c. Determine the cover values that correspond with 50% and 20% relative cover within the strata. For example, if the stratum has 60% total cover, 50% relative cover will be 0.5 *60% or 30% total cover and 20% relative cover will be 0.2*60% or 12% total cover.

Table 1. Evaluation of hydrophytic vegetation at a site.

Trees (DBH ≥7.6 cm) **Total Cover:** 0%
Saplings/Shrubs (DBH < 7.6 cm) **Total Cover:** 3% *Species considered as part of herbaceous plant layer because strata has less than 5% cover*
Herbaceous Plants **Total Cover:** 60% **50% rel. cover:** 30% **20% rel. cover:** 12% Species: *Schoenoplectus americanus* Cover: 15% Rating: OBL Species: *Distichlis spicata* Cover: 10% Rating: FAC Species: *Helianthus annuus* Cover: 4% Rating: FACU Species: *Tamarix chinensis* [1] Cover: 3% Rating:FAC *Together the cover of these four species is 32%, enough to meet the 50% relative cover requirement. No additional species have 12% cover, so these are the dominant species.*
Woody Vines **Total Cover:** 0%
 # FAC, FACW, OBL species 3 **/ # all species** 4 **= 75%**

[1]Sapling/shrub species that was included as an herbaceous plant due to low cover in strata

d. Record the name(s) of the most prevalent plant species within each strata and their percent cover. You can stop recording plant species once the total recorded cover sums to the 50% relative cover value (i.e., 30% absolute cover in our example). If any species have 20% relative cover (i.e., 12% absolute cover in our example) and are not on the list, add those species as well.
e. Once the dominant species in each stratum are listed, determine the percent of these species that are FAC, FACW, or OBL. A species can be counted twice if it is listed in two strata (e.g., trees and saplings in the tree and shrub layers).

All indicators can be a challenge to determine in the field. Wetland hydrology can be difficult to evaluate when sites are surveyed outside of the normal wet period, though often sites will at least have the FAC-neutral and topographic position secondary indicators. Hydric soil indicators will generally only be found in true soils that exhibit recognizable horizons and not on bedrock or boulder substrates or lakebed deposits. Hydric soil indicators such as iron reduction features are often absent from moderately to very strongly alkaline soils and are also often not visible in saturated soils until they dry to a moist condition (U.S. Army Corps of Engineers, 2008). It is often difficult to correctly identified all wetland vegetation during an initial field assessment. Some plant species that lack wetland indicators are upland species and other may be wetland species that are only locally common and have thus not received a national ranking. Surveyors should use best professional judgement to determine whether site is likely to fall within the USFWS definition of wetland, regardless of the indicators present in the field.

Assessment Area Establishment

An assessment area (AA) is the bounded wetland area within which sampling occurs. URAP was developed for use with circular fixed AAs of 40-m radius (~0.5 ha) whenever possible and rectangular or freeform AAs of equal or smaller area if necessary due to the shape or size of the wetland being evaluated. URAP can potentially be used to evaluate larger AAs and AAs that consist of entire wetlands, but metrics and scoring may need to be adjusted to account for these changes.

Before site visits, randomly selected sample points will be evaluated in ArcGIS, but further evaluation will usually be required in the field to determine whether the AA is appropriately located. Wetlands for UGS assessments are usually any area that meets the definition used by the USFWS for NWI mapping, as detailed above. Determination of whether an area is wetland will be conducted following the procedure outlined above. The following general principles will be followed when establishing an AA:

1. The AA should be 0.5 ha whenever possible and no smaller than 0.1 ha.
2. Regardless of AA shape, the maximum length of the AA is 200 m and the minimum width is 10 m.
3. The AA should be established in a single hydrologically connected wetland. Manmade features that denote wetland boundaries include above-grade roads, major water control structures, dikes, and major channel confluences. Natural features that denote wetland boundaries are mainly based on topography (figure 1a).

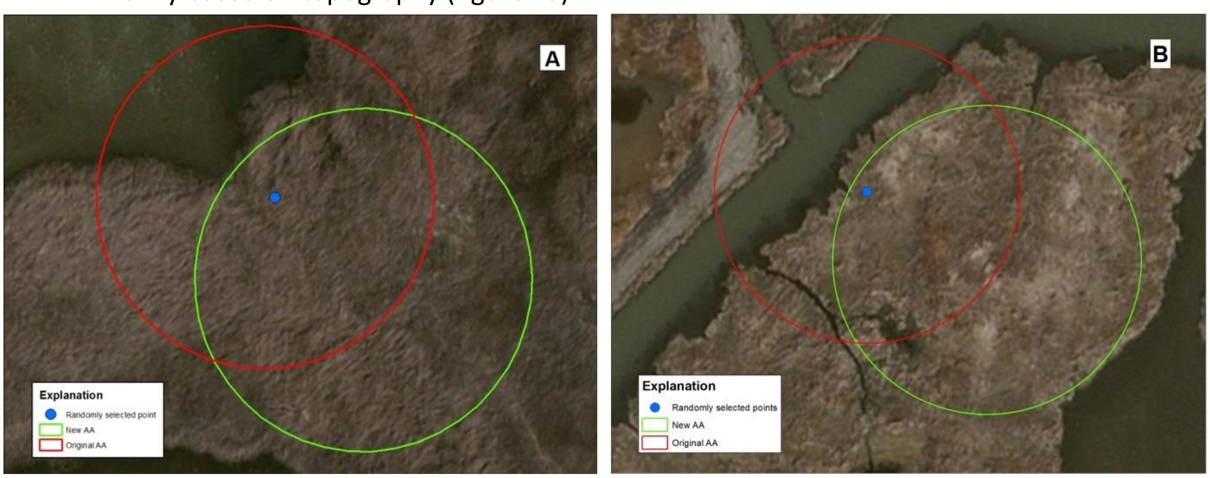


Figure 1. Examples of moving the original AA to a more appropriate survey location. On left (A), AA created by original sample point (red circle) has inclusions of water on its edge. If this water is more than 1 m deep, AA location should be shifted (green circle) so that inclusions are not directly on the AA edge, though internal inclusions are allowed. On right (B), the original AA is moved to avoid crossing the road and dike south of the canal.

4. There should be no more than 10% upland inclusions within the AA, no more than 10% non-wetland riparian area, and no more than 10% water >1 m deep, including water in a stream

channel or in the center of a pond. The AA should be shifted or reshaped to avoid upland and deep water on its edge (i.e., only inclusions within, not on the edge of, the AA are acceptable) (figure 1b).

5. The new AA must be completely within a buffer of 140 m from the original sample point. For standard 40-m circular AAs, this means that the new center point must be within 100 m of the original sample point. The AA should generally be established in the closest sampleable wetland to the original point. If a standard circular AA fits within this wetland, place the edge of the AA as close as possible to the original sample point to avoid arbitrary placement. More subjective placement may be necessary for rectangular or freeform AAs; avoid biasing placement towards or away from interesting features or difficult to sample vegetation.
6. The majority of an AA should be placed within a single wetland type, though wetlands can have up to 20% inclusions of other wetland types. If there is a firm boundary between two wetland types, move the AA edge so that it only encompasses a single wetland type. A mosaic of herbaceous and shrubby vegetation does not necessarily mean multiple wetland types. A few key notes about wetland types:
    a. Many wetland types are frequently encountered as patchworks of woody and herbaceous vegetation. These should be considered a single wetland type, unless individual patches are at least 0.5 ha in size while meeting other AA dimensional requirements (figure 2)
    b. Aquatic beds and open water are often found within emergent marshes. However, the shallow shores that are found at some lakes and ponds can often be considered part of adjacent non-marsh systems. These shores transition gradually between open water to pioneering vegetation on the exposed surface to adjacent meadows or mudflats. There shores may typically be only seasonally flooded and lack a clear bank, instead having water levels that slowly recede throughout the season (figure 3).

If the area in the vicinity of the sample point contains wetland, you will next determine the appropriate location of the AA. If the AA does not follow the general principles outlined above (<10% deep water, crossing wetland boundaries, etc.), the AA will need to be moved or reshaped. Whenever possible, keep the AA in the wetland closest to the original sample point (so that the edge is within 60 m of the original point). If a standard 40-m radius circular AA will fit in this wetland, then shift the AA to an appropriate location. Use the following rules to guide reshaping the AA:

1. Sampleable area will fit in a rectangle 0.5 ha in size. Rectangular AAs must be 0.5 ha and no narrower than 10 m wide, and no wider than 200 m (figure 4a). Example dimensions of rectangular AAs include 25 m x 200 m, 50 m x 100 m, and 70.7 m x 70.7 m. The advantage of a rectangular AA is that they are easy to set up in the field; however, many wetland edges will not conform to the edges of a rectangular AA.

   Neither circular nor rectangular AA can be drawn. Draw a freeform AA that follows along parts of the wetland boundary and is between 0.1 and 0.5 ha in size. If the entire wetland is less than 0.5 ha, draw the freeform AA around the exact outline of the wetland (figure 4b). For larger wetlands, determine an appropriate boundary for the AA that captures approximately 0.5 ha of land. Freeform AAs must be at least 10 m wide in every direction and no longer than 200 m. If a wetland is more than 200 m long, the AA will be drawn to encompass an area at least 0.1 ha in size that follows the wetland boundary, but is truncated to be only 200 m in length.

Figure 2. Sites with mixture of herbaceous and woody vegetation within a single wetland type. On left, orange polygon shows a delineated AA area of 0.5 ha. Both sites have a mixture of woody and herbaceous vegetation.

Figure 3. AA placement on the edge of open water. On the left, AA was moved from the area surrounding the point because the AA overlapped both a hard edge (the dike) as well as a sharp change in elevation between the open water to the north and the dry mudflats to the left. On the right, the site could be placed anywhere along the dry or wet portions of the mudflat.

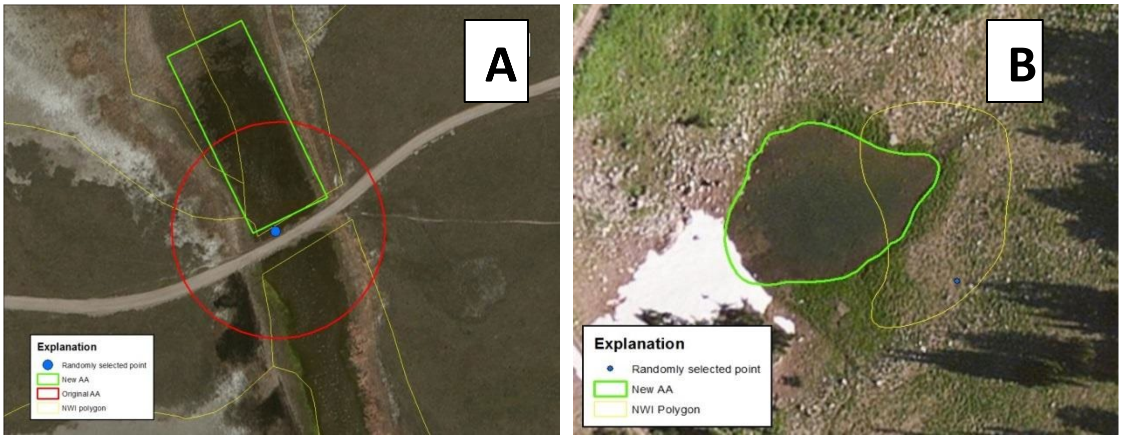


Figure 4. AAs reshaped to rectangle and freeform. Site on left (A) was redrawn as a rectangular AA, though a circular AA potentially may also fit. At the site on right (B), the randomly selected point originally fell on the edge of the NWI polygon (yellow circle). A freeform AA was drawn in red around the probable wetland area.

Once you have determined the general AA shape and location, be sure to flag the AA boundary to facilitate field evaluation. For circular AAs, flag the center and points at the north, east, south, and west along the AA boundary. For rectangular AAs, flag the corner points and intermediate points along the edges to assist in delimiting the AA boundary. Flag freeform AAs frequently enough so the boundary is clear to all surveyors.

General Site Evaluation

General Site Information

For each project, surveyors will receive an office evaluation form that includes information on site ownership, hydrology, and hydrology stressors. Update this information as needed once at the site, such as modifying directions or updating with additional contacts met in the field. If there is no target wetland present in the study area or the site is unable to be surveyed for another reason, document site characteristics using the Collector app, including photographs of the site and descriptions of the dominant vegetation and soil characteristics. For surveyed sites, record the following information:

Unique Site ID: Uniquely assigned site identifier that is also found on site maps and on the site cover sheet.

Site Name: Assign a professionally-appropriate site name that will make the site memorable weeks later if questions about the site come up. Names can be based on unique features of sites (e.g., Large Boulder Pond), events that occurred at sites (e.g., Bear Encounter Meadow), or any other name that helps make the site memorable.

Survey Date: Record the survey date using the format mm/dd/yyyy.

Surveyor IDs: Record each surveyor's unique three letter ID, which will generally be the three letter initials of the surveyor. If there are surveyors at the site that are not part of the normal field crew, record their full name and their affiliation.

Survey Date: Record the survey date using the format mm/dd/yyyy.

AA Dimensions: Select whether AA is standard circular, rectangular, or freeform in shape.

Aspect: Estimate the direction that water would flow downhill through the AA and take a compass reading in degrees in that direction (use a compass with appropriate declination; declination in Utah is approximately 10 to 13 degrees to the east; http://www.ngdc.noaa.gov/geomag-web/#declination). In some cases there may be two or more dominant aspects. For example, water may flow from a riparian edge down towards a river channel and also through a valley along the direction of channel flow. Record the aspect that best describes the aspect of the majority of the AA and make a note of the secondary aspect in the comments. If AA contains slopes in many different directions without a predominant aspect, such as may be found in many depressional wetlands, circle N/A. Circle Flat for wetlands with no discernable aspect.

Slope: Record slope in degrees in the AA using a clinometer or compass. Obtain a representative value that is about average for the area of the AA with the dominant aspect. As for aspect, make a note of a secondary slope for sites with two dominant slopes, circle N/A if there is no predominant slope, and circle Flat for sites with no discernable slope.

AA Placement and Dimension Comments: Make any notes necessary to describe AA placement, and AA slope and aspect. Select the reason that best describes why the AA had to be moved for AAs that are moved, making additional notes if necessary.

Spatial Data and Site Photographs

The UGS will typically collect all spatial and photographic data using a tablet. For circular AAs, spatial data and photographs will be recorded at points to the north, east, south, and west along the AA boundary, with spatial data also recorded at the site center. For rectangular AAs, spatial data will be recorded at each of the four corners of the AA and spatial and photographic data will be recorded approximately midway along each of the sides of the rectangle. For freeform AAs, surveyors will record linear or polygon spatial data as they walk along the site boundary and also collect point spatial data and photographs at four locations approximately evenly spaced along the AA edge.

Additional photographs and waypoint information will be collected at the location of the soil profile and water quality samples. Surveyors may also want to record photographs of unusual features, features that document ratings for some metrics, and an overview of the site (e.g., looking down on entire site from a high point).

Environmental Description and Classification of AA

Collect data to describe and classify the AA. Surveyors may need to walk around the site to assess vegetation, soil, and hydrology before completing this section, particularly for determining the water regime of the site. Collect the riverine-specific classification data for those sites in a stream floodplain or if AA contains a stream or river channel. Record notes and comments under the environmental and classification comments section at the end of the field form.

Composition of AA: Estimate the percent of the AA composed of true wetland, non-wetland riparian area, standing water >1 m in depth, and upland inclusions. Non-wetland riparian areas are areas that do not meet the definition of a wetland from above, but have distinctly different plant species and/or species that grow more robust and vigorous compared to adjacent upland areas (U.S. Fish and Wildlife Service, 2009). Riparian areas are contiguous with rivers, streams, or lakes and influenced by surface and subsurface hydrologic processes of these features. Distinguish riparian from true wetland using the wetland determination guidelines above. If it is difficult to distinguish riparian from upland areas, estimate based on available information, take photos, and makes notes.

Wetland origin: Note the probable origin of the wetland by evaluating the degree to which the wetland's hydrology has been altered or created. Features indicating alteration or augmentation include ditches from a spring that increase the total area watered by a spring, dikes and levees that increase water retention time, and excavation to increase water depth. Wetlands are considered altered if the hydropattern or the extent of inundation are likely to be moderately to severely affected by the alterations. Created wetlands can be intentional in origin, such as for mitigation projects or stock watering ponds, or accidental, such as from irrigation seepage. Wetlands that are built in areas that historically had wetlands, such as the restoration of former wetlands on agricultural fields, should be considered created. Use topographic maps and aerial imagery to help with evaluation as well as discussion with land owners whenever possible. Make note of any questions or important information used in evaluation as needed.

Ecological System and wetland type: Use the keys in the reference cards (appendix A) to select the dominant Ecological System and wetland type present within the AA. Select the fidelity to indicate how well the classification fits the AA. High fidelity means that the surveyors feel the AA matches the system description closely, and that they do not question its appropriateness. Medium fidelity means that the AA has many elements of the chosen system with some noticeable inconsistencies. Low fidelity should be selected when none of the systems seem like an appropriate fit and the selected system is just the best available match.

Cowardin classification: Record the Cowardin system and subsystem for the dominant type within the AA, based on information in the reference cards (appendix A). Also record any Cowardin modifers present at the site.

HGM class: Select the appropriate hydrogeomorphic (HGM) class using the key in the reference cards (appendix A). For sites that have more than one HGM class, select the dominant class and make a note of other classes present. For sites that are created, select the HGM class that most closely describes the functioning of the wetland and make notes to explain your decision; for example, a wetland created by irrigation seepage may be considered a wetland with low or medium fidelity to the slope class. Select the appropriate fidelity to classification based on the description of fidelity options from above.

Livestock grazing: Evaluate whether site has history of being grazed, based on freshness of dung and tracks, presence of livestock, fencing, and browse on vegetation. Use the reference card in appendix A to determine whether tracks are from cattle or native species, if uncertain.

Confined vs. unconfined: Determine whether the AA is in a confined or unconfined valley setting, based on comparison of the valley width and bankfull width. Bankfull width is the width of the stream channel at the beginning of flood stage and can be estimated based on indicators including the lower limit of perennial vegetation, scour marks on rocks or trees, or change in particle size. Valley width is the width of the area over which water could easily flood during high water years without encountering a hillside, terrace, man-made levee, urban development, or other confining feature. Most confined riverine wetlands will be too narrow (<10 m) for sampling.

Proximity to channel: Note whether the AA includes the channel and either stream bank (the area within the bankfull width). For sites that do not contain the channel, record the distance from the AA edge to the channel center. This distance does not need to be exact and can be estimated using aerial imagery.

Stream flow duration: Record your best estimate as to whether the stream is perennial, intermittent or ephemeral. Perennial streams flow year-round, and ephemeral streams only flow during or immediately after precipitation events. Intermittent streams flow seasonally in response to snowmelt and/or increased groundwater and subsurface flow from increased periods of precipitation.

Stream depth: Indicate whether the stream channel is dry, contains water only in pools, or is flowing. For flowing water, estimate the mean depth of the stream at the time of the survey. If streams are not able to be waded (≥ 1 m in depth, or lower if conditions are dangerous for surveyors), *do not* measure stream depth directly in the stream. Instead, either circle ≥ 1 m or make your best guess of stream depth from the shore.

AA representativeness: Note whether the AA contains the entire wetland and, if not, determine whether the AA has a low, moderate, or high degree of similarity to the rest of the wetland.

Major vegetation patches: List major vegetation patches within the AA. Patches are distinct vegetation patches that share similar physiognomy and species composition. Individual patches must be at least 10 m^2 (~ 3.2 m x 3.2 m) in a 0.5 ha AA and must cover a total of at least 5% of the AA. Unvegetated patches (included under water) can be listed if *individual* patches are at least 5% of the AA; otherwise, their cover should be included with the vegetation they are surrounded by. For each patch, record the overstory vegetation type as emergent, scrub-shrub, forested, aquatic bed or floating, or other. Record the estimated water regime for each patch, referring to the water regime descriptions in the Cowardin key (appendix A). When evaluating the water regime, consider survey timing (at the beginning, middle, or end of the growing season), regional precipitation patterns (drought, flood, or typical year), and site indicators of hydrology including species composition, hydric soil indicators, and presence of water during survey. Total cover of patches should add up to 100%

Vegetation and Ground Cover Sampling Procedure

We will collect data on vegetation and ground cover (e.g., litter, algae, sediments, etc.) at every site. We will record a list of all plant species found within the AA during a progressive timed meander. Markers placed at the AA boundary will be used to guide the meander search for species at the AA scale. To conduct a progressive timed meander, first determine the number of plant communities present within the AA. Allow 30 minutes for the first community and add 20 minutes for each additional community. Walk around the AA and note the time that each species was encountered. If less than three new species are encountered during the last 10 minutes, stop the survey. If three or more new species are found during the last ten minutes, continue for an additional 10 minutes. Continue until less than three new species are found in 10 minutes. Estimate percent cover of each species in the AA at the end of the meander. Plants that are unknown will be recorded and collected or keyed out after the search has ended. Record the predominant height of each species as one of six height classes and the predominant phenology as vegetative, flowering, fruiting, or standing dead. Species that are recorded as standing dead *must* have been alive during the current growing season; if they are from previous years, they should be considered litter. Cover should be recorded as the estimated percent of true vegetation cover, which is the area where shadow would be created by a species when the sun is directly overhead. This differs from the more generalized “canopy cover” that estimates cover as the area within the perimeter of any plant canopy.

Ground cover information will be recorded across the entire AA. Estimate the cover of bare ground composed of different size classes of sediment. Estimate the cover of the three listed litter types and predominant litter material present at the site. Dense litter is divided between litter that extends to the wetland surface and litter that has pockets and gaps at the wetland surface. Estimate the cover of water at the site during the time of the survey as well as the potential cover of shallow and deep water. Cover of bare ground, litter, and water should add up to between approximately 90 and 100%; the remaining ground cover is composed of the bare stems and trunks of plants. Algae cover estimates will be made for desiccated algae, wet filamentous algae (algae floating in the water column that is long and stringy), and macroalgae (generally chara). Also note whether submerged vegetation has a covering of epiphytic algae, sediment, or other film and whether substrate algae covering rocks or woody debris is present. Record the litter depth, water depth for water <20 cm, and water depth for water >20 cm at four locations across the AA.

We will collect basic information on the vertical biotic structure at sites. For all vertical biotic structure measurements, we will allow standing (upright) dead vegetation from the current growing season to be counted as a plant layer. Check all of the plant layers that are present at the site. Each layer must occupy 5% *of the portion of the AA that is capable of supporting that layer.* In other words, submerged or floating plants must occupy 5% of the area with appropriate cover of water and emergent plants are not expected in areas with exposed bedrock or in streambeds with flowing water. Plants representing each layer should have a height difference of at least 20 cm from plants representing other layers. In other words, if one species is generally around 40 cm tall and a second species is generally around 55 cm tall, these two species should be considered part of a single layer, even though one is “short” and the other “medium.” Next, estimate the cover class of the area of the AA with overlap of three or more layers and of two plant layers. A marsh composed of cattail will have no overlap. If the same marsh has only a few very small patches of duckweed, the marsh will still predominantly have no overlap. However, if there are patches of duckweed scattered throughout much of the marsh or even low cover of duckweed throughout, the marsh area would have overlap of two layers. In other words, for an area to be counted as having overlap, there does not need to be continuous overlap throughout the area but the overlap cannot be very uncommon.

Collection of Plant Specimen

Species not identified in the field will be collected and brought to the office for later identification. Collectors will do their best to obtain both flowering and fruiting individuals and to collect root samples of grass and forb species. Collectors will place each specimen in newspaper in a field press and write the unique survey site ID on the newspaper's edge with the collection number. No more than three percent of individuals in a population and no more than five cuttings from perennial species will be collected to ensure the longevity of species at sites. Collections will be numbered sequentially starting at one at each survey site. If the same species is seen at two different sites during the same day, the same collection number can be used for both observations with a note indicating the associated site, though surveyors must be very confident that the two species are the same across sites. Once at the office, specimen that are not immediately identified will be put in an office press and placed in a drying oven set to approximately 38°C for at least 24 hours.

Soil Measurements

At all sites, surveyors will dig one soil pit in each of the most common plant zones of the AA. A plant zone is considered common when it covers 30% or more of the AA, meaning that there may be up to three soil pits per AA. If standing water is present in the dominant zone patch, the pit should be dug on the edge of the water when possible to help facilitate digging the pit, as long as the vegetation near the location is representative of that zone. When the site lacks surface water, the soil pit should be dug at a representative location in the dominant vegetation zone. If no hydric indicators are present in any of the soil pits, one additional pit can be dug per plant zone, but no more than five total pits should be dug per site. The soil pit should be dug towards the beginning of the condition assessment to allow time for the water table to equilibrate and the sediments to settle out (at least 30 minutes but more time is preferred). Take a GPS point and record the waypoint for every soil pit dug (see "Spatial Data and Site Photographs", above). Water chemistry measurements will be taken from the soil pit whenever possible.

Soil samples are collected using a sharpshooter shovel and an auger. Whenever possible, dig the soil pit to a depth of 60 cm or deeper in an attempt to reach the water table. Before digging, remove any loose litter (leaves, needles, bark) but do not remove the organic surface which typically contains plant matter in various stages of decomposition (U.S. Army Corps of Engineers, 2008). The shovel should be used first to remove the top soil core. Place the core on a tarp next to the soil pit and then use the auger to reach the desired depth. *It is important to place the core on the tarp in the order and direction they are removed.* Once the hole is dug, measure and record the depth of the soil pit and carefully arrange the core sample collected to equal that measurement.

With the guidance of *Field Indicators of Hydric Soils in the United States* (U. S. Natural Resources Conservation Service, 2010) and the appropriate *Regional Supplement to the Corps of Engineers Wetland Delineation Manual* (U.S. Army Corps of Engineers, 2008 and 2010), examine the soils for hydric indicators and describe each distinct soil layer. For each layer, first determine the layer form, whether the layer is mineral, mucky mineral, or organic. Next, record the depth, color of matrix and any dominant and secondary redox features (based on a Munsell Soil Color Chart), soil texture (refer to soil texture flow chart in appendix A or record as peat, muck, mucky peat if organic), and percent living roots and coarse material if present. Coarse materials are sediments larger in size than sand (>2 mm). Refer to table 2 for a description of the redox feature types. Some redox concentrations are difficult to see under saturated conditions in the darker soil colors. In this case, you should give the soil time to dry out to a moist state, allowing the iron and manganese to oxidize and redoximorphic features to show (Natural Resources Conservation Service, 2010). Once the entire soil sample has been evaluated, record the presence of any hydric soil indicators found within the soil sample (if no indicators are found, you may need to dig an additional soil pit).

Record the time as soon as the soil pit is dug. Right before the condition assessment is complete, examine the pit and measure the water table if present by recording the depth to free water. *Record depth to water that is below the ground surface as a positive number and the height of surface water above the ground surface as a negative number.* Record the time once again to show how long the pit settled for. If the soil appears saturated, record the depth at which saturation begins. To test for saturation with organic soil, squeeze a sample between your thumb and index finger one time. If a drop

Table 2. Features that may be present within soil pits.

Feature	Chemical reaction	Location in Soils	Requirements for Formation	Color
Concentrations	Accumulation of Fe-Mn oxides (oxidation of ferrous to ferric)	Found in forms of masses (soft masses), pore linings (root channels, ped faces), or nodules and concretions (firm to extremely firm bodies)	Oxygen **must** be present for formation; most often found in the upper horizons	Fe tends to be reddish/ orangeish in color (rusty), Mn tends to be darker in color
Redox Depletions	Matrix where Fe, Mn oxides have been stripped out (depleted)	Most common along root channels or cracks; abundance and size tends to increase with frequency of inundation events	**Must** be anaerobic (no oxygen) to form; should be evident within a couple of years if wetland hydrology is present during the growing season	Grayish color with low chroma (≤2) and high value (≥ 4)
Reduced Matrix (least common)	"Reduced" means the level of reduction necessary to change ferric Fe+2 to ferrous Fe+3	Soil matrixes where low chroma is the result of chemical reduction of Fe, but not total depletion of Fe	Oxygen **must** not enter the soil (needs to be saturated) and must be biologically active to produce electrons	In some cases Fe+2 is oxidized to Fe+3 upon exposure to oxygen within 30 min (although time can vary) resulting in rusty color

Covered/Coated Sand Grains	This applies to particles masked with organic coats or oxides
Secondary Color	Soil of any other color that is distinct from the primary matrix and not one of the above features.

of water falls out, then the soil is saturated. For mineral soil, place a chunk of the soil in your hands and shake (like dice) for a few seconds, then examine the soil for water glistening on the surface. Glistening indicates that the soil is saturated.

Soil salinity data will be collected next to each soil pit. Data will be collected from a 15-cm soil sample extracted using an auger adjacent to the soil pit. Photograph and record the location using the Collector app. Record the dominant vegetation next to the soil salinity site and the predominant soil moisture and texture for the top 15-cm of soil. Complete data collection for soil profile and then gather the top 15-cm of the soil core and place into plastic container or bucket. Make sure to include any surface crust that may be present and remove as much root material and rocks as you can. Homogenize the soil in the plastic container by hand. Measure ¼ cup of soil, ensuring that the soils are loosely placed into the cup and not compacted. If soils are wet and difficult to handle, you may form a loose puck to place into the cup. Empty ¼ cup of soil into a blender cup or other larger container with a sealable lid and add 1 ¼ (~300ml) cup of distilled water. Place lid on container and shake mixture vigorously 25 times. Let the mixture settle at least 10 minutes, then insert the meter into the mixture and record the electroconductivity (EC) when the value has stabilized. If the initial reading value is less than 2500 µS, record a second reading at least five minutes after the first reading. If the two readings differ by more than 100 µS, record additional readings five minutes apart until the readings differ by less than that amount.

Water Chemistry Data

Collect water chemistry data at one or more locations throughout the site, recording the location and a site photograph with the Collector app. If water is evident after the settling period in the soil pit, use a bailer or cup to obtain a water sample from just below the water surface level in the pit, being careful not to disrupt the sediments too much. Place water samples in a plastic container or measure in situ to minimize electromagnetic interference when measuring electroconductivity (EC). Use a handheld multiparameter meter to measure pH, EC, and temperature of the water sample. Rinse tips of meters with some of the water before collecting measurements and rinse with distilled water before storage. Water chemistry samples can also be collected from a shallow wetland well if a soil pit is not dug at a site. After all soil and water measurements are completed, make sure to fill the soil pit back in so that no hole is left in the AA that may trip a person or livestock. Calibrate the meter with known EC and pH solutions no less than once per week, and ideally once per day, and maintain proper storage. For storage, pour a small amount of storage solution into the meter cap (enough to immerse the electrode) and close the cap. If storage solution is not available, use pH 4 buffer.

Collect at least one surface water chemistry measurement per site if water is available or more if there are several representative locations. Circle whether the surface water sample is from within a channel, a pool outside the channel, immediately adjacent to a location of groundwater discharge (e.g., a springhead pool), or the base wetland surface (such as within a marsh). Record the total depth of the water where the sample is obtained and circle to indicate whether water is standing or flowing. Record the color of the water as stained or clear. A transparency tube will be used to measure turbidity at selected sites where surface water is present. Transparency is inversely related to turbidity and total suspended solids (Dahlgren and others, 2004). Follow the instruction below to record an accurate measurement (adapted from Minnesota Pollution Control Agency's Water Chemistry Assessment Protocol for Depressional Wetland Monitoring Sites http://www.pca.state.mn.us/index.php/view-document.html?gid=10251). Last, record pH, EC, TDS, and temperature data using the handheld meter.

Transparency Tube Directions:

1. Carefully lower the cleaned tube into the water trying not to stir up any sediment that could contaminate the sample. After the tube is filled, cup the open end with your palm so no water is lost. To avoid disrupting settled particles, sample locations greater than 15 cm in depth whenever possible. If helpful, a smaller cup or container can be used to collect the water to pour into the tube.
2. Stir or swirl the tube to ensure the sample is homogenous, being careful not to induce air bubbles. Out of direct sunlight and without wearing sunglasses, look down the tube to try and view the black and white disk on the bottom. Your eye should be roughly 10 to 20 centimeters from the top of the tube.
3. If the disk is not visible when the 60 cm tube is filled, slowly release water out of the valve on the bottom until you can distinguish the contrast between the two colors. Record the depth of the water in the transparency tube when you can first distinguish the two colors on the disk using the measurements on the side of the tube.
4. Circle = if water had to be released from the tube in order to see the black and white disk. Circle > if the disk was visible when the tube was filled; this indicates that the total visibility is greater than the 60 cm of the filled tube.

Collect water quality data for laboratory analysis from one location per site if an appropriate location is available. Laboratory samples should be collected from surface water, not from water within soil pits. Water can be collected from inlets providing water to the wetland, the base surface water from a marsh, from a springhead, or from a channel, pond, or lake that is hydrologically connected to the site. Water should not be collected from very shallow areas where water has collected, such as in hoofprints. Photograph the sampling location and collect all other water quality data at the location as well. Be careful not to overfill water sampling bottles because preservatives may be flushed from the bottle.

Buffer Transects, Land Use Index, and Stressor Checklist

Evaluating land use and stressors within and surrounding the wetland is an important step in understanding current and future conditions of the site. To better characterize how land use and stressors might impact the site, surveyors will evaluate a 100-m buffer surrounding the site and complete the Land Use Index and Stressor Checklist forms at all sites. The Land Use Index and Stressor Checklist are adapted from Colorado Natural Heritage Program's Ecological Integrity Assessment (Lemly and others, 2016; Lemly and others, 2017).

To survey the 100-m buffer, surveyors will walk 100-m transects in each of the cardinal directions whenever possible to collect data on the presence and intensity of stressors. If surveyors cannot walk the full 100-m transect due to issues with land ownership or obstructions such as deep water, they will either estimate the values for the transect or walk a transect in one of the ordinal directions. As surveyors walk each transect, they should make note of the land use and any evidence of stressors they see and record the number of cow patties observed on each transect, as well as the presence or absence of livestock trails, pugging, and unnatural bare soil patches at least 1 m^2 in size. Record these observations under Buffer Disturbances.

To complete the Land Use Index form, surveyors will use field observations, office evaluation information, and aerial imagery to estimate the percent area that each land use category occupies within a 500-m envelope around the site. Each area can only be assigned to one land use so that land use will add up to 100% for the site. If land use categories overlap, record the land use with the lowest value (i.e., the most intensive land use) for the overlapped area. Record percent area as the nearest whole number except that you can record 0.5% for very small features or to ensure that total cover adds up to 100%. User's notes for specific land use categories can be found in table 3. Coefficient values are pre-determined and should not be changed. These coefficients are intended to weight intensive land uses more heavily than passive ones. Calculate the land use category score by multiplying the land use coefficient for each category by the proportion of the 500-m buffer in that category. Next, sum each category score to calculate the Total Land Use Score. The Colorado Natural Heritage Program converts the Total Land Use Score to ranks based on thresholds found in table 4 (Lemly and others, 2016); the UGS will tentatively use these thresholds until we are able to validate them for Utah or develop our own thresholds.

To complete the Stressor Checklist, surveyors will use field observations, office evaluation information, and aerial imagery to estimate the scope and severity of stressors to the 100-m landscape surrounding the plot, and the vegetation, soil, and hydrology within the plot. For each stressor, rate the geographic scope and the severity of impact using the scope and severity ratings provided in table 5 by recording or circling values for each stressor. User notes in table 6 provide additional information on how to interpret individual stressors. Severity values have been pre-assigned for many stressors though surveyors are not limited to these values. If a different value better describes the severity of the stressor, surveyors may write in the appropriate value and make a note about why the value was chosen. Do not rate stressor and category combinations that are in grey; for example, do not rate the scope and impact of development (stressor #1) for plot soil, nor the trash or refuse (stressor #22) impact on hydrology. Assess the severity of landscape stressors for their impact to the buffer, not how they may impact the AA itself. Assess factors that affect site hydrology by looking at both the contributing basin and the site itself; do not limit the evaluation of hydrology stressors to only those within the site or buffer. Hydrology stressors may have been initially recorded in the office, but should be evaluated and updated as needed based on field observations.

Calculate the impact for each individual stressor by using the impact calculator in table 7. If a stressor occurs both within the 100-m landscape and the plot itself, calculate and record both scores. After individual stressor scores have been recorded, sum the impact scores within each category for a total impact score for each category. The Colorado Natural Heritage Program converts each categorical score to a rating (e.g., low, medium, high) based on thresholds in table 8 (Lemly and others, 2017). The

Colorado Natural Heritage Program also assigns an overall rating to sites by multiplying each categorical score by 0.3, except that the soils score is multiplied by 0.1, summing the four scores together, and then applying the thresholds from table 8. The UGS will determine appropriate thresholds for scores after an adequate amount of field data are collected in Utah.

Table 3. User notes for specific land use categories.

Land Use Category	User Note
Dams and reservoirs	Stock ponds and smaller dammed lakes in the Uintas that do not have obvious disturbed shorelines will not be included in this category.
Dams and reservoirs—WMAs	Areas where boating is permitted will be considered dams and reservoirs. Look for boat ramps or review information available online: https://wildlife.utah.gov/hunting/maps.html and https://www.fws.gov/uploadedFiles/Bear_River_Migratory_Bird_Refuge_Hunting_Brochure.pdf
Grazing—montane areas	Assume whole area is grazed if within a mapped grazing allotment or there is evidence of grazing in buffer, except for on steep talus slopes or within lakes; assume light grazing unless visible evidence of trails or excessive bare ground.
Grazing—pasture	Pasture will typically be considered moderate grazing unless site notes or imagery indicate heavy grazing.
Permanent crop	Grass, hay, alfalfa, and orchards are all considered permanent crops.
Preserves	Conservation preserves like Great Salt Lake Shorelines Preserve and Gilmore Audubon Sanctuary can be classified as natural land if no other land uses are present.
Recreation—montane areas	Area along trails will generally be light or moderate recreation, depending on evidence of use, as well as areas near lakes that are more commonly used. Open space associated with large, naturally vegetated lots can be considered moderate recreation. Intensive recreation includes low-use ATV tracks, areas under ski lifts, etc.
Recreation—WMAs	Most areas within WMAs will be considered moderate recreation unless they are far from roads with no visible access. Areas with distinct ATV tracks will be considered intense recreation.
Roads—gravel	Gravel roads can be classified as unpaved roads.
Roads—montane areas	Two-track roads that are used for management and are not a regularly used road can be considered intense recreation.
Sewage lagoons	Sewage lagoons are categorized as pavement. They are structurally similar to mining, but pavement captures their impact more fully.
Vegetation conversion	This category can include areas adjacent to paved roads where material was removed or deposited as well as areas that are mowed or chemically treated.
Yards	Yards in suburbs can be lumped in as domestic or separated out as recreation fields (golf courses, sports fields, lawns) if large enough.

Table 4. Ranks based on the Land Use Index score.

Rank	Score	State
Excellent (A)	4	Land Use Index = 9.5-10.0
Good (B)	3	Land Use Index = 8.0-9.49
Fair (C)	2	Land Use Index = 4.0-7.99
Poor (D)	1	Land Use Index = <4.0

Table 5. Explanation of scope and severity ratings for stressors.

SCOPE OF THREAT (% affected by direct threat)		SEVERITY OF THREAT (degree of degradation to AA or landscape)	
1=small	Affects small portion (1-10%) of AA or landscape	1=slight	Likely to slightly degrade/reduce
2=restricted	Affects some (11-30%) of AA or landscape	2=moderate	Likely to moderately degrade/reduce
3=large	Affects much (31-70%) of AA or landscape	3=serious	Likely to seriously degrade/reduce
4=pervasive	Affects all or most (71-100%) of AA or landscape	4=extreme	Likely to extremely degrade/destroy or eliminate

Table 6. User notes for stressor checklist.

Category	Stressor	User Note
Hydrology	General	Severity of 4 should be limited to features that have dominant control over site (e.g., water almost entirely from flood irrigation with little or no natural hydrology).
Hydrology	Excavation	Do not need to list this for WMA impoundments or for restored wetlands where there is no longer evidence of excavation.
Hydrology	Excess irrigation	Sites that are entirely flood irrigated will typically get a severity of 4; primarily flood irrigated with some natural inputs could get a severity of 3 or lower.
Hydrology	Impoundment release	List impoundment and control of flow and energy with scope of 4 and severity 3. Only list canals if site is direct impacted by canals as well as released impoundment water.
Hydrology	Impoundments in WMAs	Area within impoundments will typically have listed impoundments, canals, and control of flow and energy, each with a scope of 4 and severity of 2, assuming each of these features are present.
Hydrology	Impoundments in WMAs	If sites are dried at the time of visit due to management, record under "Other."
Hydrology	Large dams/reservoirs	Include if dam is between site and major upstream tributary; do not need to include control of flow and energy and impoundments as well as dams.
Hydrology	PS discharge	Maximum of 2 for severity unless discharge is very close to site and very direct.

Hydrology	Roads acting as berms	List roads acting as berms as "Impoundments, berms, etc." and list separately as NPS discharge (urban/stormwater) if likely to affect water quality as well.
Hydrology	Stock ponds	List both impoundment and excavation for water retention if stock pond appears created.
Hydrology	Urban/ stormwater	List roads within about 30 m upgradient of sites in this category, typically with a severity of 1. Can list roads further away if likely to impact site (e.g., unvegetated slope leading to site, crosses stream upgradient from site).
Recreation	General	For the landscape evaluation, include recreation if you know that it occurs in the buffer, even if you do not see physical evidence. For rating within the AA, only rate recreation if you see evidence that people use the wetland itself, such as social trails, campfire rings, or boat ramps leading to site.
Recreation	ATV road	If true ATV road, can list as road and not include otherwise. If ATV tracks are not part of road, can be listed as both indirect soil impacts and motorized recreation. However, if tracks are likely a rare occurrence and due to management, list as indirect soil disturbance only.
Recreation	Campgrounds	List non-motorized recreation for area around campgrounds where people will walk around off-road; paved areas will typically be listed as development or roads, not motorized recreation.
Recreation	Near roads	Assume non-motorized recreation along roads if there are points of access, pull-outs, etc. and features that might be used for recreation (e.g., river for fishing).
Recreation	Near trails	Non-motorized recreation should be listed along trails and anywhere nearby that seems likely to be used (lakes, rivers for fishing), but not on steep slopes or densely vegetated areas that are infrequently used.
Recreation	Parking areas	Unpaved parking areas for recreation can be called motorized recreation.
Recreation	WMAs	List motorized recreation for impoundments used by boats but change severity to 2 since use is seasonal; remainder of WMAs will typically be non-motorized recreation. Very remote WMAs with little usage may not have recreation listed at all.

Table 7. Calculator for translating scope and severity ratings to an impact score.

Threat Impact Calculator		**Scope**			
		Pervasive = 4	**Large = 3**	**Restricted = 2**	**Small = 1**
Severity	**Extreme = 4**	Very High = 10	High = 7	Medium = 4	Low = 1
	Serious = 3	High = 7	High = 7	Medium = 4	Low = 1
	Moderate = 2	Medium = 4	Medium = 4	Low = 1	Low = 1
	Slight = 1	Low = 1	Low = 1	Low = 1	Low = 1

Table 8. Formula for converting categorical impact scores and overall weighted score to an overall rating.

Score	***Rating***
10+	Very High
7 – 9.9	High
4 – 6.9	Medium
1 – 3.9	Low
0 – 0.9	Absent

Condition Assessment

Background and Scoring

The URAP condition assessment is composed of 18 metrics divided into five categories, including landscape context, hydrologic condition, physical structure, vegetation structure, and plant species composition (table 9). Four of the metrics are evaluated independently and then combined to create an overall buffer metric score. Metrics are generally scored by evaluating which of four potential states most closely describes the assessed wetland. States reflect the continuum of potential conditions, from reference standard to highly degraded, that may be found for a particular aspect of wetland condition. States are assigned letter ranks from A to D; table 10 shows a conceptualization of the differences among the ranks in terms of degree of degradation, example conditions, and management priorities. Some metrics have more than four states to account for a greater diversity of recognized states, and the best condition state at some sites is assigned a value of AB because of the difficulty in distinguishing between A and B states. These metrics include A-, AB, or C- states.

URAP condition scores are calculated by first converting all rank values to numeric values based on the following: A or AB—5, A—4.5, B—4, C—3, C-—2, D—1. The mean metric score is then calculated within each category (only using the overall buffer score and not the derivative components for the landscape context category), based on the categories shown in table 10. Means are taken across a variable number of metrics per site since not all metrics are evaluated at every site. Overall condition scores are obtained by taking the mean value across all categorical scores. Current use of URAP does not support converting categorical and overall condition scores back to a rank.

Table 9. Condition metrics evaluated by the Utah Rapid Assessment Procedure, listed under metric categories. Some metrics are evaluated directly within the assessment area (AA), some in areas surrounding the AA, and some take into consideration both local and landscape factors.

Metric	Description
Landscape Context	
Percent Intact Landscape	Percentage of 500 m buffer surrounding AA that is directly connected to AA and composed of natural or semi-natural (buffer) land cover
Percent Buffer[1]	Percentage of AA edge composed of buffer land cover
Buffer Width[1]	Mean width of buffer land cover (evaluated up to 100 m in width)
Buffer Condition- Soil and Substrate[1]	Soil and substrate condition within buffer (e.g., presence of unnatural bare patches, ruts, etc.)
Buffer Condition-Vegetation[1]	Vegetation condition within buffer (e.g., nativity of species in buffer)
Hydrologic Condition	
Hydropattern[2]	Naturalness of wetland inundation frequency and duration
Turbidity and Pollutants[3]	Visual evidence of degraded water quality, based on evidence of turbidity or pollutants
Algae Growth[3]	Evidence of potentially problematic algal blooms within AA (evaluated both in water and in areas with large patches of dried algae)
Water Quality	Evidence of water quality stressors reaching AA or within AA
Connectivity	Hydrologic connection between AA edge and surrounding landscape
Physical Structure	
Substrate and Soil Disturbance	Soil disturbance within AA
Vegetation Structure	
Horizontal Interspersion[4]	Number and degree of interspersion of distinctive vegetation patches within AA
Litter Accumulation[5]	Naturalness of herbaceous litter accumulation within AA
Woody Debris[5, 6]	Naturalness of woody debris within AA
Woody Species Regeneration[5, 6]	Naturalness of woody species regeneration within AA
Plant Species Composition	
Relative Cover Native Species	Relative cover of native species (native species cover / total cover)
Absolute Cover Noxious Species	Absolute cover of noxious weeds

[1]Buffer metrics are combined into one overall buffer score using the formula:
overallBuffer=(percentBuffer*bufferWidth)0.5*([bufferConditionSoil+bufferConditionVeg]/2)0.5
[2]Evaluated with respect to similar wetlands within hydrogeomorphic class.
[3]Only evaluated when water or large patches dry algae are present at sites.
[4]Exclude from scoring for emergent marsh, aquatic bed, shallow water, and playa wetland types.
[5]Evalute with respect to expected values for wetland type.
[6]Only evaluated when woody debris and woody species are expected at sites.

Table 10. Description of condition categories, ranked from A through D (Lemly and others, 2011).

Rank	Description
A	*Reference Condition (No or Minimal Human Impact):* Wetland functions within the bounds of natural disturbance regimes. The surrounding landscape contains natural habitats that are essentially unfragmented with little to no stressors; vegetation structure and composition are within the natural range of variation, nonnative species are essentially absent, and a comprehensive set of key species are present; soil properties and hydrological functions are intact. Management should focus on preservation and protection.
B	*Slight Deviation from Reference:* Wetland predominantly functions within the bounds of natural disturbance regimes. The surrounding landscape contains largely natural habitats that are minimally fragmented with few stressors; vegetation structure and composition deviate slightly from the natural range of variation, nonnative species and noxious weeds are present in minor amounts, and most key species are present; soils properties and hydrology are only slightly altered. Management should focus on the prevention of further alteration.
C	*Moderate Deviation from Reference:* Wetland has a number of unfavorable characteristics. The surrounding landscape is moderately fragmented with several stressors; the vegetation structure and composition is somewhat outside the natural range of variation, nonnative species and noxious weeds may have a sizeable presence or moderately negative impacts, and many key species are absent; soil properties and hydrology are altered. Management would be needed to maintain or restore certain ecological attributes.
D	*Significant Deviation from Reference:* Wetland has severely altered characteristics. The surrounding landscape contains little natural habitat and is very fragmented; the vegetation structure and composition are well beyond their natural range of variation, nonnative species and noxious weeds exert a strong negative impact, and most key species are absent; soil properties and hydrology are severely altered. There may be little long term conservation value without restoration, and such restoration may be difficult or uncertain.

Plant Species Composition Metrics

Relative Cover Native Species

Definition and background: This metric measures the relative percent cover of native plants species at a site. Wetlands in good ecological condition are expected to have high cover of native species both because non-native species are most likely to enter a wetland when there is associated disturbance and because intactness of the plant community is one component of wetland condition. Non-native plants in a wetland can displace native plants, change nutrient cycles, affect food web dynamics, modify hydrology, and alter the physical structure used by wildlife. The degree to which non-native plants affect wetlands is assumed to be related to their abundance at a site. One or a few individuals of a non-native species may not be an issue of concern whereas greater numbers have a higher likelihood of altering natural processes in the wetland.

Measurement protocol: Relative cover of native species is calculated as the total cover of native plant species divided by the total cover of all species (table 11). Relative cover estimates can be calculated from species lists obtained in the field or using ocular estimates of relative percent cover. Species that are common and not able to be identified in the field should be collected for office identification to assist in calculation of this metric. Species that are not able to be identified should be excluded from the calculation unless their nativity is known.

Table 11. Metric rating for relative cover native species.

Rank	State
AB	AA contains >95% relative cover of native plant species.
C	AA contains >80–95% relative cover of native plant species.
C-	AA contains 50–80% relative cover of native plant species.
D	AA contains <50% relative cover of native plant species

Absolute Cover Noxious Weed Species

Definition and background: Some species are designated as noxious weeds by individual states or the federal government. This designation applies to species that are known to cause harm to agriculture, horticulture, natural habitats, humans, or livestock, and species with this designation often must be controlled or contained based on state or federal regulations. Noxious weed lists highlight species of economic and political concern, though in some cases species may not make the list due to political constraints (i.e., species is deemed too difficult to regulate), and the political process of listing species may be slow to list emerging threats.

Measurement protocol: Estimate the total percent cover of all plants on the noxious weed list for Utah using either plant community data from meander survey or field ocular estimates (table 12). See reference cards for list of noxious weed species in Utah.

Table 12. Metric rating for absolute cover invasive species.

Rank	State:
A	Noxious weeds absent.
B	Noxious weeds present, but sporadic (<3% absolute cover).
C	Noxious weeds common (3–10% cover).
D	Noxious weed abundant (>10%) cover.

Landscape Context Metrics

Percent Intact Landscape

Definition and background: The percent intact landscape metric evaluates the size of the intact landscape (i.e., area with buffer land cover) directly connected to and within 500 m of the AA. For metric evaluation, the area of this intact landscape is converted to a percent by dividing the intact area by the total area of a 500-m radius circle surrounding the AA. Wetlands embedded in large natural landscapes are likely to be subject to less human disturbance, such as hikers that flush birds from nests. Large natural landscapes may also support species movement through the landscape, which is important for seed dispersal, maintenance of genetic diversity in plants and animals, and allowing animals to access a variety of habitats. Wetlands that are surrounded by natural land cover are more likely to be connected via dispersal to other wetlands and are more likely to support animals that need both upland and wetland habitat. We have selected a distance of 500 m for the sake of this metric because 1) it is a distance commonly used in other wetland assessments, and 2) it is not too large of an area to evaluate in the field.

Measurement protocol: Evaluate the 500 m buffer surrounding your AA either on a paper map or via spatial data on a tablet in Collector. Spatial data such as land cover and road layers may help in evaluating features in the landscape. Determine the area of buffer land cover within which the AA is embedded. Small non-buffer inclusions (e.g., a dwelling in the middle of an unfragmented landscape) should be subtracted from the intact landscape area. Once an intact area reaches a road (do not consider low-use dirt tracks) or other linear non-buffer landcover, a hard boundary is formed even if natural land cover exists on the other side. zone of a road's influence, such as trash and road fill along the road border, should also be considered non-buffer land cover. Estimate the percent of the 500 m radius area that forms an intact landscape contiguous with the AA and select the appropriate state from table 13. See table 14 for a list of what is considered buffer land cover.

Table 13. Metric rating for percent intact landscape.

Rank	State
A	Intact: AA embedded in >90–100% unfragmented, natural landscape.
B	Variegated: AA embedded in >60–90% unfragmented, natural landscape.
C	Fragmented: AA embedded in >20–60% unfragmented, natural landscape.
D	Relictual: AA embedded in ≤20% unfragmented, natural landscape.

Percent Buffer

Definition and background: Percent buffer is the percent of the edge of an AA that is surrounded by land cover that serves as a buffer against stressors. Land cover plays an important role in either mitigating or contributing stressors to a wetland. Natural or semi-natural land cover may mitigate impacts from more distant stressors by filtering out phosphorous, nitrogen, sediment, and other water quality pollutants, whereas some land cover types release these pollutants into a wetland. Surrounding land cover can also influence wetland temperature and microclimate and contribute organic matter to the wetland (McElfish and others, 2008), and sites with more natural land cover may be subject to less human visitation and thus less anthropogenic disturbance. Surrounding land cover is also important for wildlife habitat and providing wildlife and gene flow connectivity between wetland patches.

Measurement protocol: Determine the percent of the perimeter of the AA that has buffer land cover using the definitions of buffer land cover provided in table 14. Very small sections of buffer land cover will not count towards the percent buffer; buffer cover must extend at least 10 meters along the perimeter of the AA and 10 meters out from the edge of the AA to be counted (see buffer percentages in table 15). When evaluating a land cover type not specifically listed, consider the extent to which that cover type contributes sediment, nutrients, and other pollutants to a wetland. Make note of any unusual cover types so that they can be reevaluated in the office if necessary.

Table 14. Land cover types considered buffer and non-buffer.

Buffer Land cover	Non-buffer Land Cover
• Vegetated natural and semi-natural areas including forests, grasslands, shrublands, wetlands, and open water • Natural unvegetated areas including permanent snow or ice cover and natural rock outcrops or sandy and gravel areas. • Old fields undergoing succession • Rangeland[1] • Partially vegetated pastures[1] • Recently burned natural land with at least some vegetative recovery[1] • Low use tracks such as single-use ATV tracks or undeveloped and unmaintained dirt tracks that are vegetated in the middle and only used once or a few times a year. • Vegetated levees, natural substrate ditches • Recreational areas with little substrate disturbance (bike, horse, and foot trails with narrow width of influence)	• Commercial and residential areas, parking lots, railroads and train yards • Lawns, sports fields, traditional golf courses • Dirt and paved roads • Mined areas • Agriculture including row crops, orchards, vineyards, clear-cuts • Animal feedlots, poultry ranches, animal holding pens with mostly bare soil • Severely burned land with little vegetative recovery • Recreational areas with substantial disturbance (wide paths, paved areas, trash/dumping) • Oil and gas wells • Wind farms

[1]These land cover types can vary considerably in the degree to which they serve as buffer cover. We will use the buffer condition-soil metric to help distinguish between soil disturbance-related features with varying degrees of buffer functionality.

Table 15. Metric rating for percent buffer.

Rank	**State**
A	Buffer land cover surrounds 100% of the AA.
A-	Buffer land cover surrounds >75–<100% of the AA.
B	Buffer land cover surrounds >50–75% of the AA.
C	Buffer land cover surrounds >25–50% of the AA.
D	Buffer land cover surrounds ≤25% of the AA.

Buffer Width

Definition and background: The degree to which a buffer can mitigate impacts to a wetland depends in part on buffer width. Wider, intact buffers can filter out more pollutants before they reach a wetland and also often have less human visitation and associated stress. A review by the Environmental Law Institute found that effective widths for wetlands are 9 to 30 m for sediment and phosphorus removal and 30-49 m for nitrogen removal (measured as 30–100 ft and 100–160 ft by McElfish and others, 2008). Recommended widths for wetland water quality for the Minnehaha Creek Watershed District in Minnesota were between 15 and 30 m, depending on the particular function and buffer slope (measured as 50 and 100 ft by Emmons & Olivier Resources, 2001). A meta-analysis found that 30 m buffers could remove between 68 and 100% of sediment, nitrogen, phosphorus, and pesticides, with differences in effectiveness depending on pollutant, slope, and vegetative cover of buffer (Zhang and others, 2010). Unfortunately, most buffer width studies have been conducted in the eastern United States. Buffers in the arid west that are composed of natural vegetation may need to be wider than buffers examined in other studies due to generally sparser vegetation, more contributing water coming from sheet flow, and differences in common soil types (Buffler, 2005). Johnson and Buffler (2008) recommended minimum buffer widths between 21 and 67 m (and wider if certain features were present in the buffer) for agricultural areas in the intermountain west, depending on soil type, slope, and surface roughness.

Measurement protocol: On aerial imagery of the AA or in Collector, draw eight transects extending 100 m from the edge of the AA along the cardinal and ordinal directions (N, NE, E, SE, S, SW, W, NW). Estimate the length of continuous transect that runs from the AA edge to the first place without buffer land cover for each transect (table 16). Estimates can be based on aerial imagery, but features that are not clear from imagery or that may have changed since the imagery was taken need to be investigated in the field.

Table 16. Metric rating for buffer width.

Rank	State
A	Mean width >95 m.
A-	Mean width >75 and ≤95 m.
B	Mean width >50 and ≤75 m.
C	Mean width >25 and ≤50 m.
D	Mean width <25 or no buffer exists.

Buffer Condition- Soil and Substrate

Definition and background: Evaluating buffer soil and substrate condition allows us to better determine the state that the buffer land cover is in and thus its buffering capacity. For example, both rangeland and pasture areas can vary in their condition from heavily overgrazed with extensive areas of exposed soil to intact except for occasional shallow hoof prints. Areas with disturbed soils may contribute more sediment to wetlands and lose their effectiveness at filtering pollutants. Many soil disturbances cause channelization, which can provide a pathway to move water more quickly towards a wetland rather than filtering the water through buffer land cover. Sites with soil disturbance may also provide less habitat for wildlife and be more prone to plant invasion.

Measurement protocol: Walk through enough of the 100 m buffer to determine the extent to which the substrate in the buffer is altered or disturbed. Evaluation can be supplemented by examination of aerial imagery. Only evaluate area that is considered buffer, not other land cover types. Select one of the statements in table 17 that best describes the condition of the buffer land cover. Evaluate this metric by thinking about both the severity and spatial extent of disturbed soil conditions in the buffer.

Table 17. Metric rating for buffer condition – soil and substrate.

Rank	State
A	Intact soils. Unnatural bare patches, pugging, and soil compaction are absent or extremely rare with minimal impact (e.g. one or a few shallow vegetated single-use ATV tracks). Cryptobiotic soil, if expected, is present and undisturbed.
B	Moderately disrupted soils. Some amount of bare soil, pugging, compaction or other disturbance exists, but extent and impact are minimal. Areas with more severe disturbances are absent or rare.
C	Extensive moderately disrupted soils. Areas with more severe disturbance may occur in a few sections of the buffer or disturbance may be more widespread and of moderate impact.
D	Unnaturally barren ground, highly compacted soils, or other severe soil disturbance covers a moderate to large portion of the buffer or more moderate disturbance covers the entire buffer.
N/A	No buffer land cover present.

Buffer Condition-Vegetation

Definition and background: The condition of buffer vegetation can influence many properties in the AA. The presence of non-native plant species in the buffer can make the AA susceptible to invasion, particularly when the non-natives are hydric species. Non-native plants in the buffer can also lead to changes in nutrient cycling, fire regimes, and other processes that may in turn affect the AA. Non-native species may differ in their ability to control pollutant loads and modify hydrologic properties in the surrounding landscape.

Measurement protocol: Walk through enough of the 100 m buffer to determine the dominant vegetation, supplementing the evaluation with examination of aerial imagery. Do not forget to look for the presence of *Bromus tectorum* (cheatgrass) and for non-native grasses associated with pastures. Only evaluate area that is considered buffer land, not other land cover types. Select one of the following statements in table 18 that best describes the condition of the buffer vegetation.

Table 18. Metric rating for buffer condition–vegetation.

Rank	State
A	Abundant (≥95%) ***relative*** cover native vegetation and little or no (<5%) cover of non-native plants.
B	Substantial (≥75–95%) ***relative*** cover of native vegetation and low (5–25%) cover of non-native plants.
C	Moderate (≥50–75%) ***relative*** cover of native vegetation.
D	Low (<50%) ***relative*** cover of native vegetation.
N/A	No buffer exists.

Hydrologic Condition Metrics

Hydropattern

Definition and background: Hydropattern is a term used to describe the frequency, duration, timing, and aerial cover of inundation of a wetland (Kadlec and Reddy, 2001; U.S. EPA, 2008). Hydropattern is a defining characteristic of wetlands that exerts substantial control on their physical and biological properties. There are two components to hydropattern: hydroperiod (frequency and duration of inundation) and timing of inundation. Frequency of inundation refers both to the number of flood events within a year (intra-annual frequency) as well as to the number of years when flooding at a site occurs (inter-annual frequency).

Duration of wetland inundation has been shown to affect richness and community composition of invertebrate (Tarr and others, 2005), amphibian (Snodgrass and others, 2000), and plant (Webb and others, 2012) species. Hydroperiod, including inundation frequency, also may affect nutrient cycling in wetlands (Tanner and others, 1999). Timing associated with water levels can be important for wetland flora and fauna; for example, species' development stages may need to be synchronized with particular water levels in order to successfully reproduce (U.S. EPA, 2008). A review found that changes in inundation timing frequently affect the establishment, growth, and species richness of wetland plant communities (Webb and others, 2012) and timing of flooding affected macrophyte species richness and biomass in floodplain wetlands in Australia (Robertson and others, 2001).

We are interested in stressors to hydropattern that occur during the growing season (period between last spring freeze and first fall freeze) because water availability during this time drives plant species composition and thus the biotic structure of wetland vegetation, and this time is likely to be more critical for the reproduction and development of many wildlife species. Furthermore, many aspects of nutrient cycling, such as decomposition, mineralization, nitrification, and denitrification, are likely to occur much more slowly at lower temperatures due to decreased plant and microbial activity (Picard and others, 2005; Kadlec and Reddy, 2001). Changes to hydropattern outside the growing season can also affect functional services such as flood attenuation; this metric does not emphasize these potential changes.

Measurement protocol: First, identify all ***major*** sources of water to the site (table 19). For example, most sites in Utah will receive some water via snowmelt and precipitation, but these sources will only be major for sites that are relatively isolated from other water sources (e.g., rain-filled depressions, snowmelt-created lakes). Indicate the source that is dominant, if known, if known. Next, review aerial photography, topographic maps, and information recorded in the office evaluation to identify hydrologic stressors and modifications. Consider each stressor's impact relative to the natural inputs of water at a site. For example, a site will score lower if it receives irrigation return flows at a time when it would normally be dry versus if it receives those flows in addition to large natural inputs of springflow throughout the growing season. Next, evaluate whether the site has any of the indicators of altered inundation or saturation patterns listed under table 20. Soil disturbance will be considered a stressor to hydropattern when it is likely to cause abnormal ponding or drying in the wetland based on depth and extent of disturbance and the site's hydrology; sites with small areas of minor pugging or rutting can still be rated as A for hydropattern. Finally, select the statement that best describes the alteration to hydropattern during the growing season (table 21). Examples of potential stressors are listed under each possible state, though a state that has most of the listed stressors may fall into a lower state due to their cumulative effect.

Examples

Artificial Wetlands in Highly Managed Setting (duck clubs, WMAs, wildlife refuges): Artificial wetlands, such as those within large impoundments, that are managed for wildlife habitat or natural functions will typically be rated as C since the hydrology is very tied to berms, canals, and other structures that affect

Table 19. List of major water sources that may be found at sites.

Natural Sources	*Unnatural Sources*
___ overbank flooding from channel ___ overbank flooding from lake ___ groundwater discharge/high groundwater from spring or seep ___ alluvial aquifer (elevated water table, us. near river/stream) ___ natural surface flow ___ direct precipitation __ direct snowmelt	___ irrigation via direct application (incl. managed ditch) ___ irrigation via seepage (e.g. leaking ditch) ___ irrigation via tail water run-off (irrigation return flows) ___ discharge from impoundment release ___ urban run-off/culverts ___ pipes directly feeding wetlands __ other (list)________________________

Table 20. Indicators of reduced or increased extent and duration of inundation or saturation.

Condition	Indicators
Reduced Extent and Duration of Inundation or Saturation	• Upstream spring boxes, diversions, impoundments, pumps, ditching, or draining from the wetland. • Evidence of aquatic wildlife mortality. • Encroachment of terrestrial vegetation. • Stress or mortality of hydrophytes. • Compressed or reduced plant zonation. • Drying organic soils occurring well above contemporary water tables.
Increased Extent and Duration of Inundation or Saturation	• Berms, dikes, or other water control features that increase duration of ponding (e.g., pumps). • Diversions, ditching, or runoff moving water into the wetland, including irrigation return flows and direct irrigation. • Late-season vitality of annual vegetation. • Recently drowned riparian or terrestrial vegetation. • Extensive fine-grain deposits on the wetland margins.
Other Indicators	• Soil disturbance that channelizes water, causes ponding, or dries out wetlands (e.g., deep putting or hummocking, ruts that channelize water)

all aspects of hydropattern, though management likely also attempts to produce conditions somewhat resembling a natural analog. Some examples of artificial wetlands that may be scored as D include (1) marshes that have been dried out for management such as grazing or burning, (2) unvegetated impoundments flooded only in the fall that do not have playa characteristics, and (3) impoundments filling in with weedy upland species because they are no longer regularly flooded. Wetlands that form via sheetflow from water released from impoundments will often be scored as D because these wetlands usually have hydrologies that do not resemble a natural analog. Artificial wetlands will rarely be rated as B, but one example of a "B" score is a wetland in a managed setting that rarely receives managed water and resembles a natural analog, such as a playa wetland that infrequently receives sheetflow from upgradient impoundments.

Playas: Playa sites will typically have a salt crust with high groundwater or surface soil cracking with no evidence of groundwater in the soil pit. Playas also typically have high soil salinity and characteristic saline-tolerant species. Early in the growing season or after large storms, soil salinity levels may decrease due to the input of fresh water, though vegetation should still largely be saline-tolerant species. Some sparsely or unvegetated wetlands may appear to be playas based on their lack of vegetation cover, but not actually have saline soils or characteristic species due to artificial hydrology. These sites will be rated as C or D. Playas sites that appear to have natural hydrology based on soil salinity, plant species, and water table depth, but receive minor unnatural water inputs infrequently or at the end of the growing season may be scored as B.

Table 21. Metric rating for hydropattern.

Rank	State
A	Hydropattern within the AA is natural. There are no major hydrologic stressors that impact the hydropattern. There may be long-established, distant sources of groundwater or surface water extraction within contributing area to the AA, but these only have minimal impact on dampening the water levels in the AA and do not change the overall pattern of water level fluctuation within the AA.
B	Hydropattern deviates slightly from natural conditions. Minor modifications at site or in contributing area affect inflow and outflow of water. Some examples include slightly increased timing and flashiness from impervious surfaces, decrease in inundation due to dams on tributaries, small inputs of tailwater irrigation, small alterations to size of channels or berms, secondary flooding at the end of the growing season, or pugging or rutting that moderately affect hydrology. *If wetland is artificially controlled,* the management regime closely mimics a natural analogue (it is very unusual for a purely artificial wetland to be rated in this category).
C	Hydropattern deviates moderately from natural conditions. The hydropattern may be predominantly or entirely created (e.g.- managed impoundment), though it still somewhat resembles a natural analogue. For example, seepage from a canal during the growing season may create conditions somewhat similar to a natural seep or spring. Artificially impounded sites that are inundated and allowed to draw down in a somewhat natural pattern will usually fall into this category. Site may have hummocking or other soil disturbance that substantially impacts hydrology. *If wetland is artificially controlled,* the management regime approaches a natural analogue. Site may be passively managed, meaning that the hydropattern is still connected to and influenced by natural high flows timed with seasonal water levels.
D	Hydropattern is extremely different from natural conditions. Site may receive all water from flood irrigation with no connection to natural seasonal fluctuations or may be severely limited or eliminated due to groundwater pumping or dams blocking flow. *If wetland is artificially controlled,* the site is actively managed and not connected to any natural season fluctuations. Sites in this category experience extreme changes in hydropattern such as groundwater pumping causing a spring to run dry, dikes blocking all flow except in extreme flood years, or detention basins that undergo short fill and release cycles.

Wet Meadow: Wet meadows will typically have evidence of shallow flooding (surface water, biotic crust, soil cracking) or a high water table (organic soils, water table, saturation) at least part of the growing season, though hydrology may be absent by mid to late summer.

Flood-Irrigation and Irrigation Return Flows: Sites that receive water entirely from flood irrigation or irrigation return flows that are no longer connected to natural hydrology or are totally created will typically be scored as D because the flooding and drying patterns are unlikely to mimic a natural analog. Sites that are flood-irrigated but still connected to the natural hydrology may be rated C.

Managed River (e.g., Bear River): Wetlands along rivers can be impacted by upstream dams, water withdrawal, and return flows. Wetlands along rivers that are heavily impacted by these stressors will typically be rated as C, though they can be rated higher or lower depending on conditions at the site.

Managed Reservoir (e.g., Cutler Reservoir, Rockport Reservoir): Wetlands on the shores of managed reservoirs will frequently be scored as C since reservoir management will typically approach a natural analog, but not directly mimic it. In some cases, these wetlands may cycle between periods of extreme flooding and extreme drying and, in other cases, these wetlands may see little water level fluctuation. Site conditions may cause some sites to score as D such as at sites with mostly annual species or substantial bare areas on the shoreline, indicating that water levels have fluctuated too rapidly to allow perennial vegetation to establish and persist, or at sites with substantial other hydropattern stressors that also impact the site, such as agricultural runoff or berming from roads. Wetlands along passively managed reservoirs or natural waterbodies with dams may score as B if they are thought to closely mimic a natural analogue. Wetlands along Utah Lake have frequently been rated as either B or C.

Turbidity and Pollutants

Definition and background: Water quality is difficult to assess visually in the field, but there are some water quality problems that are frequently visually apparent. Turbidity is the most readily apparent water quality indicator. Water with high turbidity has high amounts of suspended or dissolved particles in the liquid that scatters light, giving it a cloudy or murky look (http://water.epa.gov/type/rsl/monitoring/vms55.cfm). High turbidity can alter the chemical and physical structure of that water. The increased amount of particles absorbs more heat, increasing temperature and decreasing the concentration of dissolved oxygen the water holds. Turbid water also limits light penetrating into the water column, decreasing the potential for photosynthesis. The settling of the particles can have significant effects on the life cycle of aquatic organisms by covering spawning beds and benthic macroinvertebrates communities, especially in slow moving waters.

High turbidity can occur naturally; for example, due to natural erosion following high runoff events. However, turbid waters can often be an indicator of anthropogenic stressors degrading water quality. Stormwater runoff and anthropogenic soil disturbance, such as certain agricultural practices and off-road travel, can contribute to sedimentation that affects turbidity.

The particles found in turbid waters provide a host for other detriments to water quality such as bacteria and metals. Turbidity therefore can be a useful indicator of potential pollution in water (http://water.usgs.gov/edu/turbidity.html). Water color can be a more direct indicator of pollutant issues; for example, red-orange tint to water can be caused by mine tailings (Lemly and Gilligan, 2013). Another indicator of pollutants is the presence of an unnatural oily sheen on the surface of the water caused by petroleum products. This unnatural sheen will swirl and join back together when an object is pulled through it. This is a key difference from naturally produced sheens, which are formed by iron and manganese oxidizing bacteria and which pull apart, breaking into plates when they are disturbed.

Measurement protocol: When water is present in the AA, select the state that best describes the AA in table 22. For sites that score C or D, take a photo of the water so it can be referenced later, and record

Table 22. Metric rating for turbidity and pollutants.

Rank	**State**
N/A	No water present in AA
A	No visual evidence of degraded water quality. No visual evidence of turbidity or other pollutants.
B	Some negative water quality indicators are present but limited to small and localized areas within the wetland. Water is slightly cloudy, but there is no obvious source of sedimentation or other pollutants.
C	Water is cloudy or has unnatural oil sheen, but the bottom is still visible. Sources of water quality degradation are apparent (identify in comments below). Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.
D	Water is milky and/or muddy or has unnatural oil sheen. The bottom is difficult to see. There are obvious sources of water quality degradation (identify in comments below). Note: If the sheen breaks apart when you run your finger through it, it is a natural bacterial process and not water pollution.

possible sources of water quality degradation (e.g., substrate disturbance, urban runoff, extensive livestock use, etc.). High turbidity may be natural in riverine wetlands during times of peak runoff and in filled playas due to their fine sediments, whereas other depressional wetlands are generally not naturally turbid though they may be affected by recent weather events (Lemly and Gilligan, 2013). Record the presence of turbid water even when it appears natural, but add a note in the comments for these sites.

Algae Growth

Definition and background: Although algae occur naturally in the environment and can provide beneficial values, high concentrations of algae or algal blooms can be detrimental to ecosystem health. Thick algal mats block sunlight from penetrating into the water column, reducing photosynthesis potential. Decaying algae cells consume high levels of oxygen, leading to potential die-offs of oxygen-dependent aquatic life. Similar to turbidity, the presence of algae can be an indicator of water quality issues. Excessive algal growth is typically a response to high levels of nutrients, mainly phosphorus and nitrogen, in combination with warm temperatures and exposure to sunlight.

Measurement Protocol: Evaluate areas with standing water, as well as areas that obviously recently had standing water, such as drying pond edges or areas with dried algal mats (table 23). Lack of dried algal mats in the absence of surface water should not be taken as evidence of an A or B rating for this metric. Take photo if sites rates below B. Ignore macroalgae (*Chara* spp.) in the evaluation.

Water Quality

Definition and background: Water quality is an important component of wetland condition. Changes in nutrient loads and sediment input and input of metals and potential toxins can sometimes lead to toxic algal blooms, plant species composition shifts including species invasion or dominance by one or a few species, die-offs of wildlife species, shifts in macroinvertebrate composition and abundance, and food web effects. About one-third of all streams and lakes assessed for the 2010 Utah Integrated Report Water Quality Assessment 305(b) Report (Utah DEQ Division of Water Quality, 2010) were found to be

Table 23. Metric rating for algae growth.

Rank	State
N/A	No surface water at site and no evidence of dried algal mats in recently inundated areas.
A	Water is clear with minimal algal growth. Dried algal mats, if present, minimal.
B	Algal growth is limited to small and localized areas of the wetland. Water may have a greenish tint or cloudiness. Dried algal mats, if present, minimal.
C	Algal growth occurs in moderate to large patches throughout the AA. Water may have a moderate greenish tint or sheen. Site may have evidence of moderate to large patches of dried algae mats in recently inundated areas.
D	Algal mats are extensive, blocking light to the bottom. Water may have a strong greenish tint and the bottom is difficult to see. Site may have evidence of extensive dried algal mats in recently inundated areas.

impaired. In streams, total phosphorus, total dissolved solids, sedimentation, water temperature, physical substrate alteration, and benthic macroinvertebrate community impairment were the most common reasons for impairment.

Direct measures of wetland water quality are impossible to obtain without laboratory analysis of water samples that are collected at multiple points in time. This metric evaluates possible or likely nutrient, sediment, and toxin impacts to water quality via analysis of nearby water quality stressors, the degree to which they are buffered from sites, and the severity with which they are expected to occur. Evaluation predominantly focuses on areas likely to contribute surface water to sites due to the difficulty in determining contributing areas of groundwater, though known or likely groundwater contamination should also be taken into account.

Measurement protocol: Potential impacts to water quality at sites will be evaluated both with pre-screening in the office as well as an on-the-ground assessment. In the office, determine the area likely to contribute surface water to the AA based on aerial imagery, topographic maps, and elevation data. This can be done using Google Earth, ArcGIS, or paper maps. The contributing area to an isolated wetland may be composed of a small hillside upgradient from the site whereas some sites that receive input from streams and rivers will have very large contributing areas. We will consider the area from a stream to the nearest major upgradient tributary or reservoir as the contributing area for these latter AAs. Major reservoirs upstream from a riverine site may act as a buffer from stressors upstream of the reservoir, though this buffer effect is likely to be smaller for managed impoundments with short water retention times (Miller and Hoven, 2007). Stressors to a small stream will be diluted when that stream joins a larger river, and stressors to a large river can be diluted by major tributaries. Within the contributing area, determine the degree to which the landscape is composed of development, cropland, and livestock grazing. Determine whether there are Clean Water Act permittees (http://echo.epa.gov) likely to influence your site and whether the major water source to the AA has been listed as impaired by the state of Utah (https://utah-dwq.github.io/asmnt_map2022/).

During the field survey, first evaluate the water source to the site to determine whether it was the same as what was assumed during the office evaluation. Next, look for evidence of water quality stressors in the buffer and directly within the site itself. When evaluating the surrounding landscape, consider the severity of the stressor, how the inputs of the stressor reach the AA (e.g., through direct surface flow, overland travel across dirt or pavement, or overland travel across well-vegetated land cover), and the distance from the AA to the stressor.

Determine the state that best describes the water quality of the AA (table 24). Use the examples of stressors listed under each state as guidance only. For example, a site that has many of the stressors listed under the B state may be rated C due to the aggregation of the stressors. Remember to evaluate stressors based both on their severity and the frequency with which they are likely to reach a site. For example, sediment from a burned hillside may only reach the site during run-off events whereas irrigation return flows to a connected stream may reach a riverine site more frequently. Water that sits in a reservoir may lose a lot of sediment before being released, and water that runs through wetland before reaching a site may be buffered from many water quality stressors.

Table 24. Metric rating for water quality.

Rank	State
A	**There are no water quality stressors likely to impact site.** *All Sites:* Within the AA, soils are intact with no evidence of damaging soil disturbance or excessive manure inputs. Any anthropogenic stressors within 500 m up-gradient from the AA must be minor (e.g., small areas with unnatural bare ground or lightly grazed pasture, a few fertilized lawns, etc.) and unlikely to impact the site (e.g., separated from site by at least 50 m of thick vegetation and on a shallow slope from site). *For Sites receiving most water from channels:* The land cover of the contributing area for any channels reaching sites is predominantly natural with no point source dischargers that are likely to impact the site's water quality.
B	**Site likely to receive infrequent or minor inputs of water quality stressors.** *All Sites:* Within the AA, some minor dung and soil disturbance from livestock (if grazing impacts very light, may be an A); up-gradient stressors within 500 m of site are minor, somewhat buffered from site, or well-buffered if more severe (e.g., runoff from dirt road with narrow buffer or expansive area of exposed sediment with 100-m vegetated buffer). *For sites receiving most water from channels:* The entire contributing area has <20% development or cropland; entire contributing area has a few minor point source dischargers; streams and lakes that contribute directly to the site are not listed on the 303d list.
C	***Site likely to receive moderate input of water quality stressors.***

	All Sites: Within the AA, moderate dung and soil disturbance from livestock or up-gradient stressors that occur within 500 m of the site that are more moderate in extent or severity and less well-buffered from site (e.g., runoff from low-density development directly reaching site or nutrient input from a farm; consider both the slope leading to the site and the land cover between the stressor and the site; vegetated very low slope may be B and unvegetated very steep slope may be D). *For sites receiving most water from channels:* The entire contributing area has ~20-60% development or cropland, or has point source dischargers that are distant from site or only a few that are closer; streams and lakes that contribute to the site are not listed on the 303d or are listed, but water quality is likely to be attenuated or improved before reaching the wetland by passing through reservoirs or emergent vegetation.
D	**Site likely to receive substantial water quality stressors.** *All Sites:* Stressors may include: high levels of dung and soil disturbance from livestock within AA or, up-gradient stressors such as irrigation return flow water, fertilizer and pesticide application, and erosion from fires, construction, off-road vehicles, and dirt roads *discharging directly into sites.* May be considered C if run-off from the features is likely to occur infrequently, if slope is shallow, or if only a small area of the AA receives these stressors. Stressors may occur immediately adjacent or within sites or may be minimally buffered from sites (e.g., up a steep hill with very narrow or unvegetated buffer). *For sites receiving most water from channels:* The entire contributing area has>60% development or cropland, a high number of point source dischargers; or streams and lakes that directly contribute to the site are listed as impaired on the 303d list with no attenuation

Connectivity

Definition and background: This metric measures of the degree to which water within the wetland is connected to the surrounding landscape. Unaltered connectivity between a wetland and adjacent uplands or wetlands is important for increasing complexity by the formation of varied saturation zones (California Wetlands Monitoring Workgroup, 2013a) and for maintaining natural inputs into the wetland. Sites with unimpeded connectivity are more likely to accommodate rising floodwaters without dramatically changing water levels in a manner that increases stress to wetland plants and animals (Lemly and Gilligan, 2013). This metric is evaluated on the edge of the AA and provides information about the percent of wetland area within the sample frame that is connected to adjacent land.

Measurement protocol: AA shape and placement often lead to AAs being placed away from berms and other features that may impede wetland connectivity. Evaluate this metric within 10 meters of the edge of the AA, keeping in mind whether decisions about AA placement affected edge placement. For example, if a site center was shifted further than it needed to be to avoid a berm, evaluate the metric as if the berm is affecting connectivity along the AA edge. Determine the percent of edge that consists of features, such as steep banks, levees, concrete walls, rip-rap, and road grades, which could restrict the lateral movement of rising waters (table 25). Features disrupting connectivity within sites should be evaluated as well, such as berming within sites or entrenched channels. When evaluating features to determine whether they interfere with connectivity, consider the extent to which they create gradual versus abrupt transition zones between the wetland and the surrounding landscape.

Table 25. Metric rating for connectivity.

Rank	State
A	Rising water has unrestricted access to adjacent upland without levees or other obstructions to the lateral movement of flood waters. Channel, if present, is not entrenched and is still connected to the floodplain with no dikes, rip rap or elevated culverts.
B	Unnatural features such as levees or road grades limit the amount of adjacent transition zone or the lateral movement of floodwaters, relative to what is expected for the setting, but limitations exist for <25% of the AA boundary. Restrictions may be intermittent along the margins of the AA, or they may occur only along one bank or shore. Channel, if present, is somewhat entrenched, but overbank flow occurs during most floods and <25% of stream banks are affected by dikes, rip rap or elevated culverts. If playa, surrounding vegetation does not interrupt surface flow.
C	The amount of adjacent transition zone or the lateral movement of flood waters to and from the AA is limited, relative to what is expected for the setting, by unnatural features for 25–75% of the boundary of the AA. Features may include levees or road grades. Flood flows may exceed the obstructions, but drainage out of the AA is probably obstructed. Channel, if present, may be moderately entrenched and disconnected from the floodplain except in large floods and 25%-75% of stream bank may be affected by dikes, rip rap, concrete or elevated culverts. If playa, surrounding vegetation may interrupt surface flow.
D	Essentially no hydrologic connection to adjacent landscape. Most or all stages may be contained within artificial banks, levees, or comparable features. Channel, if present, is severely entrenched and entirely disconnected from the floodplain. If playa, surrounding vegetation may dramatically restrict surface flow.

Physical Structure Metric

Substrate and Soil Disturbance

Definition and background: This metric evaluates the degree to which the soil or substrate of the AA has been disturbed by anthropogenic stressors. Common sources of disturbance include ATV tracks, human trails, trampling or pugging by livestock, fill or sediment dumping, and dredging or other excavation. Soil disturbances can alter wetland hydrology, affect vegetation, and disrupt natural soil processes such as organic accumulation. Unnaturally bare soil can increase sediment inputs into water and unnaturally compacted soils may affect plant species cover and community composition.

Measurement protocol: Evaluate the AA for evidence of soil disturbance including features such as bare ground, formation of pugs, and compacted soil. Keep in mind that all of these features can also occur naturally so it is important to use best professional judgment to determine whether features are caused by natural or anthropogenic processes. For example, playas and mudflats can be naturally bare, and pugging formed by livestock grazing can appear somewhat similar to naturally formed hummocks. Select the statement that most closely matches the soil or substrate condition in the AA (table 26).

Table 26. Metric rating for substrate and soil disturbance.

Rank	State
A	No soil disturbance within AA. Little bare soil OR bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails OR soil is naturally bare (e.g., playas). No pugging, soil compaction, or sedimentation.

B	Minimal soil disturbance within AA. Some amount of bare soil, pugging, compaction, or sedimentation present due to human causes, but the extent and impact are minimal. Mild disturbance that does not show evidence of altering hydrology or causing ponding or channeling may occur across a large portion of the site, or more moderate disturbance may occur in one or two small patches of the AA. Any disturbance is likely to recover within a few years after the disturbance is removed.
C	Moderate soil disturbance within AA. Bare soil areas due to human causes are common and will be slow to recover. There may be pugging due to livestock resulting in several inches of soil disturbance. ORVs or other machinery may have left some shallow ruts. Sedimentation may be filling the wetland. The site could recover to potential with the removal of degrading human influences and moderate recovery times.
D	Substantial soil disturbance within AA. Bare soil areas substantially degrade the site and have led to severely altered hydrology or other long-lasting impacts. Deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread. Sedimentation may have severely impacted the hydrology. The site will not recover without active restoration and/or long recovery times.

Vegetation Structure Metric

Horizontal Interspersion

Definition and background: Horizontal interspersion is the number and degree of interspersion of component patches within a wetland. Degree of interspersion can also be thought of as the amount of edge between patches. A site composed of open water and one dominant vegetation patch type will be more interspersed if the open water and vegetation occur in small patches rather than if each occupies a single large patch. Greater complexity of interspersion between open water and vegetation is positively related to breeding density and diversity of marsh birds (Rehm and Baldassarre, 2007). Patches considered for this metric include open water without vegetation and vegetation patches with different dominant species. Patches are expected to differ in features such as density of cover, usability of litter for nesting, and quality and quantity of food produced within the patch, which leads to a broader range of habitat features.

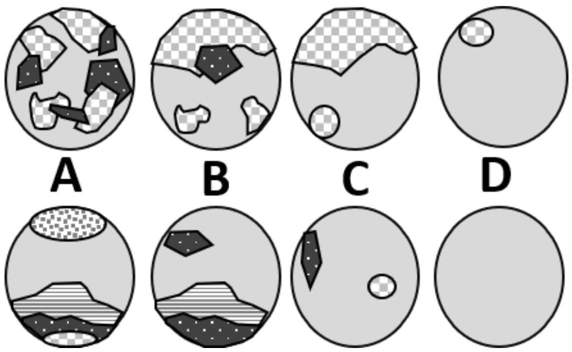
Measurement protocol: Evaluate the presence and distribution of patches of open water and vegetation within the AA (table 27). Distinct vegetation patches are patches that share similar physiognomy and species composition that are "arrayed along gradients of elevation, moisture, or other environmental factors that affect the plant community organization in a two-dimensional plan view" (California Wetlands Monitoring Workgroup, 2013a). Individual patches must be at least 10 m² (approximately 3.2 m x 3.2 m in a 0.5 ha AA) and each patch type must cover at least 5% of the AA (e.g., 250 m² in a 0.5 ha AA). List all of the patches present in the AA. Consider both the number and arrangement of patches when evaluating this metric. Use both table 27 and figure 5 to help in evaluation of this metric.

Table 27. Metric rating for horizontal interspersion.

Rank	State
A	High degree of horizontal interspersion. AA is characterized by a complex array of nested or interspersed zones. AA has both a high number of zones and a high degree of interspersion of those zones.
B	Moderate degree of horizontal interspersion.

C	Low degree of horizontal interspersion.
D	Minimal horizontal interspersion. AA characterized by one dominant zone with little to no other zones.

Figure 5. Diagram to assist with rating the horizontal interspersion metric.



Litter Accumulation

Definition and background: This metric evaluates the degree to which the abundance and distribution of herbaceous and deciduous detritus at a site resembles expected patterns at similar pristine wetlands. Litter input and decomposition rates are important determinants of rates of nutrient cycling at sites. Litter can provide shade that lowers wetland soil and water temperatures. Litter provides cover to protect animals from predation and nesting material for birds and other wildlife. Unnatural patterns of litter accumulation can be indicative of underlying stressors and are likely to be accompanied by other changes in wetland condition, such as changes in invertebrate communities (Christensen and Crumpton, 2010) and plant community composition (Larkin and others, 2011). Livestock grazing (Dobkin and others, 1998), changes in hydroperiod (Anderson and Smith, 2002; Atkinson and Cairns, 2001; Straková and others, 2012), and invasion by aggressive plant species (Eppinga and others, 2011) are some potential causes of abnormal litter accumulation.

Measurement protocol: Note the quantity and distribution of litter throughout the AA and compare to what might be expected at reference sites of a similar wetland type (table 28). Litter evaluation should occur under water as well as on the wetland surface. All dead plant material from previous years will be considered litter for the sake of this evaluation. Playas and other wetlands with sparse vegetation typically have low levels of litter whereas marshes and other densely vegetated wetlands can accumulate large amounts of litter in normal conditions. Fire, overgrazing, and mechanical plant removal (e.g., mowing, haying) can reduce litter levels and may sometimes, though not always, be accompanied by little plant recruitment. Common causes of excessive litter include reduced water levels, aggressive plant colonization, and herbicide treatment. Wetlands may naturally have large amounts of litter; wetlands with naturally high litter levels should still have seasonally appropriate levels of plant recruitment. Areas with extremely thick litter and either little plant recruitment or complete dominance by a single species may have increased litter levels. Note that recruitment levels will be naturally low early in the growing season. Select the appropriate statement from the list below and check whether the site has limited, normal, or excessive litter. If the site receives a score below A, briefly describe the evidence that suggests that the litter is abnormal, note potential causes, and document with photographs.

Table 28. Metric rating for litter accumulation.

Rank	State
AB	AA characterized by normal amounts of herbaceous and/or deciduous litter accumulation for the wetland type. In some wetlands, this may mean that new growth is more prevalent than previous years' and that litter and duff layers in pools and topographic lows are thin. Undisturbed playas may be lacking in litter altogether. Marshes may have high levels of litter accumulation, but litter should not prevent new growth or be too dense to allow more than one species to persist.
C1	AA characterized by small amounts of litter compared to what is expected.
C2	Litter is somewhat excessive.
D1	AA lacks litter.
D2	Litter is extensive, often limiting new growth.

Woody Debris

Definition and background: Woody debris is dead or decomposing wood, including fallen trees, rotting logs, and smaller woody inputs from twigs or branches or broken down from larger inputs. The importance of woody debris in riverine systems is well-documented. In-stream woody debris is important for fish communities because it provides cover to protect individuals from predation, reduces contact between fish, and allow fish to lower energy expenditures in velocity refuges (Crook and Robertson, 1999). Woody debris in streams has been shown to increase salmonid species abundance (Whiteway and others, 2010) and macroinvertebrate richness (Miller and others, 2010). While the role of woody debris in other wetland systems is not as well studied, woody debris additions to constructed depressional wetlands in Delaware led to increased overall insect richness and biomass as well as increased biomass of insect species intolerant of environmental degradation (Alsfeld and others, 2009). In systems where it is naturally found, woody debris is expected to provide habitat for aquatic and wetland species and help with retention of nutrients and organic matter.

Measurement protocol: Evaluate woody debris accumulation within the AA, compared to what is expected for the wetland type and particular site (table 29). Sites that lack woody species may nonetheless accumulate woody debris if they are hydrologically connected to nearby landscapes with woody species. Score this metric as N/A for naturally herbaceous wetlands that lack opportunity for inputs from woody species in the surrounding landscape.

Table 29. Metric rating for woody debris.

Rank	State
N/A	There are no obvious inputs of woody debris and none are expected for the wetland type. Inputs are not available within site, along site edge, or along nearby up-gradient hydrologically connected flowpaths.
AB	AA characterized by moderate amount of coarse and fine woody debris, relative to expected conditions. For riverine wetlands, debris is sufficient to trap sediment, but does not inhibit stream flow. A wide size-class diversity of downed woody debris and standing snags is present and common

	where expected. For non-riverine wetlands, woody debris provides structural complexity, but does not overwhelm the site.
C1	AA characterized by small amounts of woody debris.
C2	Debris in AA is somewhat excessive.
D	AA lacks woody debris, even though inputs are available.

Woody Species Regeneration

Background and definition: The woody species regeneration metric evaluates the age class structure of woody species at sites. Sites should generally contain a range of age classes, including seedlings, small shrubs or saplings, and mature shrubs or trees. Woody species age class structure is a good indication of chronic stressors or major changes at sites due to the long maturity time required to reach adult size. The presence of natural regeneration at sites expected to have woody species is important for providing wildlife habitat and woody debris inputs. Overgrazing by livestock or native species can lead to high mortality of seedlings and saplings and thus little recruitment to the adult age class (Russell and others, 2001). Younger age classes may also dominate sites recovering from intense fire or sites that experience frequent fires (Grady and Hoffmann, 2012). Chronic changes in hydrology can also affect regeneration. Riparian sites that experience abrupt changes in flow levels due to river regulation or water withdrawal may have decreased regeneration (Amlin and Rood, 2002). Invasive woody species can replace native woody species or invade sites that previously had little woody species cover. These species may provide some of the same functional services as native woody species, but also have a high potential to impact natural processes at sites such as nutrient cycling (Ehrenfeld, 2003), hydrologic processes (Huddle and others, 2011), and plant community composition. Sites with high levels of invasive woody species receive a low score for this metric regardless of the structure of native woody species regeneration occurring at the site.

Measurement protocol: Select the statement that most accurately describes the age structure of native woody species within the AA (table 30). If woody species are naturally uncommon or absent at sites, select N/A. If sites have more than 5% cover of Russian olive or tamarisk, circle both the last statement indicating this and one of the first six statements that describes the regeneration status of native woody vegetation. Sites with very low woody species cover (~ <2.5%) are typically rated as either N/A (woody species naturally uncommon/absent) or a rating below A to indicate issues with regeneration. Sites where woody species are expected but sparse or absent due to disturbances can be rated as D.

Table 30. Metric rating for woody regeneration.

Rank	State
N/A	Woody species are naturally uncommon or absent.
A	All age/size classes of desirable (native) woody species present.
B	Age/size classes restricted to mature (full size) individuals and young sprouts. Middle age/size groups absent. Regeneration moderately impacted for some reason (describe).
C1	Stand comprised of mainly mature (full size) individuals, with seedlings and sapling (smaller individuals) absent.
C2	Stand mainly evenly aged/sized young sprouts that choke out other vegetation.

D1	Woody species predominantly consist of decadent or dying individuals. Decadent individuals are those with greatly reduced growth, such as which often occurs at sites where species have been over-browsed.
D2	AA has >5% canopy cover of *Elaeagnus angustifolia* (Russian olive) and/or *Tamarix* (tamarisk) or other invasive woody species. If you select this state, select an additional statement that describes native regeneration in AA.

Auxiliary Metrics

Auxiliary metrics include those metrics that will not be included in scoring but will be collected to increase our understanding of structure and dynamics in Utah wetlands across different types of wetlands.

Structural Patch Richness

Definition and background: Structural patch richness is a measure of the number of different physical surfaces or features present in a wetland. Physical processes such as energy dissipation and water storage contribute to the development of natural physical features (California Wetlands Monitoring Workgroup, 2013b) and thus the presence of expected structural patches may indicate that natural physical processes are occurring appropriately. Natural physical complexity is assumed to promote "natural ecological complexity, which in turn generally increases ecological functions, beneficial uses, and the overall condition of a wetland" (California Wetlands Monitoring Workgroup, 2013b). Not all potential structural patch types are expected to occur in all wetland types; for example, many structural patches are specific to wetlands with channels.

Measurement protocol: We do not yet have enough data to determine the expected number and types of structural patches in Utah wetlands. We will obtain baseline data on the presence and cover of different structural patches and develop metric statements once adequate data across the condition gradient have been collected for each wetland type. Record the cover for each patch type present in the AA (see cover reference diagram in appendix A). For features that occupy less than 1% of the AA, record the approximate number of square meters that they cover. Otherwise, select the appropriate cover class that represents the percent of the AA occupied by the feature. Where indicated, also select whether the majority of a particular patch type is currently wet or dry by circling W or D. Features have been organized into categories to facilitate selection in the field. The California Rapid Assessment Method has a photo dictionary that is useful for identifying patch types (http://www.cramwetlands.org/documents).

Topographic Complexity

Definition and background: Topographic complexity refers to the variability in vertical physical structure in a wetland. The topographic complexity metric considers the presence and abundance of microtopography and macrotopography at a site. The Wetland Science Institute defines microtopography as vertical features with less than 15 centimeters of relief including "small depressions, swales, wallows, and scours that would hold water for a short (hours to days) time after a rainfall, runoff, or flooding event" (The Natural Resources Conservation Service's Wetland Science

Institute, 2003). Macrotopography refers to the larger-scale heterogeneity in structure caused by elevational features such as benches and slopes of varying steepness. For the purposes of this assessment, macrotopography include any vertical, physical features greater than 15 cm in height, such as deep depressions, terraces, swales, or sloughs and also include topographic elevation gradients that support distinct vegetation communities or hydrologic regimes.

Measurement Protocol: Record a description of each distinct macrotopographic feature (i.e., elevation gradient) that occurs within the site. Elevation gradients must be at least 15 cm in height difference and can include features such as benches, slopes of varying steepness, channels, and pools. Gradients must have an edge of at least 8 m (e.g., length of channel, perimeter of pools or higher elevation "island", length of edge between two slopes) or cover at least 5% of the AA. Also record the amount of AA area with microtopography features including woody debris, boulders, sediment mounds, vegetation hummocks, tufted herbaceous litter, and other similar features. If not certain whether the feature is considered microtopography, make a note in the comments.

Amphibian Habitat Metrics

Background and Scoring

Amphibian metrics were developed to provide a rapid method for evaluating habitat for two state sensitive amphibians, the Columbia spotted frog and boreal toad. Metrics were developed in consultation with the Ecological Integrity Tables for each species, a summary of key indicators for the species with ratings associated with each indicator (Oliver, 2006 and 2007). The tables were screened for habitat-based indicators; data from the tables were supplemented with literature review.

Amphibian metrics are converted to a mean score for each species and then evaluated to determine whether sites meet or exceed thresholds that determine whether sites may be suitable habitat, first converting ranks to point values based on the following: A—5, B—4, C—3, D—1. For boreal toad, we first obtain a final vegetation metric score by combining the shrub cover metric and tall forb cover metric. Sites are assigned the lower of the two metric scores if overabundance is an issue for either forbs or shrubs and otherwise assigned the highest value of the two scores. For boreal toad, we take the mean value of the four boreal toad-specific metrics plus the presence of north shore and slope and water depth metrics. Metrics for the boreal toad have been extensively tested at sites with known breeding populations to determine their suitability for evaluating boreal toad breeding habitat (Menuz, 2016; Menuz, 2017a). Sites with mean metric values of 3.8 or higher are most likely to be suitable for boreal toad breeding. For Columbia spotted frog, we take the mean value of three of the Columbia spotted frog-specific metrics (ignoring the waterbody substrate metric) plus the presence of north shore and slope and water depth metrics. More limited testing has been conducted with the Columbia spotted frog metrics with data from eight known breeding sites and four sites within the breeding range of the species. All but one site had scores of 4.4 or higher; the lowest scoring site received a score of 3.6. We preliminarily will consider mean metric scores ≥3.6 to be potentially suitable for Columbia spotted frog breeding.

Boreal Toad Metrics

Breeding Waterbody

Definition and background: Suitable breeding waterbodies for boreal toad are typically pooled or slow-moving waters that are large enough not to dry up before tadpoles mature and deep enough not to freeze at night during the summer, such as lakes, ponds, and large pools (Oliver, 2007). Lotic waters are typically too cold and swift for breeding, though low-gradient backwaters and oxbows may be used. Surface water must be present for the duration of the time from egg mass to tadpole development, which may take approximately 75 days (McGee and Keinath, 2004), though the exact duration will vary depending on the rate of development.

Measurement protocol: Determine what types of waterbodies are present within the AA (table 31). Also consider waterbodies immediately adjacent to the AA if the waterbody shore is within the AA or comprises the AA boundary. Rank the site for the highest-quality feature present so, for example, a site would receive a rating of A if it has both beaver ponds and a flowing stream. Sites without any indication of surface water or that are only flooded for very short periods of time, including sites that are periodically flood irrigated and allowed to dry out, should be rated as D.

Shallow Water Temperature

Definition and background: Boreal toad typically lay their eggs on the shallow edges of larger waterbodies or in shallower ponds that can warm rapidly in the sun (Oliver, 2007). Very cold

Table 31. Metric ratings for boreal toad breeding waterbodies.

Rank	**State**
A	lentic and large enough not to dry up and deep enough not to freeze solid at night during summer including lakes, ponds (especially beaver ponds), and large pools (including artificially created ponds and pools).
B	lotic: low-velocity, low-gradient streams or springs.
C	lotic: flowing rivers and streams OR lentic but very small or uniformly shallow: temporary pools, small puddles.
D	No surface water typically present at site (e.g., less than a few weeks of surface water per growing season) or surface water present intermittently throughout summer (e.g., field flood irrigated and then completely dried out periodically all summer) (skip the next three metrics)

temperatures can be deadly to eggs and warmer temperatures allow for faster development of eggs into tadpoles, providing more time for tadpoles to develop into metamorphs that can survive outside water before water freezes or dries up.

Measurement protocol: Measure water temperature using a handheld meter in the highest quality breeding waterbody present at the site (e.g., in a beaver pond and not a flowing stream) in areas most suitable for breeding, particularly shallow unshaded areas along the north shore of the waterbody if available. Take measurements towards the warmest part of the day if possible to capture the potential peak temperatures. Estimate the likely peak water temperature, taking into account likely increases in temperature if measurements are made early in the morning or on an overcast day (table 32).

Table 32. Metric ratings for boreal toad shallow water temperature. /

Rank	State
A	28–34 °C
B	16–27 °C or 35 °C
C	11–15 °C or 36 °C
D	≤10 °C or ≥37 °C

Hibernation Features

Definition and background: Boreal toad spend winter outside of the water in hibernacula, which can include animal burrows, rockslide or debris piles, beaver lodges, rocky chambers near streams, and cavities under boulders or tree roots (McGee and Keinath, 2004; Oliver, 2007). They can move several kilometers from breeding waterbodies to hibernacula, though for the sake of this metric we will only search within AAs and their buffers. Boreal toad will cross roads and other unnatural features to move to hibernacula, though these disturbances can increase their mortality.

Measurement protocol: Walk a 100-m transect line in the buffer on the north, east, south, and west sides of the AA to search for potential hibernation features, including woody debris piles, animal burrows, and loose soil, and determine the connectivity of the features to the AA (table 33). Also, estimate the availability of hibernation features in the remainder of the buffer and search the AA itself for features. Circle all the types of features observed and then select the metric state that best fits the description of the availability of hibernation features in the AA and a 100-m buffer surrounding the AA.

Table 33. Metric ratings for boreal toad hibernation features.

Rank	State
A	Features such as burrows (esp. ground squirrels), interstices of beaver dams, old beaver lodges, overhanging stream banks, rocky chambers near streams, cavities under boulders or tree roots, loose soil, and/or woody debris piles common and connected to summertime habitat.
B	Above features present but not abundant. Some area with features may be disconnected from summertime habitat due to low use roads or other low severity fragmentation, but some connected features present.
C	Above features present but rare and/or only present on very steep slopes or disconnected from summertime habitat by busy roads, development, or other severe fragmentation.
D	None of the above features present or no surface water typically present.
Observed Hibernation Features (circle one or more feature): None observed Burrows Beaver Dam Beaver Lodge Undercut Stream Bank Boulders Loose Soil Woody debris piles	

Understory-Forming Vegetation

Definition and background: Boreal toad make extensive use of terrestrial habitats after breeding. Understory-forming vegetation may be important to prevent evaporative water loss while allowing them to move freely in the understory. Boreal toads are associated with at least moderate shrub cover in terrestrial habitat (McGee and Keinath, 2004; Oliver, 2007). However, Menuz (2006) speculated that tall forbs such as *Rudbeckia occidentalis* (western coneflower) and *Solidago altissima* (Canada goldenrod) may play a similar role as shrubs in preventing evaporative loss after finding that three of seven breeding sites in northern Utah had little to no shrub cover. The same study found that sites with ≥60% shrub cover also did not have boreal toad, potentially because of lack of appropriate basking habitat.

Measurement protocol: Evaluate this metric within the AA and in the valley bottom or floodplain terraces in the 100-m buffer (i.e., do not evaluate on steep slopes in the buffer). Determine the aerial extent of each vegetation type (shrub and tall forb) within terrestrial portions of the valley bottom (table 34). Cover estimates are for the area occupied by each vegetation type, not the shade cover that occurs when the sun is directly overhead.

Table 34. Metric ratings for boreal toad understory-forming vegetation.

Shrub	**Tall Forbs**	**State**
A	A	Ample cover near waterbodies. Generally this will entail 33 to 60% of the area along a stream floodplain or valley bottom near a pond or lake with moderate to dense cover of understory-forming species.
B	B	Moderate cover near waterbodies, with approximately 21 to 33% of area with moderate/dense cover, or cover abundant, but very patchy
C1	C1	Low cover near waterbodies, with approximately 5 to 20% of area with moderate/dense cover.
C2	C2	Overly abundant cover near waterbodies. Between 60% and 80% of non-water area along stream floodplain or valley bottom with understory species. Little basking habitat present
D1	D1	No or only a few scattered areas with cover present (<4% cover)
D2	D2	Extremely abundant cover near waterbodies. Over 80% of non-water area along stream floodplain or valley bottom with understory cover. Basking habitat extremely rare.

Columbia Spotted Frog Metrics

Breeding Waterbodies

Definition and background: Columbia spotted frog need to breed in waterbodies with minimal flow that are large enough not to dry up in summer and deep enough not to freeze solid at night during the summer. In Utah, they typically breed in beaver ponds, river oxbows, stock ponds, and spring complexes. Surface water must be present from egg mass deposition through tadpole development.

Measurement protocol: Determine what types of waterbodies are present within the AA (table 35). Rank the site for the highest-quality feature present so, for example, a site would receive a rating of A if it has both beaver ponds and a flowing stream. Sites without any indication of surface water or that are only flooded for very short periods of time, including sites that are periodically flood irrigated and allowed to dry out, should be rated as D.

Table 35. Metric ratings for Columbia spotted frog breeding waterbodies.

Rank	State
A	Waterbodies suitable for breeding present. Waterbodies large enough not to dry up in summer and deep enough not to freeze solid at night during the breeding season with minimal flow. Examples include **beaver ponds, oxbows,** and **springs-fed pools.**
B	Stock ponds (excluding those that are spring-fed, which belong above); shallower sections of spring complexes (likely to freeze or dry up).
C	Lotic systems (rivers or streams) OR lentic but very small or uniformly shallow (e.g., temporary pools, small puddles).
D	No surface water typically present at site or site with water regime of A or drier (score waterbody metrics as D).

Waterbody Substrate

Definition and background: Columbia spotted frog area thought to typically breed in waterbodies with finer substrates, such as deep organic muds and silts (Oliver, 2006).

Measurement protocol: Evaluate this metric in waterbodies that rank highest for the Columbia spotted frog breeding waterbody metric. Sink your hand or a ruler into the bottom of the waterbody to determine the substrate material and whether it is hard-packed or loose and then select the appropriate rank (table 36).

Table 36. Metric ratings for Columbia spotted frog waterbody substrate.

Rank	State
A	Deep organic, mud, or silt is common at bottom of waterbodies (soft enough to be burrowed into).
B	Substrate of deep mud/silt present but uncommon.
C	Gravel/sand predominant waterbody substrate with deep mud/silt absent OR substrate is hard-packed mud or silt.
D	Cobble, boulder, or bedrock predominant substrate with deep mud/silt absent.

Waterbody Vegetation

Definition and background: Emergent, floating, and submergent vegetation in breeding waterbodies can provide structure to attach egg masses to and cover to protect tadpoles from aquatic predators, but excessive emergent vegetation can shade out the water. Interspersion of about 50% emergent and 50% open water (or water with floating or submergent vegetation) may be ideal for Columbia spotted frog (Oliver, 2006).

Measurement protocol: Evaluate this metric in waterbodies that rank highest for the Columbia spotted frog breeding waterbody metric. Estimate cover only for the portions of the waterbodies that are < 1m deep (table 37).

Table 37. Metric ratings for Columbia spotted frog waterbody vegetation.

Rank	State
A	At least 20% of waterbody shallows have some type of emergent, floating, or submerged vegetation and no more than 50% of shallows have emergent vegetation (score one grade lower if emergent vegetation is very dense, e.g., hard to see through to water surface).

B	Waterbody shallows either have between 10 and 20% cover of any vegetation OR between 50 and 80% of emergent vegetation, potentially over-shading site (score one grade lower if emergent vegetation is very dense).
C	Waterbody shallows with either >1 to 10% vegetation OR between 80 and 95% emergent vegetation with few openings in the water (score one grade lower if emergent vegetation is very dense).
D	No or <1% vegetation in waterbody shallows or emergent vegetation densely covers entire waterbody.

Overwintering Waterbodies

Definition and background: Columbia spotted frog hibernate in non-freezing well-oxygenated water, such as groundwater-fed systems, deep pools (≥1 m), and perennially flowing water. A slight flow of water can be important to maintain oxygenation (Oliver, 2006). Overwintering sites are typically within 100 m of breeding sites. Features such as overhanging banks, holes, log debris, and lose soil can help provide shelter and protection from freezing.

Measurement protocol: Evaluate all perennial waterbodies within the AA and surrounding 100-m buffer and then select the state that fits the best (table 38).

Table 38. Metric ratings for Columbia spotted frog overwintering waterbodies.

Rank	State
A	Waterbodies very suitable for hibernation present. Waterbodies include well-oxygenated areas unlikely to freeze, particularly perennially flowing streams (including oxbows), springhead pools, or ponded water at least 1 m deep at deepest point. Waterbodies include ample hibernation features such as overhangs, holes, log debris, or loose soil that can provide protection from freezing.
B	Moderately suitable waterbodies for hibernation present. Waterbodies include the above types, but hibernation features may be less common or waterbodies may occasionally freeze to bottom.
C	Marginally suitable waterbodies for hibernation present. Water may not be particularly well oxygenated or may freeze most years or hibernation features may be rare or absent.
D	No potential overwintering habitat near AA (e.g. no water present or all water is likely to freeze or dry up).

Metrics for Both Species

Presence of North Shore

Definition and background: The north shore of waterbodies is often a favorable location for amphibians to lay egg masses because these areas receive the most sunlight (Oliver, 2006; Oliver, 2007). Warmer water can lead to faster development from egg to tadpole, which can be important in areas where the growing season is short. East-west aligned waterbodies will have the most north shore present, such as an east-west flowing river or an oval-shaped pond with the long axis in the east-west direction. Sinuous streams and round or squarish waterbodies may also have ample north shore present. North shore is considered a habitat feature for both boreal toad and Columbia spotted frog.

Measurement protocol: This metric will be evaluated for the highest rated waterbodies identified in the boreal toad and Columbia spotted frog breeding waterbody metrics. Use the site map, and a compass if necessary, to determine the orientation of the waterbodies at the site and select the best rank for this metric (table 39).

Table 39. Metric ratings for presence of north shore.

Rank	State
A	Ample north shore present (shore on north side of waterbody).
B	Moderate amount of north shore present.
C	Minor amount of north slope present.
D	Little or no north shore present OR waterbody densely covered in emergent/woody vegetation with no openings.

Slope and Water Depth Near Shore

Definition and background: Boreal toad and Columbia spotted frog typically lay their eggs in shallow water (<10 cm for boreal toad, <20 cm for Columbia spotted frog) where solar radiation can warm the water to appropriate temperatures for tadpole development (Oliver, 2006; Oliver, 2007). Waterbodies with gentle slopes can provide a large area with shallow water even in the case of water fluctuation since a portion of the slope will be around 10 to 20 cm deep at most water levels.

Measurement protocol: This metric will be evaluated for the highest rated waterbodies identified in the boreal toad and Columbia spotted frog breeding waterbody metrics. Select the rank that best describes the presence of shallow water on gentle slopes on the waterbody edge (table 40).

Table 40. Metric ratings for slope and water depth.

Rank	State
A	Mostly gentle slopes and/or large area, esp. along north shores, with gentle slopes; water <10 cm common. Changes in water levels typically lead to much greater horizontal rather than vertical change.
B	Mixture of gentle and steeper slopes with some areas with <10 cm deep water; gentle slopes common but not predominant, not occupying the majority of the north shores.
C	Gentle slopes present, but uncommon. Few areas with water <10 cm deep.
D	All shorelines with steep slopes OR water <10 cm not present.

Amphibian Stressor Metrics

Livestock Disturbance

Definition and background: Livestock grazing during the breeding season can cause direct mortality to amphibians from trampling (McGee and Keinath, 2004; Oliver, 2006; Oliver, 2007). High levels of vegetation removal from livestock grazing can also increase mortality from desiccation due to lack of cover (McGee and Keinath, 2004), though some studies suggest that moderate levels of grazing may help maintain areas of open water and recreate missing natural disturbance regimes (Watson and others, 2003). This metric was adapted from the Ecological Integrity Table for Columbia spotted frog (Oliver, 2006), but is relevant to boreal toad as well.

Measurement protocol: Examine the AA and surrounding buffer for signs of livestock grazing, including cow patties, tracks and pugging, and browse (table 41). Signs of high intensity grazing include large areas of bare soil, deep pugging, and very grazed down willows and herbaceous plants. Estimate timing of grazing based on freshness of any dung, tracks, and browse.

Table 41. Metric ratings for livestock disturbance.

Rank	State
A	No evidence of livestock grazing in AA or buffer
B	Low intensity grazing in buffer; no grazing in AA.
C	High intensity buffer grazing or winter AA grazing, or low intensity AA summer grazing.
D	High intensity grazing in AA in summer

Impervious Surface

Definition and background: Impervious surfaces can alter hydrology of nearby waterbodies by increasing run-off and flashiness of flows and can affect water quality through siltation and run-off of contaminants such as oil and grease (Oliver, 2006). This metric is most relevant to Columbia spotted frog because they are more likely than boreal toad to breed in areas near impervious surface. For the sake of this metric, concrete, asphalt, and gravel surfaces will all be considered impervious.

Measurement protocol: Evaluate the distance from the edge of the AA to the nearest impervious surface, such as paved or gravel roads, parking lots, sidewalks, and roofs (table 42).

Table 42. Metric ratings for distance to impervious surface.

Rank	State
A	>300 m
B	200-300
C	100-200
D	<100 m

Mining

Definition and background: High concentrations of metals such as zinc, cadmium, and copper can cause delayed growth and mortality in amphibians, including the boreal toad (Jones and others, 1998). These metals sometimes accumulate in areas with past mining legacies, including many of the high elevation areas where boreal toad breed.

Measurement protocol: Evaluate both the AA and surrounding 100-m buffer to look for any indications of mining, including mine tailings or mine shafts. Use site maps to assist in the evaluation. If there is evidence of current or historic mining in the AA or buffer, select Yes and otherwise select No.

Wildlife Indicator Checklist

Background

The wildlife indicator checklist is designed to provide a quick method for evaluating whether a site has potential to provide habitat for wildlife species within specific taxonomic groups and for wildlife in general. The wildlife indicator checklist was initially developed in 2016 using a combination of best professional judgement from wildlife experts and literature review (Menuz, 2017b). The UGS compiled a list of potential wildlife indicators from existing assessment protocols and asked wildlife specialists to rate each indicator for its importance to taxa of interest (e.g., wading birds, amphibians). The list of indicators was refined at a working group meeting, through meetings with wildlife specialists, and through literature review. The draft wildlife indicator checklist was robustly field-tested in 2017 to test for consistency within and across survey teams and substantial modifications were made as the result of this testing (Menuz and McCoy-Sulentic, 2019b). The wildlife indicator checklist is still in the process of development and final scoring methods have not yet been developed.

General Measurement Protocol

Record data for the wildlife indicator checklist near the end of the survey after walking through and observing most of the site. Most indicators are rated as True or False, and some also having a not applicable (N/A) option. A True statement indicates the presence of a feature or a less disturbed state and a False statement indicates the opposite. Use site maps to help with indicators related to surrounding land use. Interpret the phrase "seasonally flooded" the same as the Cowardin seasonally flooded water regime (i.e., surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years). Mark features as present if they are present in a quantity that makes it reasonable to locate within 20 minutes of survey. For example, do not mark "site includes bulrush species" as True if there are just one or two individuals, but do mark as True if they are present in a very small patch (<1% cover). Below is more specific guidance for some of the categories of indicators.

Species Observations

Species observational data are collected for background information only. Surveyors are not expected to be skilled in wildlife identification, and wildlife surveys will be rapid and opportunistic rather than detailed. Furthermore, surveys will occur at a single visit rather than the repeated surveys required to estimate detection and occupancy rates. Surveyors will only record species to the level of taxonomic certainty that they are comfortable with (e.g., red-tailed hawk vs. hawk vs. raptor vs. bird) and lack of presence is not indicative of true absence of a species. Data will be used to compile a (non-exhaustive) list of wildlife species observed in different regions or wetland types within a project area and to assess the link between habitat features and wildlife functional groups. Particular species of interest may also be shared with partner agencies; for example, sightings of amphibians may be uploaded to the iNaturalist Herps of Utah page and sightings of sensitive wildlife species will be shared with biologists at the Utah Division of Wildlife Resources.

Measurement protocol: While walking up to a new site, pay attention to any wildlife species that may be using the wetland because some species may be driven from their cover and out of the site by your approach. Throughout the survey, pay attention to any wildlife or wildlife signs that you see, including footprints, scat, beaver dams, and nests. Take photographs when possible to aid in identification back in the office and be as detailed as possible in the observation notes. Do not record species that are merely flying over or are adjacent to the site and do not record species if you cannot place it into a taxonomic group (e.g., "heard rustling, may be mouse or frog" should not be recorded).

Habitat Types

Most wildlife species require more than one habitat to fully support them, including habitat for breeding, feeding, and cover. Most avian species and some other wildlife move between habitat patches to meet their needs, making an isolated wetland less valuable than a wetland embedded within a complex of other natural wetland and upland land cover. The habitat type indicators evaluate the diversity of habitat within sites as well as whether those types are present within 1 km of sites. Habitat types must be present in the indicated depth range in the majority of spring (April, May, June) or fall (July, August, September).

Measurement protocol: The presence of habitat types will be determined after walking an adequate portion of the AA and examining aerial imagery on site maps or handheld tablet computer. Within the AA, each habitat type must occupy at least 5% of the assessment area and no more than 10 patches can be combined to meet the size threshold. (10 m^2 in a standard 40-m radius AA). Within 1 km of the AA, each habitat patch must occupy at least 1000 m^2. Two challenges of this evaluation are determining whether regions meet the hydrologic requirements and evaluating the 1 km area without being able to field verify the imagery. To address the first challenge, surveyors will use information from the office evaluation, soil profile, and vegetation communities to determine which habitat types likely are present. For example, a site with no surface water during a fall visit likely has the “shallow emergent water” indicator if *Schoenoplectus americanus* is a dominant species. Surveyors can use National Wetlands Inventory data to evaluate likely wetland types present in the 1 km buffer, though these data are often out of date and multiple habitat types may be represented by a single Cowardin code. The field form lists Cowardin codes that may indicate presence of particular habitat types.

Aquatic Mollusk Collection and Habitat Metrics

Background

The UGS is collaborating with the Utah Division of Wildlife Resources (UDWR) to include mollusk-specific components to wetland surveys to help fill data gaps identified in the Wildlife Action Plan by addressing an inadequate understanding of distribution and range, inadequate inventory and assessment methods, and inadequate survey methods for many aquatic mollusk species and the habitats where they are found. The UGS is working closely with the UDWR to increase the UGS’s capacity to monitor for aquatic mollusks, and has adapted the Tier 1 level springsnail survey protocol from the Springsnail Conservation Strategy for Nevada and UT (Museum of Northern Arizona Springs Stewardship Institute, 2020)

As the UGS is in the process of developing expertise in mollusk identification, the specific components included are focused on specimen collection and preservation and documentation of locality. Observers are not expected to be experts in mollusk identification but are expected to take detailed notes on the morphological characteristics of each species found, provide a best guess at taxonomy using available resources, and properly preserve the specimen for future identification and potential genetic testing.

Measurement and collection protocol

To search for aquatic mollusk species, a 15-20-minute focused mollusk survey will be conducted at each site. A surveyor will examine 10 randomly selected locations and take 10 grab samples in likely aquatic habitats such as aquatic beds, marshes, and other areas of standing water and submerged vegetation. In aquatic habitats, grab samples are taken by roiling substrate and vegetation and capturing snails during 3-seconds of sampling approximately 100 cm^2 of habitat using a 12 cm diameter kitchen sieve with 1 mm mesh. Quickly place all snails and shells collected in a sample in a water-filled tray or plastic container, count and record the number of live individuals and shells encountered for each species and immediately return them to minimize stress and prevent mortality unless specimen collections will be made. For sites without surface water, select 10 random locations and examine substrate and vegetation by hand, occasionally turning over leaves and sweeping around the base of plants in dense vegetation to search for shells or live mollusks. Calculate the mean number of each species of snail captured in these grab samples to calculate a catch per unit effort (CPUE). Record counts for individual grab samples for both live mollusks and shells and the CPUE itself. Observers may also make incidental observations while carrying out other components of URAP. Record which species, if any, were only collected incidentally, and do not include incidental observations in CPUE calculations. If only incidental collections were recorded, use the area of the AA as the area surveyed. Be aware that some mollusk species are only a few millimeters long.

Data will be compiled based on the Tier 1 survey form outlined in the draft Nevada and Utah conservation strategy (Museum of Northern Arizona Springs Stewardship Institute, 2020). Many of the metrics for this survey are taken from site information already gathered for general site information, though additional information to be recorded includes the spring name and spring ID number if applicable, an ease of access rating, how much time was spent surveying and by how many people, whether a grab sample or meander survey was conducted and for how long, and species information.

Record the presence of springs if they occur at the site, and if so, record the spring name and spring ID number which may be found in the springs layer or at the Springs Stewardship Institute online mapper (www.springsdata.org). The ease of access ranks the ease with which the public could visit the site, with categories 1 through 5. Category 1 = inaccessible/private sites clearly marked with no trespassing signs, access only by cross-country hiking; Category 2 = sites that can be accessed only by arduous trail hike (e.g., > 5 miles); Category 3 = sites accessed by easy trail hike (e.g., 1 to 5 miles) and four-wheel drive vehicle; Category 4 = sites easily accessed by walking less than 1 mile or a two-wheel drive, high clearance vehicle; and Category 5 = sites immediately adjacent to high-quality gravel road or a paved road. Record the area surveyed if grab samples are not used. This can be estimated using aerial imagery in GIS. Record the name or physical description of each mollusk species found at a site including information such as the aperture dimensions and location (left or right opening), color, overall dimensions, or number of coils. Also record the number of live and dead (shells) collections made per grab sample and the CPUE for each species. Record the time you begin and end searching the plots to note the total time spent for the survey effort. Record the spatial coordinates of any mollusk collections in the collector app and take a photo of the area it was collected from. Consider drawing the area occupied by each species on the site map if different species occupy distinctly different habitat.

If mollusk collections are made, collect an appropriate number of individuals as to not adversely impact the population. For example, if a species is extremely abundant, try to take around 25 individuals; if a species is not abundant, consider collecting only empty shells, taking pictures, or collecting only 1-3 live individuals. Keep aquatic snails in a properly labeled 1-liter container nearly filled to the top (about 1 inch of head space) with water from where the snails were collected. Keep the sample cool in a cooler with ice. Do not keep the snails in the jar of water for more than 12 hours. Preservation should be done at the end of the day they were collected when you return to camp or to the office. If a site has multiple species, all specimens can initially be collected in the same container, but species should be preserved in separate containers.

Preservation protocol

Aquatic snails

For very small snails, such as spring snails (*Pyrgulopsis*), drop directly into 95% ethanol.

For larger specimens, try to pop the operculum off the snail to ensure tissues will be preserved. Use the hot water method for preserving larger specimens via the following steps:

1. Place live snails in container deep enough for them to be submerged in the container when it is filled with water (but don’t fill with water yet).
2. Allow time for snails to come out of their shells and start flailing around
3. While snails are coming out of their shells, heat water to a rolling boil.
4. Pour boiling water on snails, let snails sit in water for 15-25 seconds, and then pour off water.
5. Place snails in a container with 95% ethanol.
6. Wrap the base of the container’s cap with electrical tape to help prevent evaporation of ethanol.

NOTE: Metal mesh strainers can be useful in this process. Put a strainer in the bottom of your container, let the snails come out in the strainer, and then fill the cup/bowl with water covering the snails. After 15-25 seconds you can just pick up the strainer and have the snails. This allows you to not worry about pouring out very hot water and not pouring out snails.

Terrestrial snails

Put snails in jar completely filled with water, wait until snails are nonresponsive (about 12 hours), then add snail directly to 95% ethanol.

Labeling specimen collections

For labeling voucher specimens, include how the specimen was preserved (e.g., formalin, ethanol) so that others will know if the specimen can be used for DNA. Indicate the level of certainty in the identification of the specimen. If labels are printed on Resistall or Rite in the Rain paper, labels may be included in the jar along with the ethanol. Wrap a second label around the container and attach with rubber bands or tape. List the full name for the collector(s). The voucher number will be the site ID with a hyphen and then the unique mollusk number (e.g., CB-001-1). Live and dead (shells) collections should be separated before submission to DWR.

Label example:

Taxon:________________%certainty_____________
SiteID:_______________________________________
Collectors:____________________________________
State:____County_________________Elev:______(ft)
Site Description_______________________________
Preservation:____________UTM zone:____________
UTM E:_____________UTM N:______________NAD83
Specimen live/dead? Date:_____________________

Water Quality and Hydrologic Function Metrics

Background

The UGS is using a modified version of a protocol developed in Washington State to evaluate wetland water quality and hydrologic (flood and erosion reduction) functions (Hruby, 2014). The Washington State Wetland Rating System assesses wetlands by HGM class, including depressional, slope, riverine, or lake fringe wetlands. Wetlands are evaluated and scored separately for their capacity to perform, landscape potential to perform, and societal value of each function. Each of the three components (capacity, landscape potential, and societal value) is composed of one or more metrics and each metric is composed of two or more statements with point values associated with each statement. Sites are then rated as low, medium, or high for capacity, landscape potential, and societal value based on the total number of points they were assigned across all metrics in the category. Scoring for sites is detailed in the Washington State Wetland Rating System manual (Hruby, 2014).

The UGS has made two major changes to the Washington State Wetland Rating System field forms based on testing and evaluation conducted in 2019. First, we added additional explanatory text to the field forms to make it easier for surveyors to accurately and consistently rate metrics. Explanatory text is derived from the Hruby (2014) user's manual and includes important definitions and examples that UGS surveyors felt were lacking when they used the field forms. Second, the UGS has eliminated one of the metrics from the societal value section of the hydrologic function. This metric asked whether specific sites were identified as important in a regional flood control plan. Flood control plans in Utah rarely if ever identify specific sites, so we felt that this was not useful to evaluate in Utah.

There are several challenges with using a protocol designed for another state for the URAP assessment. First, the Washington State Wetland Rating System is designed for assessing whole-wetlands rather than plots within wetlands. Surveyors will sometimes need to evaluate a wetland beyond the boundary of the AA to adequately address metrics. For example, when evaluating the characteristics of surface water outflow in depressional wetlands, surveyors should determine whether the wetland has an outlet, not merely whether there is an outlet within the AA. For other metrics, such as clay or organic soils, surveyors should only evaluate conditions within the AA itself. Surveyors will need to be clear on which metrics need to be evaluated within an AA versus in the whole wetland. Second, the Washington State Wetland Rating System was obviously designed and tested for use in

Washington only. It may include some attributes that are not relevant to Utah and may exclude other attributes that are important to Utah. Furthermore, Washington State Wetland Rating System has separate protocols for eastern and western Washington. UGS is currently using the eastern Washington version, but there may be some cases where the western Washington version is more appropriate. The UGS will continue to evaluate the appropriateness of use of the protocol as we collect more data.

Use Notes

Surveyors should use the Washington State Wetland Rating System for Eastern Washington (Hruby, 2014) for guidance on rating each component. The manual includes important information for rating each metric. Surveyors should also use the key in the manual for determining which HGM class to consider the site for the sake of the functional assessment. Data from the office evaluation will be important for rating many components of the assessment, including determining whether a region or basin is on the 303(d) list and whether a TMDL has been developed for the site or basin.

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Appendix A (continued)

Reference Materials for URAP Surveys

Contents

Checklist of Field Equipment

<u>**Items for Overnight or Remote Travel**</u>

- First aid and car emergency kit
- Satellite phone / emergency beacon
- Plant press with newspaper
- Ethanol
- Stove for boiling water/preserving mollusks

<u>**Paper Items**</u>

- <u>File Folder</u>
  - Site maps / office evaluation
  - Forms (main forms, soil & water, metrics, and ground cover/veg)
  - Emergency contact numbers
  - Permits
- URAP User's Manual
- WA State Wetland Rating System manual
- Army Corps Regional Supplement

<u>**General Group Gear**</u>

- Tablets with apps and charger (2)
- <u>Action Packer</u>
  - GPS
  - Measuring tape (50 m)
  - Plastic bags for plant samples
  - Hand sanitizer / bug spray / socks
  - Extra mollusk containers
  - Extra rulers and weeders
  - Munsell or other soil color chart
  - Water quality meters (high and low)
  - Plant & mollusk identification guides
- <u>Pencil Case</u>
  - Mollusks containers (2)
  - Extra AA batteries
  - Pencils, sharpie, lead
  - Compass
  - Flagging tape
  - Hand lens
  - Gloves

<u>**Core Center**</u>

- Sharpshooter or auger
- Waders and knee boots
- Large water jug
- Cooler with ice
- Large tarp for keeping gear dry
- Three containers for water quality lab samples per site
- <u>Disinfectant bucket</u>
  - Scrub brush for cleaning shoes
  - Sprayer with sparquat
  - Gloves
- <u>Gear bucket</u>
  - Pin flags
  - Pocket knife
  - Handheld ruler (2)
  - Soil tarp
  - Distilled water
  - Tupperware for mixing soil
  - Blender cup (2)
  - Plastic measuring cup (1/4 cup)
  - Plastic measuring cup (300 ml)
  - Transparency tube
  - Mesh sieve
  - Weeder to dig plant specimen

<u>**Individual Field Gear**</u>

- <u>Gear assigned to individuals</u>
  - Laminated reference guides
  - Pencils
  - Clipboard
- <u>Personal gear</u>
  - Large backpack
  - Water bottles
  - Food for field
  - Insect repellent, head net
  - Sun screen
  - Cell phone (for emergencies)

Field Order of Operations and To Do Checklist

1) Locate plot center. Make mental note of any wildlife observed while walking into AA.
2) Determine whether site can be sampled (wetland present and at least 0.1 ha). If site cannot be sampled, collect soil profile data (you do not need to collect soil salinity) and fill out Wetland Field Eval Survey123 form. Document site with photos in Collector.
3) Determine AA placement. AA edge can be no more than 140 m from the original survey point.
4) Flag out boundary and collect coordinates on AA boundary and photos using tablet
5) Determine the number of vegetation zones within AA and which need to be sampled with soil pits (those with ≥30% cover within AA).
6) Water quality/soils surveyor
    a. Select location to dig soil pit in first vegetation zone.
    b. Collect soil salinity sample adjacent to selected pit site and measure initial EC after 5 and 10 minutes of settling time. Rinse meter.
    c. Dig soil pit and describe soil profile. Record time when pit is complete so that total settling time of pit can later be determined. Flag pit. Take photo and GPS location of soil pit using tablet.
    d. Repeat steps a-d for each additional vegetation zone with >30% cover in AA.
    e. Determine location(s) to collect waterbody data. Collect descriptive and handheld parameter data in up to three waterbodies at the site, sampling a variety of waterbody types if different types exist in the AA. Take photo and GPS location of soil pit.
    f. Collect water quality laboratory sample in waterbody most likely to have the largest influence on the site's overall hydrology.
    g. Pay attention to and record any mollusks encountered while collecting soil and water quality data. Conduct focused mollusk survey when other data collection is complete and record all data in Mollusk Survey123 form.
7) Botanist
    a. Conduct timed meander of AA. Record litter and water depth measurements during this process and come up with ground cover estimates and site sketch. Record
    b. Pay attention to and record any mollusks encountered during survey. Provide mollusk information to water quality surveyor, who will record that data in the Mollusk Survey123 form.
8) Walk 100 m buffer transects (whoever is done first) and fill out buffer data in paper field forms.

WALK AROUND BUFFER AND AA AS NEEDED TO COMPLETE TASKS 9 TO 11. If one surveyor is done before the other, they may start the data collection for the components that are straight-forward, but will wait for their field partner to complete the remainder. For example, a surveyor may record *Not present* for most of the buffer stressors and then discuss with field partner the severity of a road and non-native cover stressors to finalize the stressor checklist.

9) Update and fill out Office Eval Survey123 form by verifying site hydrology information, recording stressor data, and updating hydrology stressor data.

10) Fill out vegetation zones, structural features, land use index, and wildlife data on paper forms.
11) Fill out URAP condition metrics in URAP 2020 Survey123 form.
12) Fill out WA Functional Rating Survey123 form.
13) Go through checklist before Leaving the Field (next page)

Checklist Before Leaving the Field

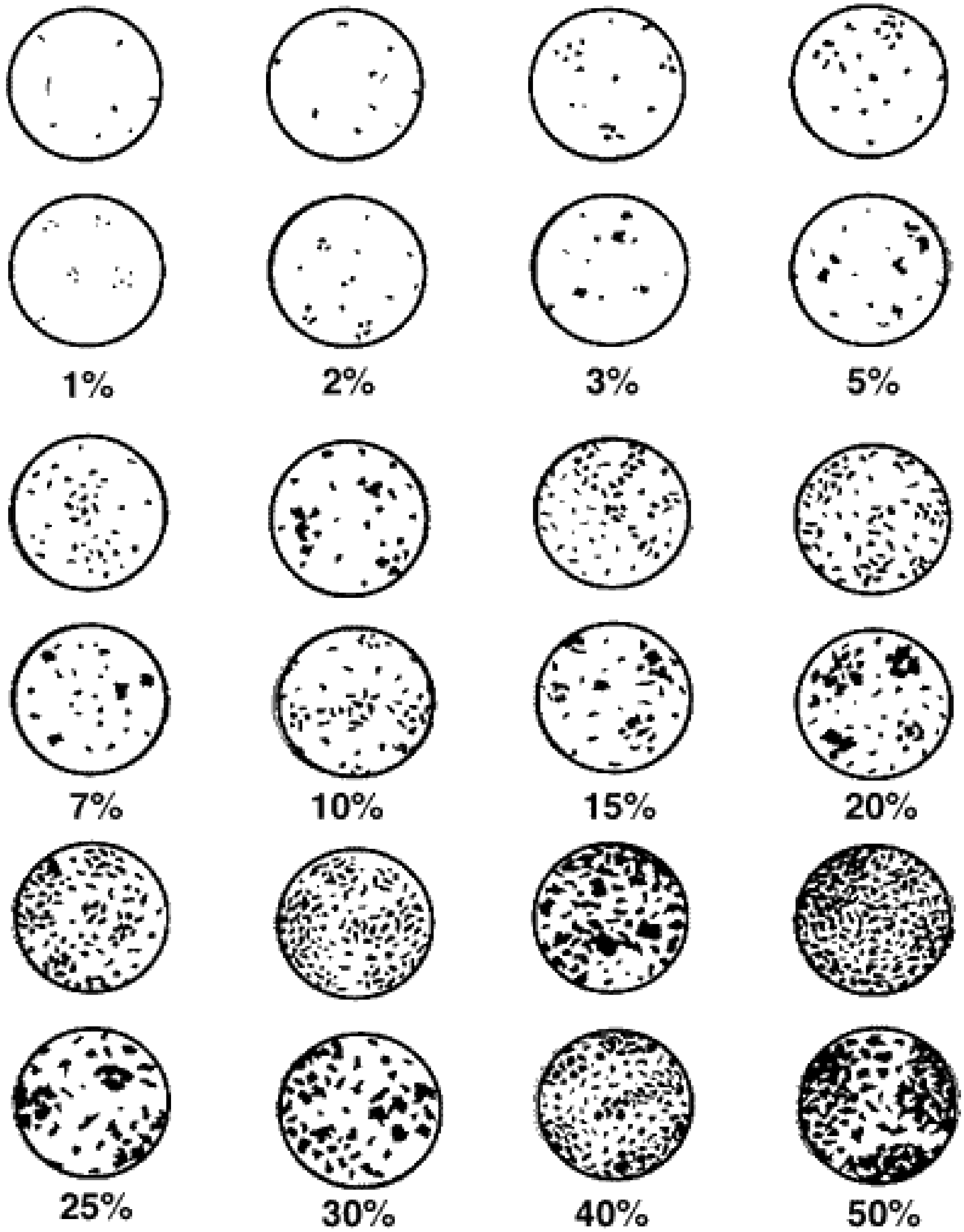
□ Ensure field forms are complete and submit tablet data for all of the forms.
□ Remove all flags, tapes, and ropes.
□ Make sure all spatial data and photos are record. Take photos of:

- Algae, litter, woody debris, and woody species regeneration
- Photos to illustrate unusual features or features that cannot be identified
- Any photos that may be illustrative for future training purposes

□ Collect all unknown plant species
□ Record soil pit settling time and water level data and **fill in soil pits**
□ Check to make sure you leave with field gear that you brought, especially

1. Tablet
2. External battery for tablet
3. Water quality meters
4. 50-m tape
5. Handheld tapes
6. Compasses
7. Soil auger

Plant Cover Reference Cards[1]



[1] From https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/cmi_ground_sampling_procedures_2018.pdf

Noxious Weed List

Species in bold have been observed during UGS' program surveys. List and observed species information up-to-date as of June 2019.

Family	Scientific Name	Common Name	Growth Habit	Arid West	WMVC	Noxious Class
Apiaceae	**Cicuta douglasii**	**western water hemlock**	**forb**	**OBL**	**OBL**	**Duchesne**
Apiaceae	**Conium maculatum**	**poison hemlock**	**forb**	**FACW**	**FAC**	**3**
Asteraceae	Acroptilon repens	hardheads	forb			**3**
Asteraceae	**Arctium minus**	**lesser burdock**	**forb**	**FACU**	**UPL**	**Morgan, Summit**
Asteraceae	**Carduus nutans**	**nodding plumeless thistle**	**forb**	**FACU**	**UPL**	**3**
Asteraceae	Centaurea calcitrapa	red star-thistle	forb			1B
Asteraceae	Centaurea diffusa	diffuse knapweed	forb			2
Asteraceae	Centaurea melitensis	Maltese star-thistle	forb			1A
Asteraceae	Centaurea solstitialis	yellow star-thistle	forb			2
Asteraceae	Centaurea stoebe	spotted knapweed	forb			2
Asteraceae	Centaurea stoebe ssp. micranthos	spotted knapweed	forb			2
Asteraceae	Centaurea virgata	squarrose knapweed	forb			2
Asteraceae	Centaurea virgata ssp. squarrosa	squarrose knapweed	forb			2
Asteraceae	Chondrilla juncea	rush skeletonweed	forb			2
Asteraceae	**Cirsium arvense**	**Canada thistle**	**forb**	**FACU**	**FAC**	**3**
Asteraceae	**Cirsium vulgare**	**bull thistle**	**forb**	**FACU**	**FACU**	**Beaver, Iron, Wayne**
Asteraceae	**Ericameria nauseosa**	**rubber rabbitbrush**	**shrub**			**Garfield**
Asteraceae	Lactuca tatarica	blue lettuce	forb	FAC	FAC	Juab
Asteraceae	Lactuca tatarica var. pulchella	blue lettuce	forb			Juab
Asteraceae	**Leucanthemum vulgare**	**oxeye daisy**	**forb**	**UPL**	**FACU**	1B
Asteraceae	**Onopordum acanthium**	**Scotch cottonthistle**	**forb**			**3**
Asteraceae	Scorzonera laciniata	cutleaf vipergrass				1B
Boraginaceae	**Cynoglossum officinale**	**gypsyflower**	**forb**	**FACU**	**FACU**	**3**
Boraginaceae	Echium vulgare	common viper's bugloss	forb			1B
Brassicaceae	Alliaria petiolata	garlic mustard	forb	FACU	FACU	1B
Brassicaceae	Brassica elongata	elongated mustard	forb			1B
Brassicaceae	Brassica tournefortii	Asian mustard	forb			1B
Brassicaceae	Cardaria	whitetop				**3**
Brassicaceae	Cardaria chalepensis	lenspod whitetop	shrub			**3**
Brassicaceae	**Cardaria draba**	**whitetop**	**forb**			**3**
Brassicaceae	Cardaria pubescens	hairy whitetop	forb	UPL	FACU	**3**
Brassicaceae	Hesperis matronalis	dames rocket	forb	FACU	FACU	4
Brassicaceae	**Isatis tinctoria**	**Dyer's woad**	**forb**			2
Brassicaceae	**Lepidium latifolium**	**broadleaved pepperweed**	**forb**	**FAC**	**FAC**	**3**
Chenopodiaceae	Halogeton glomeratus	saltlover	forb			Washington

Clusiaceae	Hypericum perforatum	common St. Johnswort	forb	FACU	FACU	1B
Convolvulaceae	Convolvulus	bindweed				**3**
Convolvulaceae	**Convolvulus arvensis**	**field bindweed**	**forb**			**3**
Convolvulaceae	Convolvulus equitans	Texas bindweed		FACU	FACU	**3**
Cyperaceae	Cyperus esculentus	yellow nutsedge	sedge	FACW	FAC	Davis
Elaeagnaceae	**Elaeagnus angustifolia**	**Russian olive**	**tree**	**FAC**	**FAC**	4
Euphorbiaceae	Euphorbia esula	leafy spurge	forb			2
Euphorbiaceae	Euphorbia esula var. esula	leafy spurge	forb			2
Euphorbiaceae	Euphorbia myrsinites	myrtle spurge	forb			4
Fabaceae	Alhagi maurorum	camelthorn	shrub	FAC	FAC	1B
Fabaceae	Cytisus scoparius	Scotch broom	shrub			4
Fabaceae	Cytisus scoparius var. scoparius	Scotch broom	shrub			4
Fabaceae	**Galega officinalis**	**professor-weed**	**forb**			1B
Lamiaceae	Salvia aethiopis	Mediterranean sage	forb			1A
Lythraceae	**Lythrum salicaria**	**purple loosestrife**	**forb**	**OBL**	**OBL**	2
Poaceae	Aegilops cylindrica	jointed goatgrass	grass			**3**
Poaceae	Arundo donax	giant reed	grass	FACW	FACW	1B
Poaceae	Cynodon dactylon	Bermudagrass	grass	FACU	FACU	3 (not WA)
Poaceae	**Elymus repens**	**quackgrass**	**grass**	**FAC**	**FAC**	**3**
Poaceae	Imperata cylindrica	cogongrass	grass		FACU	4
Poaceae	**Phragmites australis**	**common reed**	**grass**	**FACW**	**FACW**	**3**
Poaceae	**Phragmites australis ssp. australis**		**grass**	**FACW**	**FACW**	**3**
Poaceae	Sorghum almum	Columbus grass	grass			**3**
Poaceae	Sorghum halepense	Johnsongrass	grass	FACU	FACU	**3**
Poaceae	Taeniatherum caput-medusae	medusahead	grass			2
Poaceae	Ventenata dubia	North Africa grass	grass			1A
Polygonaceae	Polygonum cuspidatum	Japanese knotweed		FACU	FACU	1B
Scrophulariaceae	Linaria dalmatica	Dalmatian toadflax	forb			2
Scrophulariaceae	Linaria dalmatica ssp. dalmatica	Dalmatian toadflax	forb			2
Scrophulariaceae	Linaria vulgaris	butter and eggs	forb			2
Solanaceae	Hyoscyamus niger	black henbane	forb			2
Solanaceae	Solanum elaeagnifolium	silverleaf nightshade				Washington
Solanaceae	Solanum rostratum	buffalobur nightshade	forb			Davis, San Juan
Tamaricaceae	**Tamarix**	**tamarisk**	**tree**			**3**
Tamaricaceae	Tamarix aphylla	Athel tamarisk		FAC	FACW	**3**
Tamaricaceae	**Tamarix chinensis**	**five-stamen tamarisk**	**tree**	**FAC**	**FAC**	**3**
Tamaricaceae	Tamarix parviflora	smallflower tamarisk		FAC	FACW	**3**
Tamaricaceae	Tamarix ramosissima	saltcedar				**3**
Zygophyllaceae	Tribulus terrestris	puncturevine	forb			**3**

Key A. WETLANDS AND RIPARIAN AREAS OF THE INTER-MOUNTAIN BASINS AND COLORADO PLATEAU

1a. Herbaceous wetlands restricted to canyon wall seeps in the Colorado Plateau region. Hanging gardens are dominated by primarily by herbaceous plants, a number of these being endemic to the Utah High Plateau and Colorado Plateau regions. Composition varies based on geology and ecoregion. Common species include *Adiantum capillus-veneris*, *Adiantum pedatum*, *Mimulus eastwoodiae*, *Mimulus guttatus*, *Sullivantia hapemanii*, *Cirsium rydbergii*, and several species of *Aquilegia*………………**Colorado Plateau Hanging Garden (Hanging Garden)**

1b. Wetlands not restricted to canyon seeps as above……………………………………………………………………………………**2**

2a. Wetland systems most often immediately associated with riparian areas, floodplains, or permanent, intermittent or ephemeral streams. Though wetlands associated with Great Salt Lake may be considered part of a delta in the HGM classification system, in this classification those wetlands are considered based on their geographic and physical location within a terminal basin and are not considered to be riparian unless they are within an active floodplain………..**3**

3a. Wetlands dominated by herbaceous species within the floodplain with standing water at or more typically >15 cm above the surface throughout the growing season, except in drought years. Vegetation typically dominated by species of *Typha*, *Scirpus*, *Schoenoplectus*, *Carex*, *Eleocharis*, *Juncus*, and floating genera such as *Potamogeton*, *Sagittaria*, and *Ceratophyllum*. The floodplain expression of this system is located in the floodplain, but may be disconnected from flooding regimes. Hydrology may be entirely managed. Soils are highly variable. This system includes sloughs and other natural floodplain marshes as well as a variety of managed wetlands on the floodplain (e.g., recharge ponds, moist soil units, shallow gravel pits, etc.)……………………………………….**North American Arid West Emergent Marsh (Emergent Marsh)**

3b. Wetlands dominated by a mix of woody species with herbaceous species common, but not often dominant, there is not often standing water for long periods of time…………………………………………………………...**4**

4a. Barren and sparsely vegetated wetlands restricted to intermittently flooded streambeds and banks that are often lined with shrubs such as *Sarcobatus vermiculatus*, *Ericameria nauseosa*, *Fallugia paradoxa*, *Artemisia tridentata* ssp. *tridentata*, and/or *Artemisia cana* ssp. *cana* (in more northern and mesic stands) that form relatively dense stringers in open dry uplands. *Grayia spinosa* may dominate in the Great Basin. Shrubs form a continuous or intermittent linear canopy in and along drainages but do not extend out into flats. Patches of *Distichlis spicata* common where water remains for the longest periods………………………….
………**Inter-Mountain Basins Wash (Wash)**

4b. Typically tree-dominated wetlands with a diverse shrub component often occurring as a mosaic of multiple communities, though can lack or have a limited tree component. The system is highly variable depending on landscape context and is diagnostic only in its ecoregional location and association with lotic systems. Sites span a broad elevation range from 1220 m (4000 feet) to over 2135 m (7000 feet). The variety of plant associations connected to this system reflects elevation, stream gradient, floodplain width, and flooding events. Dominant trees may include *Abies concolor*, *Alnus incana*, *Betula occidentalis*, *Populus angustifolia*, *Populus balsamifera* ssp. *trichocarpa*, *Populus fremontii*, *Salix laevigata*, *Salix gooddingii*, and *Pseudotsuga menziesii*. Dominant shrubs include *Artemisia cana, Cornus sericea, Salix exigua, Salix lasiolepis, Salix lemmonii,* or *Salix lutea*. Herbaceous layers are often dominated by species of *Carex* and *Juncus*, and perennial grasses and mesic forbs such *Deschampsia caespitosa, Elymus trachycaulus, Glyceria striata, Iris missouriensis, Maianthemum stellatum*, or *Thalictrum fendleri*. Introduced forage species such as *Agrostis stolonifera, Poa pratensis, Phleum pratense*, and the weedy annual *Bromus tectorum* are often present in disturbed stands. *These sites may also be included in the* ***Columbia Basin Foothill Riparian Woodland and Shrubland*** *class, not described here until additional information is collected on the difference between these types and occurrence in Utah*................................ ……**Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland (Great Basin Woodland)**

2b. Wetland Ecological Systems of Inter-Mountain Basins not immediately associated with riparian areas, floodplains, or permanent, intermittent or ephemeral streams………………………………………………………………………**5**

5a. Small (<0.1 ha), herbaceous wetlands occurring in wind-deflated depressions of dune fields. These wetlands occur in the Pink Coral Dunes in Utah and potentially occur in other Great Basin dune fields…………………………………………….**Inter-Mountain Basins Interdunal Swale Wetland (Interdunal Swale)**

5b. Wetlands not associated with wind-deflated depression in dune fields……..…………………………………..**6**

6a. Wetland includes an open to moderately dense shrub layer dominated or codominated by *Sarcobatus vermiculatus*, but often occurs as a mosaic of multiple plant communities. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations…… …………………………………………………………**Inter-Mountain Basins Greasewood Flat (Greasewood Flat)**

6b. System dominated by herbaceous species, vegetation can be dense or sparse, soil and water chemistry is saline or not……..**7**

7a. Total vegetation cover is sparse to barren and site experiences intermittent to temporarily flooded water regime. Vegetation cover is generally <10% plant cover, though there can be patches of denser vegetation and edges are often ringed by more dense vegetation; the site is predominantly sparsely vegetated in most years). Sites typically experience intermittent flooding (i.e., flooded without detectable seasonal periodicity), though may have a temporarily flooded water regime (i.e., flooding early in the growing season and then drying). Sites are located in closed depressions or occur as part of large terminal basins (Great Salt Lake, Sevier Lake, Salt Marsh Lake). Salt crusts are common throughout, with small *Distichlis stricta* beds in depressions, sparse shrubs around the margins, and pioneering annual species such as *Salicornia*. The water is often prevented from percolating through the soil by an impermeable soil subhorizon. Soil salinity varies with soil moisture, greatly affecting species composition. Characteristic species may include *Allenrolfea occidentalis, Sarcobatus vermiculatus, Grayia spinosa, Puccinellia lemmonii, Leymus cinereus, Distichlis spicata, and/or Atriplex spp* ……………………..**Inter-Mountain Basins Playa (Playa)**

7b. Total vegetation cover is moderate to dense (generally > 10% plant cover), usually with at least a seasonally flooded water regime, though may vary…………………………………………………….……..**8**

8a. Located in similar locations as the **Inter-Mountain Basins Playa**, but with generally higher herbaceous vegetation cover (>10%) and usually with seasonal to semi-permanently flooded water regime**,** though water tables can vary due in areas with high levels of management. This system can also experience seasonal drying to expose mudflats colonized by both annual and perennial vegetation. Can be associated with hot and cold springs, located in basins with internal drainage. Soils are alkaline to saline clays with variable, fine texture soils and may have hardpans. Typical species include *Distichlis spicata, Puccinellia lemmonii, Poa secunda, Muhlenbergia* spp., *Leymus triticoides*, *Schoenoplectus maritimus, Schoenoplectus americanus, Triglochin maritima, and Salicornia* spp. Communities found within this system may also occur in floodplains (i.e., more open depressions), but probably should not be considered a separate system unless they transition to areas outside the immediate floodplain. Types often occur along the margins of perennial lakes, in alkaline closed basins, with extremely low-gradient shorelines………………**Inter-Mountain Basins Alkaline Closed Depression (Alkaline Depression)**

8b. Herbaceous wetlands with standing water at or more typically >15 cm above the surface throughout the growing season, except in drought years. Water levels are often high at some point during the growing season, but managed systems may be drawn down at any point depending on water management regimes. Vegetation typically dominated by species of *Typha, Scirpus, Schoenoplectus, Carex, Eleocharis, Juncus*, and floating genera such as *Potamogeton, Sagittaria*, and *Ceratophyllum*. The isolated expression of this system can occur around ponds, as fringes around lakes including Great Salt Lake, and at any impoundment of water, including irrigation run-off. The hydrology may be entirely managed or artificial. Water may be brackish or not. Soils are highly variable…………………………………………………………………………… ……………………………………………….**North American Arid West Emergent Marsh (Emergent Marsh)**

Key to HGM Classes

1a. Wetland is located on the shore of or adjacent to a waterbody (i.e., lake, impoundment) or in a valley, floodplain, or near a stream channel. Dominant water source is from waterbody or surface/subsurface connections with stream and not from precipitation or groundwater………**2**

2a. Wetland located on the shore of or adjacent to a lake, pond, or impoundment AND wetland hydrology is predominantly influenced by bidirectional flows related to changes in waterbody level……………………………………**3**

3a. Wetland adjacent to waterbody that is greater than 8 ha (20 acres) and ≥2 m deep at its deepest point. Waterbody may be natural (i.e., Great Salt Lake, Utah Lake) or artificial (many reservoirs)….**Lacustrine Fringe**

3b. Wetland adjacent to smaller and/or shallower waterbody………………………………………**go to 6b in the key**

2b. Wetland is located in a valley, floodplain or near a stream channel OR downslope from a waterbody. Wetland's dominant water source is unidirectional and horizontally spreading…………………………………………………………………**4**

4a. Wetland is located in a valley, floodplain or near a stream channel and water is from horizontal water movement from channel overbank flooding or subsurface hydrologic connections to the stream channel. Oxbows that receive overbank flooding are included in this classification, though beaver ponds are considered depressional………………………………………………………………………………………………….**Riverine**

4b. Wetland is located immediately downstream from an impoundment and receives water from impoundment release. Water typically does not reach site through a well-defined channel, instead spreading horizontally from the release site, though some shallow channels may be present……**…Impoundment Release**

1b. Wetland not as above. Main water source may be from precipitation, overland flow, or groundwater or water may be impounded stream water………**5**

5a. Wetland meets ***all*** of the following criteria: a) is located on a slope (can be very gradual or nearly flat); b) groundwater is the primary water source; c) surface water, if present, flows through the wetland in one direction and usually originates from seeps or springs; and d) water leaves the wetland without being impounded. **NOTE:** *Small channels can form within slope wetlands, but are not subject to overbank flooding. Surface water does not pond in these types of wetlands, except occasionally in very small and shallow depressions or behind hummocks (depressions are usually < 3 ft diameter and less than 1 foot deep)*...**Slope**

5b. Wetland does not meet all of the above criteria…………………………………………………………………………**6**

6a. Wetland is topographically flat with precipitation as the primary water source. Surface water and groundwater inputs may be present, but not significant (<10%). ……………………………………..**Mineral Soils Flats**

6b. Wetland not as above. Wetland either in flat area with high groundwater inputs (check water table) or in topographic depression or impounded area. **7**

7a. Wetland located within or hydrologically controlled by artificial impoundment >8 ha (20 acres) in size (but <2 m deep- otherwise see Lacustrine Fringe)………………………………………………………………**8**

8a Wetland located within impounded area. Primary water fluctuations are vertical with rising and falling water levels due to steep impoundment sides and relatively even bottom surface level ……………………………………………………………………………………………**Depressional Impoundment**

8b. Wetland hydrologically controlled by impounded area. Primary water fluctuations are bidirectional, with water spreading and receding horizontally with changing water levels. Sites often on mudflats that gently slope toward impoundments………**Depressional Impoundment Fringe**

7b. Wetland is located in a topographic depression or impounded area where water ponds or is saturated to the surface at some time during the year OR wetland in flat area with no obvious depression with water level maintained by high groundwater.Water typically from precipitation, snowmelt, overland runoff, or intersection with groundwater table, but can also be from small (<8 ha) natural or artificial impoundment of streams. Outlet, if one exists, is generally higher than the deepest part of the depression……….**Depressional**

Key to Utah Wetland Types of the Central Basin Ecoregion

Mixed Sites: Sites will be considered mixed wetland types if at least 30% of the site is composed of a zone that is a different wetland type from the majority of the site. Freshwater woody wetlands are often composed of patches of woody and graminoid vegetation and will generally be considered a single wetland type. Common mixed wetland types include fresh meadow and marsh, saline meadow and marsh, and playa and saline meadow, though other combinations may also be found.

Soil Salinity: Soil salinity values listed in the key are raw field values from 1:5 soil to water mixtures.

Water Regimes: Most wetland types have characteristic water regimes associated with them. See below for a list of water regimes commonly associated with each wetland type in existing UGS and BLM data, though other regimes could also be associated with the site. Use the water regime table as a reference both when keying out your site and when assigning water regimes to each zone in the vegetation zones component.

Wetland Type	Primary Regimes (≥20% of sites)	Secondary Regimes (≥10 - <20% of sites)
Aquatic bed	G, H	F
Fresh meadow	B	A, C, D, E
Marsh	E, F	H
Mudflat	C, E	A, B
Playa	A, J	B, C
Saline meadow	C, E	None
Shallow water	G, H	None
Woody wetland	A	B, C, E, F

1a. Wetland typically with at least 20% cover of woody species, though disturbed sites may have lower cover of woody species but characteristic native or introduced forb species such as *Arctium minus, Cynoglossum officinale, Mentha arvensis, Solanum dulcamara, Maianthemum stellatum* and *Urtica diocia*. If woody vegetation is composed entirely of *Tamarix* seedlings, key under 1b………………………………………………………………………………………**2**

2a. Wetland typically riverine or depressional, non-saline (usually <1000 µS), and with high species richness and high vegetation cover. Vegetation commonly found in mosaics with patches of meadow and sometimes marsh. Water typically reaches the site during flood events or from a high alluvial aquifer. Overstory vegetation often includes *Acer negundo*, *Cornus sericea*, *Populus fremontii*, *Rosa woodsia,* and *Salix exigua*, though non-native species such as *Elaeagnus angustifolia, Salix fragilis*, and *Tamarix* are also common. Understories can have a mixture of forb and graminoid species; *Arctium minus, Cynoglossum officinale, Mentha arvensis, Solanum dulcamara, Maianthemum stellatum* and *Urtica diocia* are all characteristic of this wetland type…… **Woody wetland**

2b. Wetland with highly saline soils (typically >3000 µS and often much higher) that typically have evaporative salt crusts due to high water tables or are depressions that briefly flood, leaving behind evaporative salts and surface soil cracks. Sites have a low diversity of very salt-tolerant species, often low overall vegetation cover, and a relatively high portion of the cover is composed of annual forb species compared to other wetland types. *Allenrolfea occidentalis* is the most common woody species found at these sites, though *Atriplex tridenata* or *Sacrobatus vermiculatus* may also be present and the subshrub *Sarcocornia utahensis* may also be common. Other common species include the native forbs *Salicornia rubra*, *Suaeda calceoliformis*, and *Cressa truxillensis*, the introduced forb *Bassia hyssopifolia* and *Frankenia pulverulenta*, and the native grass *Puccinellia simplex.*

The native grasses *Distichlis spicata* and *Hordeum jubatum*, and introduced grass *Phragmites australis* are also often present, but with lower cover than found at other wetland types………………………………………………………..**Playa**

1b. Wetland with less than 20% cover of woody species or has little to no vegetation. If wetland is disturbed with low woody species cover and forb species including *Arctium minus, Cynoglossum officinale, Mentha arvensis, Solanum dulcamara, Maianthemum stellatum* and *Urtica diocia* are present, key under both 1a and 1b to find the best fit………..**3**

3a. Wetland typically has standing water throughout most of the growing season, often to a depth of ≥10 cm, and, when not flooded, has a high water table. Most species at site are obligate wetland species with high anaerobic tolerance. Common species may include floating and submergent aquatic vegetation and tall emergent species such as *Schoenopletus* spp. and *Typha* spp. or site may have low or no vegetation cover. Sites that are dried out for management or due to unusual climatic conditions may have high cover of pioneering annuals……**4**

4a. Wetland has standing water ≥10 cm at the time of survey and very low vegetation cover, typically less 10%, and low cover of the macroalgae chara. Any species that are present are typically obligate wetland species with high anaerobic tolerance or species found on drier edges………………………………**Shallow Water**

4b. Wetland has at least 10% cover of vegetation or the macroalgae chara……………………………………………**5**

5a. Wetland dominated by submergent or floating aquatic vegetation or the macroalgae chara, with typically low cover of emergent species (<5%, though sometimes as much as 15%). Wetland are typically depressional and often artificial impoundments. Sites are rarely dry during the growing season. Sites usually have only a few species; characteristic species include *Lemna, Stuckenia pectinata*, *Zannichellia palustris*, and *Ruppia cirrhosa*……………………………… **Aquatic Bed**

5b. Wetland dominated by emergent obligate wetland species such as *Bolboschoenus maritmus, Typha* spp. and *Schoenoplectus* spp. and the non-native grass *Phragmites australis*; submergent and floating species are often also present. Species such as *Distichlis spicata*, *Juncus arcticus*, and *Hordeum jubatum* may be found along drier edges of the site with low cover…………………….**Marsh**

3b. Wetland with surface water or high water table all or part of the growing season; sites that are flooded will typically have surface water <10 cm in depth or be completely dry with a low water table for about half the growing season most years. Vegetation may be composed of perennial graminoids, salt-tolerant annual species, or salt-tolerant anaerobic species that can tolerate strong fluctuations in water levels. ……………………………………**6**

6a. Wetland with highly saline soils (typically >3000 µS and often much higher) that typically have evaporative salt crusts due to high water tables or are depressions that briefly flood, leaving behind evaporative salts and surface soil cracks. Sites have a low diversity of very salt-tolerant species, often low overall vegetation cover, and a relatively high portion of the cover is composed of annual forb species compared to other wetland types; sites are sometimes bare. Common species include the native forbs *Salicornia rubra*, *Suaeda calceoliformis*, and *Cressa truxillensis*, the introduced forb *Bassia hyssopifolia* and *Frankenia pulverulenta*, the native grass *Puccinellia simplex*, and the shrub and subshrub species *Allenrolfea occidentalis* and *Sarcocornia utahensis.* The native grasses *Distichlis spicata* and *Hordeum jubatum*, and introduced grass *Phragmites australis* are also often present, but with lower cover than found at other wetland types………..**Playa**

6b. Wetland not as described above. If wetland has highly saline soils, cover is typically dominated by perennial graminoid species instead of annual species and site may be flooded for more than a brief period each growing season………**7**

7a. Wetland not strongly saline, with soil salinity typically <1000 µS, and site characterized by a high cover of perennial graminoid species that vary in their salinity tolerance and a moderate diversity of species (typically ≥14). Hydrology varies greatly within this group, including seasonally and perennially saturated slope wetlands and shallowly flooded depressional wetlands; drier sites have higher cover of grasses and wetter sites have higher cover of spikerushes and sedges with occasional inclusions of species seen in marsh sites. Common graminoid species include the native *Eleocharis palustris*, *Eleocharis rostellata*, *Carex nebrascensis, Carex praegracilis,* and *Juncus arcticus* and the introduced *Agrostis stolonifera*, *Alopecurus arundinaceus*, and *Thinopyrum ponticum.* The native saline-tolerant grasses *Distichlis spicata* and *Hordeum jubatum* are also common in fresh meadows, but occur with lower cover and less dominance than in saline meadows. Native forbs associated with fresh meadows include *Argentina anseria, Epilobium ciliatum, Glaux maritima, Lycopus asper, Mimulus guttatus,* and *Ranunculus cymbalaria, Trifolium fragierum* and introduced forbs include *Cirsium arvense, Trifolium fragiferum*, and *Trifolium repens*………**Fresh Meadow**

7b. Wetland more strongly saline, with soil salinity typically >1000 µS, and site typically dominated by one or a few highly salt-tolerant graminoid species such as *Distichlis spicata*, *Phragmites australis, Hordeum jubatum,* or *Bolboschoenus maritimus*; overall diversity is typically <20 species. Species that are not highly salt tolerant are typically found with low cover or are short-lived annuals or biennials, though sometimes sites have less saline-tolerant marsh species on site edges……………………………………………………………………….**8**

8a. Wetland typically flooded about half the growing season and then dry with water table well below surface the remainder of the growing season, though site may occasionally be completely dry or completely flooded all growing season depending on climate and management. Wetlands typically located along the shores of shallowly flooded lakes such as Great Salt Lake or Utah Lake, or within or adjacent to shallow impoundments managed for waterfowl. The most abundant species are usually *Bolboschoenus maritimus, Distichlis spicata*, or *Phragmites australis;* if the latter two species, the site typically has evidence of occasional more frequently flooding through the presence of low-cover *Typha* spp. or other anaerobic-tolerant species. Some sites have a high cover of *Tamarix* spp. seedlings or high cover of ruderal annual species that colonize when the site is dry………**Mudflat**

8b. Wetland either flooded for about a quarter of the growing season or less or with seasonal high water table. *Distichlis spicata* always present and frequently dominant or sometimes site dominated by *Phragmites australis* or *Hordeum jubatum.* Other common species include the native grass *Puccinellia nuttalliana,* native forb *Triglochin maritima,* and introduced forbs *Lepidium latifolium* and *Bassia hyssopifolia. Eleocharis palustris, Juncus arcticus* and *Schoenplectus americanus* are sometimes present on the margins; if these species have high cover, consider fresh meadow or, for the latter species, a mixed classes with marsh. Sites also frequently have low cover of species commonly found in playas, including *Salicornia rubra* and *Sueada calcoelofornis*……………………………………………………………………………………….***Saline Meadow***

Key to Cowardin Systems, Subsystems, and Classes of Utah[2]

Consider the entire wetland when determining which system and subsystem to assign to the AA. palustrine.

Systems

(ESTUARINE and MARINE systems omitted)

1a. Persistent emergents, trees, shrubs, or emergent mosses cover ≥30% of the area. Persistent emergents are herbaceous species that remain erect year-round even when senesced, such as cattails and bulrushes. ……………………………………………………………………………………**Palustrine**

1b. Persistent emergents, trees, shrubs, or emergent mosses cover <30% of substrate, but non-persistent emergent may be widespread during some seasons of the year……………………………**2**

2a. Situated in a channel; water, when present, usually flowing…………………………..**Riverine**

2b. Situated in a basin, catchment, or on level, sloping ground; water usually not flowing…………**3**

3a. Area 8 ha (20 acres) or greater……………………………………………………**Lacustrine**

3b. Area less than 8 ha……………………………………………………………………**4**

4a. Wave-formed or bedrock shoreline feature present or water depth 2 m or more….**Lacustrine**

4b. No wave-formed or bedrock shoreline feature present and water less than 2m deep…………… ……………………………………………………………………………………**Palustrine**

Subsystem[3]

Riverine

1a. Flowing water in channel throughout the year……………………………………………………**2**

1b. Channel contains flowing water for only part of the year. When water is not flowing it may remain in isolated pools or surface water may be absent…………………………………………**Intermittent**

2a. Gradient low and water velocity slow; No tidal influence and some water flows throughout the year; the substrate consists of mainly of sand and mud; oxygen deficits may sometimes occur, the fauna is composed mostly of species that reach their maximum abundance in still water, and true planktonic organisms are common; floodplain is well-developed……………………**Lower Perennial**

2b. Gradient high and water velocity fast; No tidal influence and some water flows throughout the year; the substrate consists of rock, cobbles, or gravel with occasional patches of sand; natural dissolved oxygen concentration is normally near saturation; fauna is characteristic of running water, and there are few or no plankton forms; very little floodplain development………………**Upper Perennial**

Lacustrine

1a. Water greater than 2 m deep, not all Lacustrine habitats include this subsystem…………………**Limnetic**

1b. Water less than 2 m deep, all wetland habitats in the Lacustrine System include this subsystem. Extends from the shoreward boundary of this system to a depth of 2 , below low water or to the maximum extent of non-persistent emergent, if these grow at depths >2 m…………………………**Littoral**

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[2] Modified from Artificial Keys to the Systems and Classes, Cowardin et al. 1979, Appendix E

[3] Subsystems are applied to Riverine and Lacustrine Systems only, there are no Subsystems for Palustrine Systems

***Classes*[4]**

1a. During the growing season of most years, areal cover by vegetation is <30%……………………………….**2**

2a. Water regime very wet: permanently flooded (H), intermittently exposed (G), semipermanently flooded (F). Substrate usually not soil……………………………………………………………………………………**3**

3a. Substrate of bedrock, boulders or stones occurring singly or in combination covers ≥75 of the area (rock >25.4 cm)…………………………………………………………………………………………**Rock Bottom**

3b. Substrate of organic material, mud, sand, gravel, or cobbles with <75% aerial cover of stones, boulders or bedrock (rock >25.4 cm)…………………………………………………**Unconsolidated Bottom**

2b. Water regime drier: seasonally flooded (C), temporarily flooded (A), intermittently flooded (J), seasonally flooded/saturated (E), saturated (B), or artificially flooded (K). Substrate often soil…………**4**

4a. Contained within a stream channel that does not have permanent flowing water (i.e., Intermittent Subsystems of Riverine System)…………………………………………………………**Streambed**

4b. Contained in channel with perennial water or not containing a channel……………………………**5**

5a. Substrate of bedrock, boulders, or stones occurring singly or in combination cover ≥75% of the area…………………………………………………………………………………………..**Rocky Shore**

5b. Substrate of organic material, mud, sand, gravel, or cobbles; <75% of the cover consisting of stones, boulders, or bedrock…………………………………**Unconsolidated Shore**

1b. During the growing season of most years, areal cover by vegetation is ≥30%……………………………….**6**

6a. Vegetation composed of pioneering annuals or seedling perennials, often not hydrophytes, occurring only at time of substrate exposure……………………………………………………………………………**7**

7a. Contained in a channel that does not have permanent flowing water…**Streambed (Vegetated)**

7b. Contained within a channel with permanent water or not contained in a channel…………………….. ……………………………………………………………………………………………**Unconsolidated Shore (Vegetated)**

6b. Vegetation composed of algae, bryophytes, lichens, and vascular plants that are usually hydrophytic perennials………**8**

8a. Vegetation composed predominately of nonvascular species……………………………………………**9**

9a. Vegetation macrophytic algae, mosses, or lichens, growing in water or the splashzone of shores……**Aquatic Bed**

9b. Vegetation mosses or lichens usually growing on organic soils and always outside the spashzone of shores……………………………………………………………………………**Moss-Lichen Wetland**

8b. Vegetation composed predominant of vascular species…………………………………………………..**10**

10a. Vegetation herbaceous………………………………………………………………………………………………**11**

11a. Vegetation emergent…………………………….**Emergent Wetland**

11b. Vegetation submergent, floating-leaved, or floating………………………………………..**Aquatic Bed**

10b. Vegetation trees or shrubs……………………………………………………………………………………..**12**

12a. Dominants less than 6m tall……………………………………………………………….**Scrub-Shrub Wetland**

12b. Dominants 6m taller or more……………………………………………………………………**Forested Wetland**

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[4] Classes apply to all Systems

Cowardin Water Regime Modifiers (in order from driest to wettest) [5]***:***

Consider the likely length of inundation at sites in relation to the Army Corps definition of typical wetland hydrology, *"The site is inundated (flooded or ponded) or the water table is ≤12 inches* (~30 cm) *below the soil surface for ≥14 consecutive days during the growing season at a minimum frequency of 5 years in 10* (U.S. Army Corps of Engineers, 2005). The growing season is often approximated as the period between last spring freeze and first fall freeze.

Intermittently Flooded (J): The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. The dominant plant communities under this regime may changes as soil moisture conditions change. Some areas exhibiting this regime do not fall under the Cowardin et al. definition of wetland because they do not have hydric soils or support hydrophytes. This water regime is limited to describing habitats in the arid western portions of the United States. This water regime has been used extensively in vegetated and non-vegetated situations including some shallow depressions (playa lakes), intermittent streams, and dry washes.

Temporarily Flooded (A): Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season. Plants that grow both in uplands and wetlands are characteristic of the temporarily flooded regime.

Seasonally Saturated (B): The substrate is saturated at or near the surface for extended periods during the growing season, but unsaturated conditions prevail by the end of the season in most years. Surface water is typically absent, but may occur for a few days after heavy rain and upland runoff.

Seasonally Flooded (C): Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the surface, but may vary extending from saturated to the surface to well below the ground surface.

Continuously Saturated (D): The substrate is saturated at or near the surface throughout the year in all, or most, years. Widespread surface inundation is rare, but water may be present in shallow depressions that intersect the groundwater table, particularly on a floating peat mat.

Seasonally flooded/saturated (E) – The wetland has surface water present at some time during the growing season exhibiting flooded conditions (especially early in the growing season). When surface water is absent the substrate remains saturated near the surface for much of the growing season.

Semi-permanently Flooded (F): Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

Intermittently Exposed (G): Surface water is present throughout the year except in years of extreme drought. This is applied to wetland such as inland saline lakes and marshes where there is standing water throughout the year in most years.

[5] For nontidal, inland freshwater and saline areas. From Cowardin et al. (1979), additional description for some modifiers have been included based on regional use.

Permanently Flooded (H): Water covers the land surface throughout the year in all years. Vegetation is composed of obligate hydrophytes. Mostly applied to deepwater habitats where there is little chance of drying.

Cowardin Special Modifiers

Beaver: Created or modified by beaver activity.

Partially ditched/drained: The water level has been artificially lowered, but the area is still classified as wetland because soil moisture is sufficient to support hydrophytes. Drained areas are not considered wetland if they can no longer support hydrophytes.

Farmed: The soil surface has been mechanically or physically altered for production of crops, but hydrophytes will become reestablished if farming is discontinued.

Diked: Created or modified by a man-made barrier or dam which obstructs the inflow of water

Impounded: Created or modified by a man-made barrier or dam which obstructs the outflow of water

Artificial substrate: Concrete-lined canals and areas with Rock Bottom, Unconsolidated Bottom, Rocky Shore, and Unconsolidated Shore that were emplaced by humans, using either natural materials such as dredge spoil or synthetic materials such as discarded automobiles, tires, or concrete.

Excavated: Lies within a basin or channel excavated by humans.

Examples of Palustrine System[6]:
Combine the codes for the system, class, and water regime with any special modifiers to classify wetlands. The following are examples of types of wetlands and how they would be coded for wetland mapping purposes.

1. Cattail marsh that has standing water for most of the year: **PEMF**
2. A prairie pothole dominated by grasses and sedges that is only wet at the beginning of the growing season: **PEMA**
3. A fen in the subalpine zone: **PEMB**
4. A small shallow pond that has lily pads and other floating vegetation and holds water throughout the growing season: **PABF**
5. A small shallow pond with less than 30% vegetation and a muddy substrate that holds water for most of the year: **PUBF**
6. A wetland dominated by willows adjacent to a stream that is only periodically flooded: **PSSA**

[6] Descriptions of Palustrine Systems with water regime modifiers are borrowed from Lemly, J., and Gilligan, L., 2013, Ecological integrity assessment for Colorado wetlands—field manual version 1.0- review draft: Fort Collins, Colorado Natural Heritage Program, 92 p.

Buffer Land Cover

Buffer Land cover	Non-buffer Land Cover
• Vegetated natural and semi-natural areas including forests, grasslands, shrublands, wetlands, and open water • Natural unvegetated areas including permanent snow or ice cover and natural rock outcrops or sandy and gravel areas. • Old fields undergoing succession • Rangeland[1] • Partially vegetated pastures[1] • Recently burned natural land with at least some vegetative recovery[1] • Low use tracks such as single-use ATV tracks or undeveloped and unmaintained dirt tracks that are vegetated in the middle and only used once or a few times a year • Vegetated levees, natural substrate ditches • Recreational areas with little substrate disturbance (bike, horse, and foot trails with narrow width of influence)	• Commercial and residential areas, parking lots, railroads and train yards • Lawns, sports fields, traditional golf courses • Dirt and paved roads • Mined areas • Agriculture including row crops, orchards, vineyards, clear-cuts • Animal feedlots, poultry ranches, animal holding pens with mostly bare soil • Severely burned land with little vegetative recovery • Recreational areas with substantial disturbance (wide paths, paved areas, trash/dumping) • Oil and gas wells • Wind farms

[1]These land cover types can vary considerably in the degree to which they serve as buffer cover. We will use the buffer condition-soil metric to help distinguish between soil disturbance-related features with varying degrees of buffer functionality.

Wetland Determination Reference

REGIONS	Arid West	Western Mountains, Valleys, and Coast
Climate	Generally hot and dry with a long summer dry season. Average annual precipitation mostly <15 in. (380 mm). Most precipitation falls as rain.	Cooler and more humid, with a shorter dry season. Average annual precipitation mostly >20 in. (500 mm). Much of the annual precipitation falls as snow, particularly at higher elevations.
Vegetation	Little or no forest cover at the same elevation as the site and, if present, usually dominated by pinyon pine (e.g., *P. monophylla* or *P. edulis*), junipers (*Juniperus*), cottonwoods (e.g., *Populus fremontii*), willows (*Salix*), or hardwoods (e.g., *Quercus, Platanus*). Landscape mostly dominated by grasses and shrubs (e.g., sagebrush [*Artemisia*], rabbitbrush [*Chrysothamnus*], bitterbrush [*Purshia*], and creosote bush [*Larrea*]). Halophytes (e.g., *Allenrolfea, Salicornia, Distichlis*) present in saline areas.	Forests at comparable elevations in the local area dominated by conifers (e.g., spruce (*Picea),* fir *(Abies),* hemlock *(Tsuga),* Douglas-fir *(Pseudotsuga),* coast redwood (*Sequoia*), or pine *(Pinus)* except pinyon) or by aspen (*Populus tremuloides*). Open areas generally dominated by grasses, sedges, shrubs (e.g., willows or alders [*Alnus*]), or alpine tundra.
Soils	Mostly dry, poorly developed, low in organic matter content, and high in carbonates. Soils sometimes highly alkaline. Surface salt crusts and efflorescences common in low areas	Generally better developed, higher in organic matter content, and low in carbonates. Surface salt features are less common except in geothermal areas.
Hydrology	Drainage basins often lacking outlets. Temporary ponds (often saline), salt lakes, and ephemeral streams predominate. Water tables often perched. Major streams and rivers flow through but have headwaters outside the Arid West.	Streams and rivers often perennial. Open drainages with many natural, freshwater lakes. Water tables often continuous with deeper groundwater. Region serves as the headwaters of the major streams and rivers of the western United State

Adapted from: U.S. Army Corps of Engineers. (2010). Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region Version 2.0 (No. ERDC/EL TR-10-3). Vicksburg, MS.

Determining Dominance by Hydrophytic Vegetation

We will consider sites to have hydrophytic vegetation if more than 50% of the dominant plant species present have wetland indicator ratings of OBL, FACW, or FAC. If we need to evaluate dominance of hydrophytic vegetation before surveying a site, we will make a coarse estimate of which species are dominant rather than estimating percent cover of all species present. Following are the general steps to take:

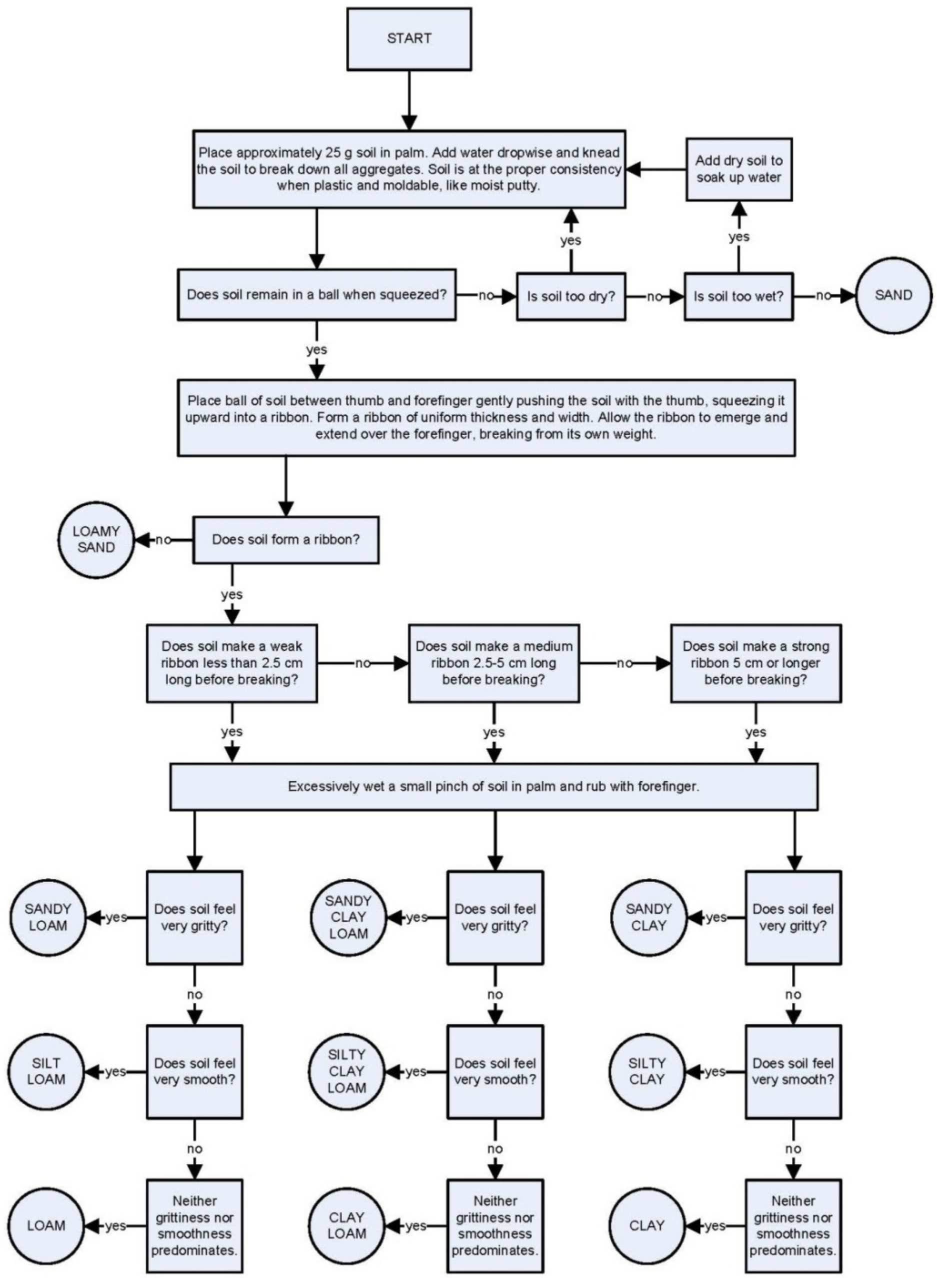
1. Determine strata (vegetation layers) present in the area. Strata include trees (DBH ≥7.6 cm), saplings and shrubs (DBH < 7.6 cm), herbaceous plants, and woody vines.
2. Estimate the percent of the assessment area covered by each strata. For example, all tree species combined (including trunks and canopy cover) may occupy 25% of the assessed area. If an individual strata has less than 5% cover, consider species in that strata part of a more abundant strata.
3. Determine the cover values that correspond with 50% and 20% relative cover within the strata. For example, if a strata has 60% total cover, 50% relative cover will be 0.5 *60% or 30% total cover and 20% relative cover will be 0.2*60% or 12% total cover.
4. Record the name(s) of the most prevalent plant species within each strata and their percent cover. You can stop recording plant species once the total recorded cover get to the 50% relative cover value (i.e, 30% absolute cover in our example). If any species have 20% relative cover (i.e., 12% absolute cover in our example) and are not on the list, add those species as well.
5. Once the dominant species in each strata are listed, determine the percent of these species that are FAC, FACW, or OBL. A species can be counted twice if it is listed in two strata (e.g., trees and saplings)

Indicators of Site Hydrology

Presence of at least one primary (P) or two secondary (S) features indicates that site has wetland hydrology. Features in italics apply to only one region; indicators that begin with a single * apply to the Western Mountains region and those with ** apply to the Arid West region. *** under type refers to indicators that are secondary in riverine systems in the Arid West and primary in Western Mountains and all other Arid West wetland types. List adapted from the Arid West and Western Mountains supplements to the Corps of Engineers wetland delineation manual and excludes indicators B7 and C9 related to aerial imagery.

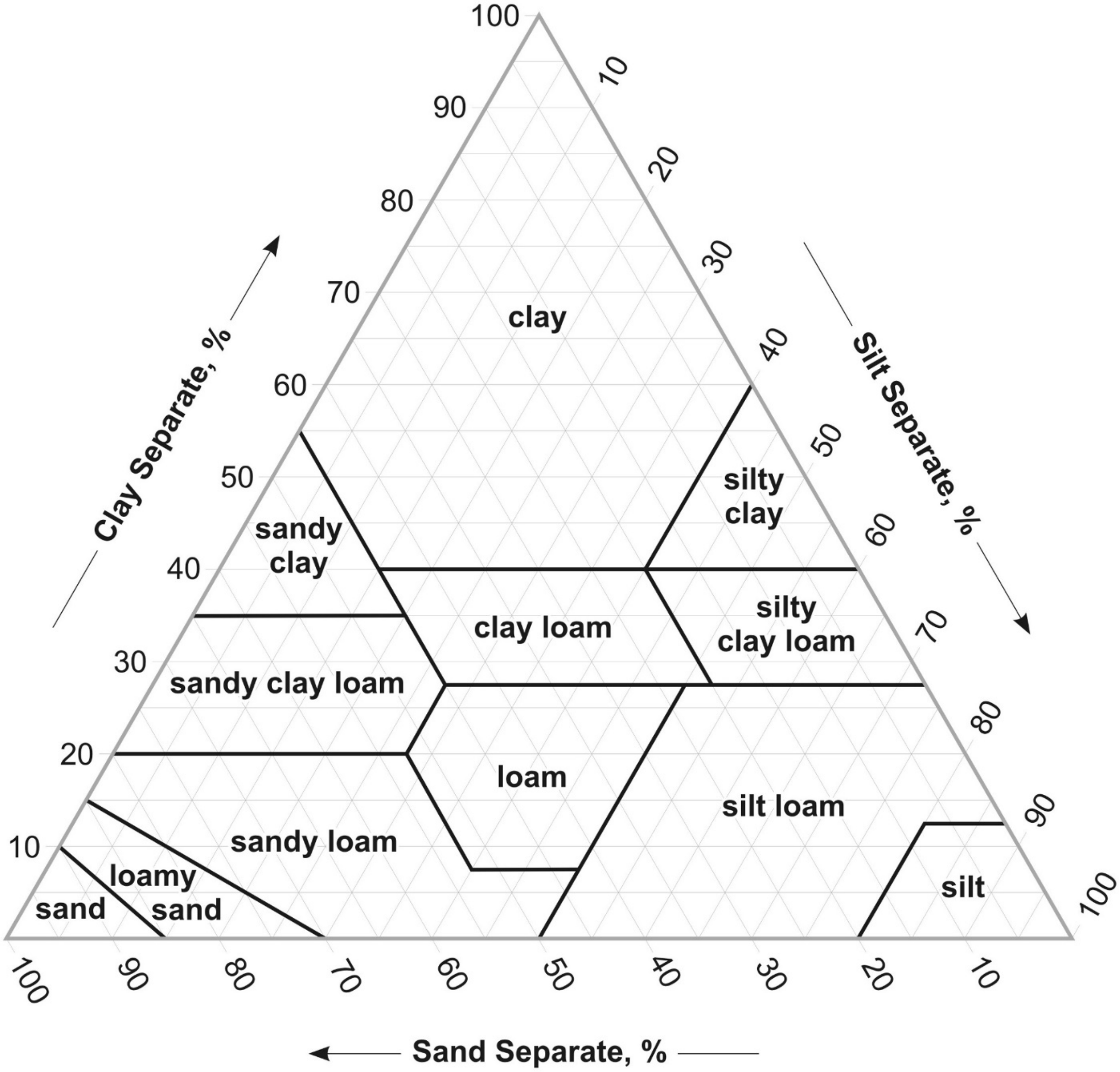
Indicator	Description	Type
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water		**P**
A2 – High water table	Within 30 cm of the soil surface	**P**
A3 – Saturation	Within 30 cm of soil surface (i.e., glistening or water shakes off soil), with water table or restrictive soil layer below	**P**
Group B – Evidence of Recent Inundation		
B1 – Water marks	Stains on bark of woody vegetation, rocks, bridge supports, fences, etc.	**P *****
B2 – Sediment deposits	Thin layers of silt or clay or organic matter on tree bark, plant stems, rocks, etc.	**P *****
B3 – Drift deposits	Rafted debris on the ground or entangled in vegetation	**P *****
**B4- Algal mat or crust*	*Mat or dried crust of algae left on soil surface (see B12)*	***P***
**B5- Iron deposits*	*Thin orange/yellow crust/gel of oxidized iron on soil surface or objects near surface*	***P***
B6 – Surface soil cracks	Excluding shrink-swell cracks in clay soils and cracks in temporary puddles that lack hydric soils and veg	**P**
**B8- Sparsely veg. concave surface*	*<5% cover of vegetation in depressions and swales due to long-duration of ponding*	***P***
B9 – Water-stained leaves	Tannin-leached leaves that have turned grayish or brownish from inundation and contrast with nearby leaves outside of the wetland. Oak, ash, maple, sycamore exhibit this indicator, cottonwoods and aspens probably do not.	**P**
B10 – Drainage patterns	Flow patterns visible on the soil surface or eroded into soil or low vegetation bent over in the direction of flow or absence of litter due to flowing water	**S**
B11 – Salt crust	Hard or brittle deposits (NOT fluffy or powdery) of salts from evaporation of saline surface water	**P**
***B12 – Biotic crust*	*Ponding-remnant biotic crusts including benthic microflora or free-floating algae (see B4)*	***P***
B13 – Aquatic invertebrates	Live individuals, diapausing eggs, crustacean cysts or dead remains of aquatic invertebrates (should be more than just a few)	**P**
Group C – Evidence of Current or Recent Soil Saturation		
C1 – Hydrogen sulfide odor	Hydrogen sulfide odor within 30 cm of soil surface	**P**
C2 – Dry-season water table	Water table between 30 and 60 cm during dry season or during drier-than-normal year	**S**
C3 – Oxidized rhizospheres along living roots	Soil layer within 30 cm of surface with ≥2% iron-oxide coatings or plagues on the surface of living roots or soil pores around roots	**P**
C4 – Presence of reduced iron	Soil layer within 30 cm of surface with reduced iron based on ferrous iron test or color change upon exposure to air	**P**
C6 – Recent iron reduction in tilled soils	Soil layer within 30 cm of surface with ≥2% redox concentrations as pore linings or soft masses in the tilled surface of soils cultivated within 2 years	**P**
***C7 – Thin muck surface*	*Layer of muck ≤2.5 thick on soil surface*	***P***
***C8 – Crayfish burrows*	*Openings in ground up to 5 cm in diameter, usually surrounded by excavated mud*	***S***
Group D – Evidence from Other Site Conditions or Data		
**D2 – Geomorphic position*	*Depression, swale or drainage way, concave position within floodplain, at the toe of a slope, on an extensive flat, or in area of groundwater discharge except on rapidly permeable soils (sand and gravel substrates)*	***S***
D3 – Shallow aquitard	Relatively impermeable soil layer or bedrock within 30 cm of the surface with hydric soils and veg. also present. Layer can be identified by lack of root penetration through layer	**S**
D5 – FAC-neutral test	Drop FAC species from dominant plant list. Are >50% of remaining species FACW or OBL?	**S**
**D7 – Frost-heave hummocks*	*Not hummocks from livestock pugging or shrink-swell clay soils*	*S*

Soil Texture Flow Chart[7] and Triangle



[7] Modified from S.J. Thien, 1979. *A flow diagram for teaching texture by feel analysis.* Journal of Agronomic Education. 8:54-55, by the NRCS. [Accessed 2013].

Soil Textural Triangle



Reference for Assessing Hydric Soil Indicators

Steps for assessing soil indicators

1. For each layer, use table of soil characteristics to determine which, if any, hydric soil characteristics may be present.
2. For characteristics that may be present, go to the indicated number(s) under the key to soil characteristics and determine if indicator(s) are actually present by going through key. Remember that indicators that begin with A apply to all soils, F to clayey/loamy soils, and S to sandy soils. Sandy soils are those that are textured as sand or loamy sand. Layers may be combined to reach necessary thickness.
3. Make sure that all layers above any of the indicators have chroma ≤2 or are <15 cm thick (except for F8).

Problem soil indicators can only be selected for sites where other hydric soil indicators are present. Indicators of wetland hydrology and hydrophytic vegetation ***must be*** present to record these features.

Table of Hydric Soil Characteristics

#	Value/Chroma	Description
1	*NA*	Organic soil layer
2	*NA*	Mucky mineral soil layer
3	*NA*	Hydrogen sulfide odor
4	≥5/1, ≥6/≤2	Depleted matrix
4	4/2, 5/2, 4/1	Depleted matrix: Must have ≥2% distinct/prominent redox concentrations
5	≥4/1 (except hues of 5G or N)	Gleyed: Hues include N, 10Y, 5GY, 10GY, 5G, 10G, 5BG, 10BG, 5B, 10B, 5PB, chroma of 1 except 5G can have chroma 1 or 2 and N any chroma
6	≤3/≤2	Need depletions or redox features to qualify
7	*NA*	Site a closed depression; soil with ≥5% redox concentrations
8	≤4/≤4	**Problem soils only**, Hue must be 7.5YR or redder, ≥2% redox depletions or concentrations
9	≤3/≤1	**Problem soils only,** must be shallow depression with bedrock within 25 cm of soil surface
10	Usually ≥5/≤2 mixed with areas with chroma 3 or 4, but not required	**Sandy soils only,** Layer with areas stripped of organic matter or iron/manganese oxides, leading to faintly contrasting patterns of two or more colors

Key to Hydric Soil Characteristics

1. **Layer of organic (peat, mucky peat, muck) present**
   a. **Problem soil, Layer of *muck* at least 2 cm thick**, value≤3, chroma ≤1, within 15 cm of surface. (***mountain region only***)……………………………………………………………………………………A10
   b. **Not a problem soil, Layer of organic at least 20 cm thick** (note about rock, etc.) (all of the below could apply)
      i. **Organic layer of 40 cm in the top 80 cm of soil** (or organic matter over bedrock or in layers with >90% rocks)?……………………………………………………………………………………A1
      ii. **Organic layer starts on surface**, soil below has chroma ≤2 (aquic conditions must be present).. ………A2
      iii. **Organic layer starts within 15 cm of surface**, has hue 10YR or yellower (5Y, etc.), value ≤3, chroma ≤1, underlain by soil with chroma ≤2………………………………………..A3

   c. **Arid West only, layer of muck 1 cm or more thick**, value ≤3 and chroma ≤1, starting within 15 cm of soil surface……………………………………………………………………………………………………A9
2. **Layer of mucky mineral soil** starting within 15 cm of soil surface
   a. **Layer 10 cm thick** …………………………………………………………………………………………………..F1
   b. **Sandy soil: layer 5 cm thick**………………………………………………………………………………………S1
3. **Hydrogen sulfide odor** within 30 cm of soil surface…………………………………………………………………A4
4. **Depleted at least 60% of matrix** (see table above)
   a. layer 5 cm thick entirely within the top 15 cm of soil……………………………………………………..F3
   b. Layer 15 cm or more thick
      i. **Layer starts within 25 cm of soils surface**……………………………………………………………F3
      ii. Layer starts within 30 cm of soil surface, layer **above** depleted matrix has value ≤3 and chroma ≤2 (if loamey/clayey) ……………………………………………………………………A11
      iii. Layer starts below 30 cm of soil surface, layer(s) **above** depleted matrix must have value ≤2.5 and chroma ≤1 to depth of 30 cm and value of ≤3 and chroma ≤1 in any remaining layers …………………………………………………………………………………………………A12
   c. Sandy soil: layer 10+ cm thick starting within 15 cm of soil surface, must have 2% or more redox conctrations..S5
5. **Gleyed at least 60% of matrix** (see table above)
   a. **Layer starts 30 cm of soil surface,** …………………………………………………………………………F2
   b. Layer starts within 30 cm of soil surface, layer **above** depleted matrix has value ≤3 and chroma ≤2………A11
   c. Layer starts below 30 cm of soil surface, layer(s) **above** depleted matrix must have value ≤2.5 and chroma ≤1 to depth of 30 cm and value of ≤3 and chroma ≤1 in any remaining layers. ………A12
   d. Sandy soil: Layer starts within 15 cm of soil surface...S4
6. **Layer with matrix value ≤3 and chroma ≤2**, 10 cm thick layer entirely within top 30 cm of mineral soil
   a. Chroma ≤1
      i. ≥2% distinct/prominent redox concentrations as soft masses or pore linings……….F6
      ii. ≥10% redox depletions (value ≥5 and chroma ≤2)………………………………………………..F7
   b. Chroma=2
      i. ≥5% distinct/prominent redox concentrations as soft masses or pore linings……….F6
      ii. ≥20% redox depletions (value ≥5 and chroma ≤2)……………………………………………….F7
7. **In closed depressions**,
   a. **≥5% distinct/prominent redox concentrations** as soft masses or pore linings in ≥5 cm layer entirely within upper 15 cm of soil…………………………………………………………………………F8
8. Problem soil, Red parent material (meets definition above), at least 5 cm thick entirely within 30 cm of soil surface, 2% or more redox depletions or concentrations……TF2
9. Problem soil, depression or other concave landform with shallow bedrock (mountain region only)
   a. Bedrock between 15 and 25 cm of surface, layer 15 cm thick starting within 10 cm of surface with value ≤3 and chroma ≤1, remaining soil to bedrock must have chroma ≤2…TF12
   b. Bedrock within 15 cm of soil surface, more than half of soil thickness has value ≤3 and chroma ≤1, remaining soil to bedrock must have chroma ≤2………………………………………….TF12
10. Sandy soils, stripped matrix

a. Layer starting within 15 cm of surface, colors listed in table are common, but not required……S6

Evaluating Soil Texture

Soil layers are only likely to be organic or mucky mineral if they are very frequently saturated or inundated. Base evaluation in part on whether site has hydrology and vegetation indicative of consistently wet conditions.

Determine whether soil is organic, mucky mineral, or mineral:

Gently rub soil material between forefinger and thumb. If soil feels gritty after first or second rub, you have mineral soil. If soil feels greasy after the second rub, rub the material two or three more times. If the soil now feels gritty or plastic, than it is mucky mineral. If the soil remains greasy, it is organic soil and further divisions need to be made (see below)

Determine whether organic soil is muck, mucky peat, or peat

Use the chart below to differentiate between types of organic soils based on the percentage of visible fibers in a rubbed and unrubbed sample and nature of material extruded when sample is squeezed

Soil Texture	% Visible Fibers		Nature of Material Extruded When Squeezing
	Unrubbed	Rubbed	
Muck	<33%	<17%	From ½ to all of sample squeezed out, water very turbid, thick and pasty, or no free water
Mucky peat	33-67%	17-40%	From no organic solids squeezed out to 1/3 of sample squeezed out; water dark brown
Peat	>67%	>40%	No organic solids squeezed out, water from clear and colorless to brown and turbid

Adapted from USDA Natural Resources Conservation Service (1999) and U.S. Army Corps (2010)

Assessment Area Soil and Substrate Disturbance Reference Card

Consider the following when assessing soil and substrate disturbance.

1) **How widespread is damage?**
2) **What is the impact on vegetation? Areas with compacted soils often have little or no vegetation growing.**
3) **What is the depth of disturbance? Is the disturbance deep enough to unnaturally channelize or pool water or to serve as an artificial dike?**

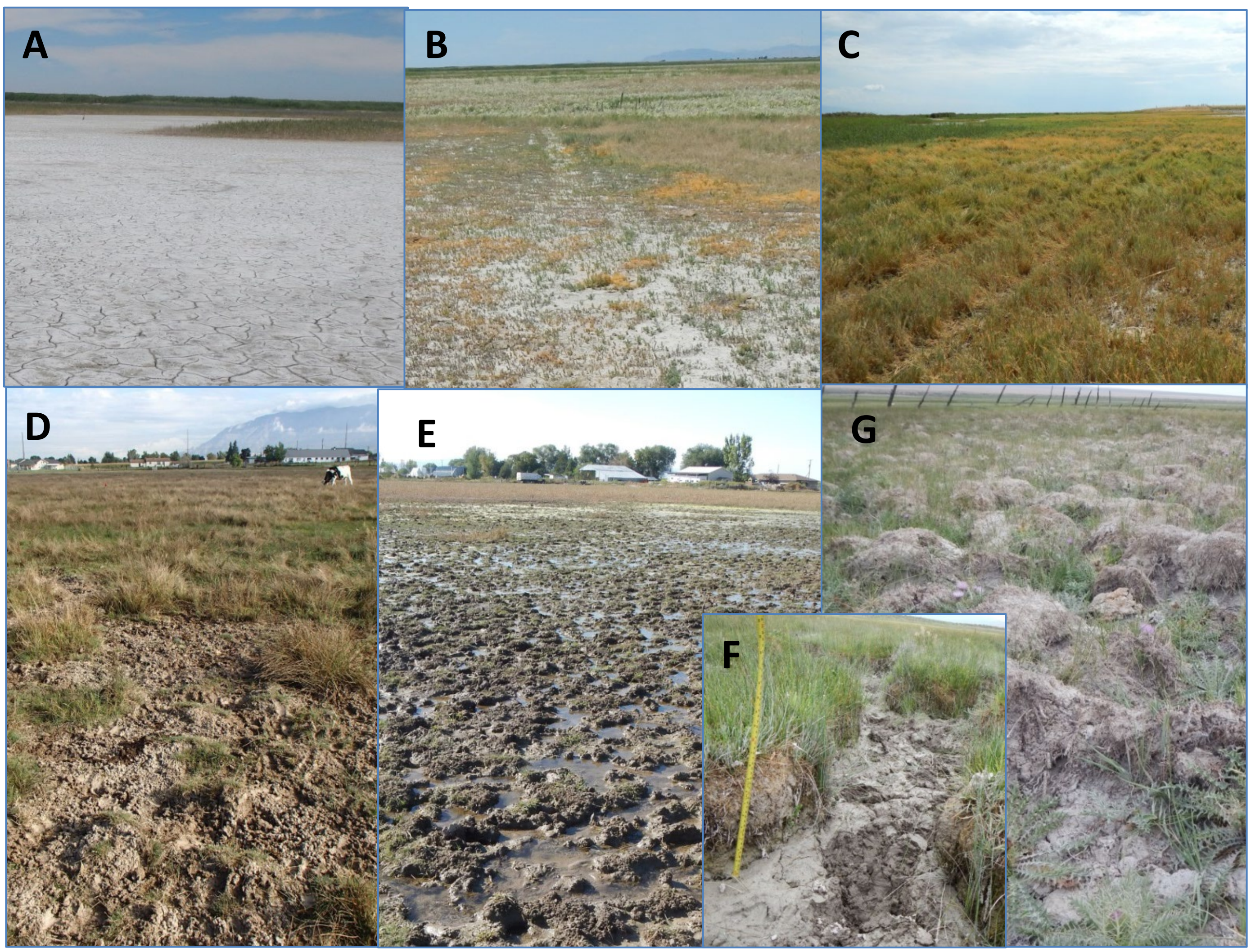
Explanation of figures:

A is a site with naturally bare soil and no signs of soil disturbance, scored as A

B shows some soil disturbance where the ground is less vegetated than surrounding areas due to compaction; height of disturbance is too low to affect hydrology; site may be scored as A if this is only disturbance because mostly revegetated or as B if this level of disturbance is more frequent across site.

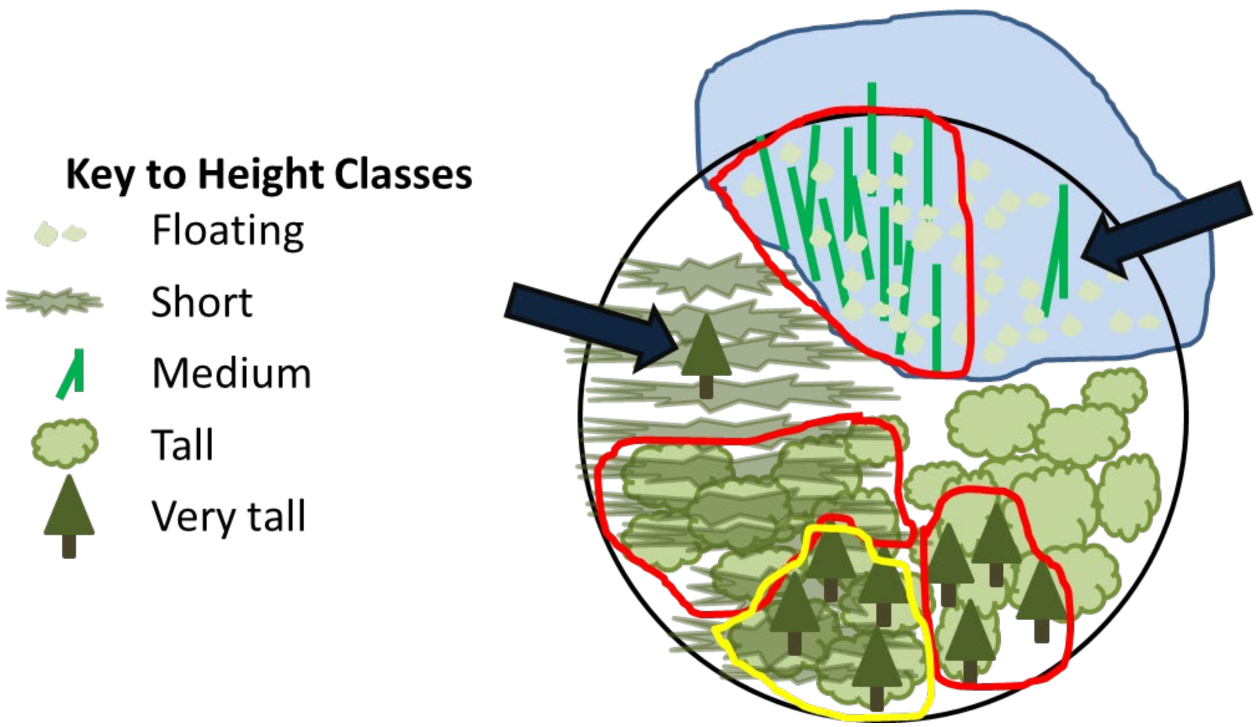
C shows tracks through vegetation. If vegetation is merely toppled over due to tracks, site may be scored as A. If vegetation is stunted or not growing due to compaction, site would likely score as B. May need to also take into account depth of any soil damage.

D, E, F, and **G** show soil disturbance due to grazing. Disturbance at site pictured in D was shallow and localized to only a few locations in site; site was scored as B. Disturbance at site pictured in E was moderately deep and found throughout entire site; site should be scored as C because damage is likely to recover on its own if cattle are removed. F and G show deep pugging that alters site hydrology and changes vegetation; site was scored as D.



Reference Card for Overlap Estimates

The diagram below shows a potential assessment area (bounded by black lines) with the distribution of different height classes of vegetation. The assessment area should be divided into regions with different overlap statuses before making overlap estimates. In the example below, areas with overlap of two heights are circled in red and three heights area circled in yellow, yielding estimates of approximately 38% and 10%, respectively. The minor regions of overlap depicted by the arrows may add an additional 1 or 2% to the overall estimation.



Utah's Wetland Birds of Conservation Concern

Abert's Towhee

http://www.allaboutbirds.org/guide/Aberts_Towhee/id

I.D. Medium sized songbird with long tail. Rusty Color under tail, and a black face. Brown Body.
Habitat: Riparian Corridors
Conservation Concern: Tier III

American Avocet

http://www.allaboutbirds.org/guide/American_Avocet/id

ID: Long upturned bill. Rusty/orange head and neck. Black and white body with long legs.
Habitat: Shallow marshes
Conservation Concern: Tier III

American White Pelican

http://www.allaboutbirds.org/guide/American_White_Pelican/id

ID: Very Large water bird with a long neck and massive bill. All white with black flight feathers.
Habitat: Open water
Conservation Concern: Tier II

Bald Eagle

http://www.allaboutbirds.org/guide/bald_eagle/id

ID: Distinct white head with yellow beak. Brown body and wings. Extremely large bird.
Habitat: Forests, or areas to perch over large bodies of water.
Conservation Concern: Tier I

Bell's Vireo

http://www.allaboutbirds.org/guide/Bells_Vireo/id

ID: Small songbird, gray to greenish above. Yellowish/White below. Two wing bars and small white eye ring
Habitat: Scrub Shrub Riparian
Conservation Concern: Tier III

Black Swift

http://neotropical.birds.cornell.edu/portal/species/overview?p_p_spp=224091

ID: Scythe like wings and long slightly forked tail.
Habitat: Shady montane cliffs and caves.
Conservation Concern: Tier II

Black-necked Stilt

http://www.allaboutbirds.org/guide/Black-necked_Stilt/id

ID: Black face, hind neck, and back. White throat and breast. Long red legs. Straight and long black bill
Habitat: Shallow wetlands and shorelines
Conservation Concern: Tier III

Bobolink

http://www.allaboutbirds.org/guide/Bobolink/id

ID: White and black rump and back. Yellow on back of head. Similar shape and size as blackbirds.
Habitat: Open grasslands
Conservation Concern: Tier II

Broad Tailed Hummingbird

http://www.allaboutbirds.org/guide/Broad-tailed_Hummingbird/lifehistory

ID: Shiny green upperparts. Males have a red throat. Females have white throat speckled with green and bronze.
Habitat: High elevation open woodlands
Conservation Concern: Tier III

Caspian Tern

http://www.allaboutbirds.org/guide/Caspian_Tern/id

ID: Large tern with a black cap and white body. Large red bill.
Habitat: Shorelines, salt marshes, mudlflats, and lakes.
Conservation Concern: Tier III

Lucy's Warbler

http://www.allaboutbirds.org/guide/Lucys_Warbler/id

ID: Small songbird. Grey above and white below. Occasional red nape. Faint white stripe over eye.
Habitat: Riparian Woodlands
Conservation Concern: Tier III

Osprey

https://www.allaboutbirds.org/guide/Osprey/

ID: Brown above and white below. Have an "M" shape in their wings when flying. White heads with a brown stripe through the eye.
Habitat: Any open water
Conservation Concern: Tier III

Short Eared Owl

http://www.allaboutbirds.org/guide/Short-eared_Owl/id

ID: Medium sized owl and mostly mottled brown. Thin streaks on chest. Yellow eyes
Habitat: Open grasslands
Conservation Concern: Tier III

Snowy Plover

http://www.allaboutbirds.org/guide/Snowy_Plover/id

ID: Small shorebird with pale tan back. White underneath and a short neck. Dark patches on side of neck/face
Habitat: Dry salt flats and shorelines that have little vegetation.
Conservation Concern: Tier III

Southwestern Willow Flycatcher

https://fieldguide.wildlife.utah.gov/?species=empidonax%20traillii%20extimus

ID: Grayish-green back and wings. Whitish throat, light grey breast, and yellowish belly. Two wingbars and a faint eye ring. Song: (Fitz-Bew)
Habitat: Dense Riparian Zones
Conservation Concern: Tier I

Whooping Crane

http://www.allaboutbirds.org/guide/Whooping_Crane/id

ID: Long neck and legs. White body with black wing tips. Red forehead and check. Larger than sandhill crane.
Habitat: Marshes and prairies
Conservation Concern: Tier I

Yellow-billed Cuckoo

http://www.allaboutbirds.org/guide/Yellow-billed_Cuckoo/id

ID: Large slim bird. Brown body and white breast. Bill is yellow and slightly downcurved. Tail has wide white and black bands from below.
Habitat: Riparian woodlands and thickets
Conservation Concern: Tier I

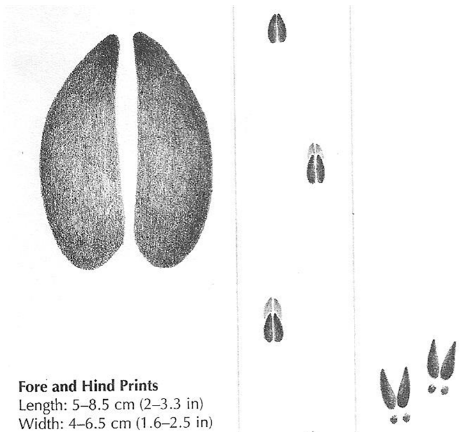
Sources

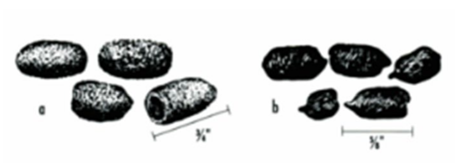
(2015) Cornell Lab of Ornithology. *All About Birds.* Retrieved from: http://www.allaboutbirds.org/

(2014) Nevada Fish and Wildlife Office. *Southwestern Willow Flycatcher.* Retrieved from: http://www.fws.gov/nevada/protected_species/birds/species/swwf.html

Wild and Domestic Ungulate Tracks

Mule Deer



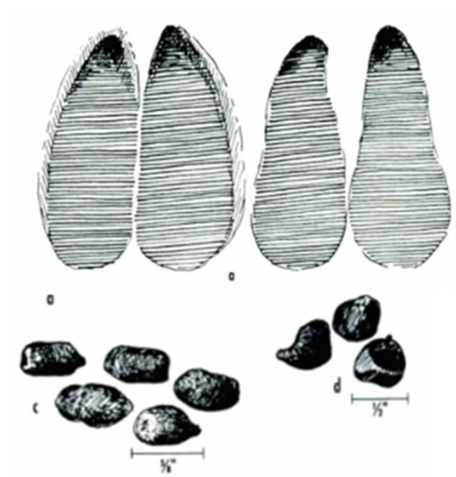


2-3.3 in. L

1.6-2.5 in. W

Overall heart-shaped track.

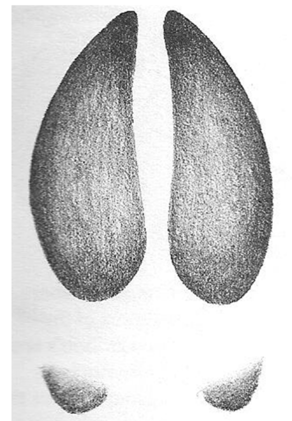
Domestic Sheep



2.5-3 in. L

Most similar in size to deer, but with front tips close to the centerline of each hoof half rather than heart-shaped. Overall blocky shaped track (if box was drawn around track, tips of hooves will extend closer to box edges than those of a deer). **Scat: More irregular and acorn-shaped than deer.**

Moose



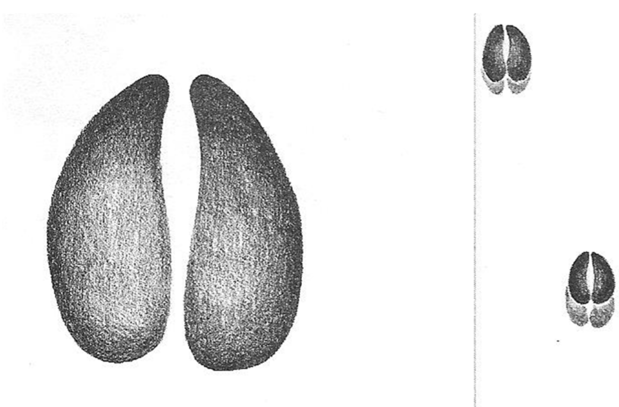
4-7 in. L

11 in. L (with dewclaws)

3.5-6 in. W

Prints generally larger than other ungulates and less rounded than elk, overall wider straddle. Juvenile moose tracks can be confused with elk. Scat: pellet form in piles, larger

Elk



3.5-5 in. L

2.5-4.5 in. W

Usually neat, rounded print. Adult elk stride: 16-34 in. Scat: pellet form in piles, larger than deer or goat droppings.

Domestic Cow

4-5 in. L

3.25-4.5 in. W

Tracks most similar in size to elk or small moose, but more rounded and cows have with distinct globular scat rather than pellets. However calf track can be confused with adult elk. Stride is usually smaller in calf than in elk of comparable size. Calf stride: 20.5-

Other tips:

-Pronghorn antelope tracks (possibly confused with deer) have concave sides along the length of the hoof as opposed to the convex sides of a deer.