ASSESSMENT OF WETLAND CONDITION AND WETLAND MAPPING ACCURACY IN UPPER BLACKS FORK AND SMITHS FORK, UINTA MOUNTAINS, UTAH

by Diane Menuz, Ryhan Sempler, and Jennifer Jones

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UTAH GEOLOGICAL SURVEY
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Cover photo: Fen along a headwaters tributary to East Fork Blacks Fork in the Uinta-Wasatch-Cache National Forest's High Uinta Wilderness in northern Utah.

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UTAH GEOLOGICAL SURVEY
contact
1594 W. North Temple, Suite 3110
Salt Lake City, UT 84114
telephone: 801-537-3300
website: geology.utah.gov

EXECUTIVE SUMMARY

The Utah Geological Survey (UGS), in partnership with the U.S. Forest Service Uinta-Wasatch-Cache National Forest (Forest Service), conducted research in 2014 to better quantify the location and condition of wetlands on the north slope of the Uinta Mountains in the Upper Blacks Fork and Smiths Fork watersheds. The three project goals were to compare accuracy of different wetland mapping techniques, assess wetland condition at randomly selected field sites, and develop a landscape model to predict wetland condition.

Three sources of wetland mapping data were used for the accuracy comparison: U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) data, mapping done by the Forest Service, and field mapping conducted by the UGS. The USFWS maps and classifies wetlands according to standards developed by Cowardin and others (1979). Wetlands are defined as areas that have wetland hydrology and typically have hydric soils and hydrophytic vegetation, but NWI mapping standards do not specify exactly how long areas must be wet or exactly how to determine the presence of these three indicators. Some wetlands mapped by NWI are only briefly or intermittently wet. Concerns that NWI may underestimate wetland area led the Forest Service to undertake a mapping project in 2006 and 2007. Wetland boundaries were identified at field sites based on vegetation and landform features, and then similar areas were identified in aerial imagery and mapped. In 2014, surveyors at the UGS made field observations to determine wetland boundaries using the U.S. Army Corps of Engineers (USACE) guidelines for wetland delineation. The USACE guidebook has specific guidelines on how to determine the presence of the three wetland indicators—predominance of hydrophytic plants, indicators of wetland hydrology, and indicators of hydric soils. Surveyors determined boundaries between USACE wetlands, transitional areas that may be considered wetlands by NWI or the Forest Service, and uplands. Boundary data collected in the field were used with aerial imagery in the office to delineate approximate USACE boundaries for comparison with the mapped NWI and Forest Service data. Wetland area and wetland classification (based on dominant overstory species) were then compared between the three mapping methods.

To determine wetland condition, the UGS used the Utah Rapid Assessment Procedure (URAP) to survey randomly selected sites from a sample frame of wetland area mapped by the Forest Service. The protocol is designed to collect data in survey plots between 0.1 and 0.5 ha in size and is composed of a series of metrics that rank wetland features from A, reference condition with no or minimal human impact, to D, severely altered from reference condition. Metrics are organized into five categories: 1) landscape context metrics evaluate the ability of the surrounding landscape to buffer the wetland from adjacent stressors and to provide intact habitat for species, 2) hydrologic condition metrics evaluate hydrologic connectivity to adjacent areas, naturalness of hydroperiod and timing of inundation, and evidence of water quality degradation, 3) the physical structure category is composed of a single metric that evaluates the degree of soil and substrate disturbance within a site, 4) vegetation structure metrics evaluate structural vegetation components, including horizontal structuring of vegetation zones and woody and herbaceous litter accumulation, and 5) plant species composition metrics evaluate the intactness of the plant community based on the presence and abundance of undesirable species. Data on stressors within and adjacent to sites and more detailed plant community composition data were also collected at sites; these data were used to validate the rapid assessment data and to provide more information about wetland condition.

Geospatial data were used to calculate landscape characteristics at each survey site, including distance to the nearest road, distance to the nearest trail, wilderness status, and potential grazing intensity. Grazing intensity data were taken from the 2014 Forest Service grazing instructions, which show the planned number of sheep and planned number of grazing days per grazing allotment subunit. These data were used to calculate the total planned number of sheep per day and per subunit area; however, grazing plans are sometimes altered and do not necessarily reflect historic grazing pressure or pressure at any particular location within a subunit. We created a series of competing models to predict URAP scores and plant community composition metrics from the landscape data.

We collected data on wetland boundaries and conducted URAP surveys at 28 sites and visited one additional site that did not have target wetland. All surveyed sites passed the USACE wetland plant dominance test and had indicators of wetland hydrology. Common hydrology indicators included plant species that passed the USACE FAC-neutral test (n=27), soil pit saturation (n=26), and high water table (n=18). We recorded hydric soil indicators at all but five sites. Histosols and depleted matrix were the most common indicators (n=12), followed by depleted below dark surface (n=7) and hydrogen sulfide odor (n=6). Some soil pits may have lacked indicators because samples were too saturated to show redoximorphic features; heavy rainfall made drying samples to a moist condition difficult. Despite not recording hydric soil indicators at five sites, we are confident that all 28 survey sites met the USACE wetland definition.

Based on our comparison of map products, the Forest Service mapped the most area and was the least discriminating between wetland types. Mapping by the UGS resulted in 6.2% and 13.1% less wetland area than NWI and the Forest Service, respectively. All but two sites were classified by the Forest Service as scrub-shrub, whereas both the UGS and NWI classified most sites as a mixture of wetland types. Scrub-shrub wetland was more frequently misclassified as emergent by NWI than the reverse based on

the dominant wetland type at each site; 15% of emergent and 40% of scrub-shrub sites were misclassified by NWI. Data from the Forest Service are the least detailed and most generalized; the data were only useful for identifying general areas where USACE and transitional wetlands occur. NWI maps are the only data that have been consistently and completely mapped across the entire study area and are the best sources for identifying wetland location. Wetland polygons from NWI could be generalized by adding a buffer to the mapped wetland polygons to highlight more transitional areas and to be more conservative in the identification of wetlands. Alternatively, NWI could be used as a base to identify areas that should be subject to a complete USACE wetland delineation to determine exact jurisdictional wetland boundaries. Data from NWI could be improved through better differentiation between emergent and scrub-shrub wetland types and through better spatial alignment of the data.

Sites were at or near reference condition based on most field measures and all but one site received an overall URAP score of A, but sites did show evidence of disturbance from grazing. Livestock grazing, usually of low severity, was the most commonly observed stressor within a 200-m buffer surrounding sites (n=22) and directly within sites (n=16). Other common buffer stressors include non-native plant species, extensive tree herbivory in areas with beetle kill, and trails, observed at 10, 8, and 6 sites, respectively. Only a few rapid assessment metrics were frequently rated below an A. Most of the lower scoring metrics were related either directly or indirectly to livestock grazing. Grazing impacts to soils in buffers and within sites were in approximately one third of sites. Impacted soils were usually considered only minimally impacted; only one site rated as C for the soil metrics. Slightly over half of the sites were scored as B or, for one site, C for potential water quality degradation due to concerns about potential effects from sheep droppings and bare soil. Eight sites scored as B and one as C for the relative cover of native plant species, indicating that these sites had less than 99% and 95% relative cover of native species, respectively. *Poa pratensis* (Kentucky bluegrass) was the most commonly recorded non-native plant species; This species is highly resistant to grazing and dominates areas that are overgrazed, though it was not found with more than 5% cover at any of the study sites. Detailed plant community composition data also indicated that sites are slightly below reference condition. We used coefficient of conservatism values (C-values), which are assigned to plant species based on their affinity to pristine or disturbed habitats, to calculate the average C-value, or Mean C, for each site. Fifteen sites were rated as A, 9 as B, and 4 as C based on Mean C thresholds established by Colorado's Natural Heritage Program, though thresholds may need to be further calibrated for our study area.

Landscape model results indicated that sites further from roads and sites within the wilderness boundary generally had healthier plant community composition measures. The relationship between livestock grazing intensity and plant community health was less clear. Sites closer to trails had healthier plant communities, which could be related to grazing; areas adjacent to trails experience less severe grazing because livestock cannot be overnighted along trails. However, the planned total number of sheep grazed in a subunit per day per unit area did not affect plant community composition measures. Findings related to grazing may be inconclusive because grazing is not spread evenly throughout an allotment subunit; some sites in a subunit may not be grazed at all and others may receive a disproportionate amount of grazing impact. Furthermore, we only had a single year of data on planned grazing activities and thus excluded historic effects.

Measures of plant community health are used to evaluate true wetland condition because plant communities are responsive to current and recent past disturbances that are not always visibly apparent or easy to measure, such as degraded water quality and past grazing pressure. However, many commonly used plant community measures rely on assigning C-values to species, which is a somewhat subjective process and can be regionally specific. Community composition in our study appeared to be spatially dependent; sites close to one another and within the same watershed had similar communities. Small discrepancies in C-value assignments will not affect study results when trends are large and conclusive. In this study, however, potential small discrepancies and a small disturbance gradient coupled with the tendency of sites close to one another to resemble one another may have made trend detection difficult. Furthermore, sites that were grazed immediately before surveys had unexpected changes in plant species composition that may have been caused by grazing making some species difficult to find or identify or by altering the relative cover of common, low C-value species and less common, higher C-value species. Plant community composition measures should continue to be developed and refined for use in Utah, and measures least sensitive to seasonal changes should be identified to better quantify disturbance in montane wetlands.

While wetlands in the study area are overall in good condition, we recommend follow-up work to better quantify the impact of grazing on wetlands in the study area. Monitoring sites should be handpicked at locations with well-understood levels of grazing intensity. Some sites should be at locations used annually as livestock camps, some at locations infrequently or never used as livestock camps, and some at locations with frequent low-intensity livestock grazing (i.e., areas where sheep frequently pass through but do not camp). Sites with high, medium, and low intensity grazing should be grouped together based on spatial proximity and wetland type to account for potential spatial autocorrelation between sites. Plant community composition could be monitored at the end of the grazing season to ensure that sites were grazed at the expected intensity and to reduce differences in plant community measures caused by temporary changes in plant species immediately post-grazing. Water quality or soil nutrient sampling may also be useful to assess differences in nutrient levels between grazing intensities. This follow-up work would provide a better understanding of the long-term effects of livestock grazing on wetlands and allow for improvement of plant-based tools for measuring wetland condition.

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INTRODUCTION

Project Background and Goals

Montane wetlands provide beneficial services such as water storage, water purification, and wildlife habitat. The Utah Geological Survey (UGS), in partnership with the U.S. Forest Service (USFS) Uinta-Wasatch-Cache National Forest (Forest Service), conducted research in 2014 to better quantify the location and condition of wetlands on the north slope of the Uinta Mountains in the Upper Blacks Fork and Smiths Fork watersheds (U.S. Geological Survey's [USGS] 10-digit Hydrologic Unit Code [HUC] watersheds 1404010701 and 1404010702 [http://nhd.usgs.gov/wbd.html]). This project has three major components:

1. **Assess the degree to which existing mapped wetland data were consistent with U.S. Army Corps of Engineers boundaries determined in the field.**

   Approach: Collect data on wetland vegetation, wetland hydrology, and soils at sites, use data to delineate likely wetland boundaries in the office, and compare results with data mapped by NWI and the Forest Service.

   - Goal 1: Determine degree of agreement between mapping methods.
   - Goal 2: Determine degree of agreement in classification between methods.

2. **Assess wetland condition at randomly selected wetlands in the study area.**

   Approach: Survey sites using the draft Utah Rapid Assessment Procedure (URAP). Collect detailed plant community composition data to better understand the effect of stressors and site condition on vegetation.

   - Goal 1: Understand wetland condition at study sites and in the study area as a whole.
   - Goal 2: Evaluate the relationship between stressors observed in the field and wetland condition as measured by URAP and plant community data.

3. **Create a model to predict wetland condition at study sites using landscape data.**

   Approach: Use landscape variables calculated in GIS to create linear regression models to predict wetland condition as measured by URAP and plant community data.

   - Goal 1: Evaluate whether potential stressors to wetland condition have a measurable effect on condition scores.

Wetland Mapping and Classification

Data on the abundance and spatial distribution of wetlands are an important component of understanding wetland condition and evaluating effects of different land management scenarios. The only nationally available mapped digital wetland maps are from the U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) program. Wetlands are defined by the program as "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water", as determined by the presence of hydrophytic vegetation, hydric soils, and saturated or flooded substrate (Cowardin and others, 1979). Areas are considered wetlands if they have all three indicators or only one or two indicators if lacking vegetation or soils (Federal Geographic Data Committee, 2013). Each mapped wetland polygon is classified using a hierarchical scheme developed by Cowardin and others (1979), which includes classification by major systems (e.g., Estuarine, Riverine, Palustrine) and class, which is based on predominant vegetation cover type (e.g., aquatic bed, emergent, scrub-shrub, forested) or, in systems with little vegetation, substrate type. The Cowardin system includes additional levels of classification, such as subsystem, subclass, water regime, special modifiers, soil and water chemistry, though these more detailed classifications are not analyzed in this report. Wetland mapping for NWI is primarily conducted using aerial imagery, and mapping in our study area occurred in the 1980s.

The USFWS wetland definition differs from the wetland delineation standards required by the U.S. Army Corps of Engineers (USACE) to determine whether a wetland is jurisdictional and subject to USACE regulation. As detailed in the USACE western mountains regional supplement, jurisdictional wetlands must have a predominance of hydrophytic plants, indicators of wetland hydrology, *and* indicators of hydric soils (U.S. Army Corps of Engineers, 2010). If all three components are not met, then a site is typically not considered a jurisdictional wetland. Furthermore, sites with less than 5% cover of vegetation are generally not considered wetland (though protocol exists for making determinations at problematic sites). No widely available mapped data of jurisdictional wetlands exists; in general, individual wetlands are delineated on a project-by-project basis.

Existing mapped data and associated classification schemes are sometimes inadequate. Wetlands are not frequently remapped by NWI to show changes in extent caused by anthropogenic factors such as land use change or water withdrawal or natural changes such as movement of beaver dams. In 2006 and 2007, the Forest Service mapped wetlands on U.S. Forest Service land on the north slope of the Uinta Mountains to estimate the amount and type of wetlands within various grazing allotments. The project was initiated because NWI wetlands appeared to underestimate the amount of wetland area within the allotments. Vegetation and landform observations were made during on-the-ground grazing allotment reviews and then similar areas were identified in aerial photos. These areas were delineated in GIS and classified using the Cowardin classification scheme. Data on hydric soils and hydrology indicators were not used for mapping. Mapping efforts were focused on sedge and willow meadows and may have missed mixed conifer wetlands and smaller wetlands.

The Cowardin classification system can be difficult to use due to the high number of potential wetland types (based on combinations of system, subsystem, class, subclass, etc.) that do not correlate with well-understood ecological units. NatureServe has developed an Ecological System classification based "groups of plant communities that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients" (http://explorer.natureserve.org/classeco.htm). These systems include recognizable wetland types such as alpine-montane meadows, fens, and arid marshes that can be determined during site visits, but are usually not broadly mapped.

Wetland Condition Assessments

Definition of Wetland Condition

This project focuses on the ecological condition of montane wetlands. Ecological condition can be defined as "the ability of a wetland to support and maintain its complexity and capacity for self-organization with respect to species composition, physico-chemical characteristics, and functional processes as compared to wetlands of a similar type without human alterations" (Fennessy and others, 2007). Condition is often evaluated in terms of degree of deviation from what is known or expected to occur at sites without any anthropogenic alteration (i.e., reference sites). Condition assessments differ from functional assessments in that the latter specifically focus on the functional aspect of condition, such as the ability of a wetland to attenuate flood waters or provide wildlife habitat, without regard to the overall naturalness of a site.

Environmental Protection Agency Framework

The U.S. 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 (GIS) and remotely sensed data to evaluate the abundance, distribution, and surrounding land use of wetlands. 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 and can miss important data that is not available spatially (such as grazing intensity). Level II 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 analyses and often rely primarily on qualitative evaluation. Level II 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 III 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 III 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. This project collected data at all three EPA-defined levels using a landscape analysis, rapid assessment, and quantitative plant community evaluation.

A wetland condition score ideally is calibrated to accurately reflect the degree to which important components of a wetland have been affected by stressors and unnatural processes. Accordingly, we can evaluate the relationship between wetland condition scores and information on nearby stressors or landscape modifications in order to gauge the degree to which scores are capturing that stressor information. Wetland condition can also be affected by historical stressors that are no longer evident on the landscape and by stressors that are not readily apparent to observers. Plant community composition data can potentially provide insight into otherwise invisible processes that have affected wetlands because plant composition can be indicative of both past and on-going disturbances such as hydrological alterations, sedimentation, vegetation removal, nutrient enrichment, and physical disturbance (Rocchio and Crawford, 2013). For this project, we use Level I stressor data and Level III landscape data to determine the responsiveness of URAP.

Background on Assessment Methods

Level I, Landscape Analysis

Landscape analyses are important tools for assessing wetland condition. They can be used to explore relationships between field observations and landscape stressors and are an efficient means to categorize the potential condition of wetlands in a large area, which can aid in identification of reference sites or sites to target for restoration projects. For this project, we calculated landscape variables in GIS to explore the relationship between landscape features and site measure of wetland condition.

Level II, Rapid Assessment Methods

Rapid condition assessment surveys were undertaken using URAP (Menuz and others, 2014). URAP was developed by the UGS in early 2014 after field surveys were undertaken to compare three different rapid assessment approaches, including the Utah Wetlands Ambient Assessment Method (Hoven and Paul, 2010), a protocol used by the EPA as part of the 2011 National Wetland Condition Assessment (www.epa.gov/wetlands/survey), and a protocol used by the Colorado Natural Heritage Program based on the Ecological Integrity Assessment developed by NatureServe (Faber-Langendoen and others, 2008). A draft form of URAP was concurrently tested for this project and for an EPA-funded project in the Weber watershed (USGS 6-digit HUC 160202). Data from both projects were used to calibrate URAP, though details of protocol calibration will only be discussed in the EPA project report, which will be complete in spring 2016. Data summarization and analytical techniques presented in this report result from the calibration work conducted on both sets of data.

The core of URAP is a series of metrics designed to allow surveyors to quickly evaluate important and visibly apparent features of wetland condition. Additional data collected at sites include a soil profile, observations of stressors observed at and surrounding the survey site, and cover of structural (e.g., woody debris, boulders, seeps, etc.) and ground cover (e.g., litter, bare ground, algae) features. The core metrics are divided into the following categories:

1. **Landscape context:** Ability of surrounding landscape to buffer wetland from adjacent stressors and provide intact habitat for species.
2. **Hydrologic condition:** Degree of hydrologic functioning related to connectivity to adjacent areas, hydroperiod, timing of inundation, and evidence of water quality degradation.
3. **Physical structure:** Degree to which the physical structure has been disturbed as evidenced by soil and substrate alteration.
4. **Vegetation structure:** Presence of structural vegetation components, including horizontal interspersion and natural woody and herbaceous litter accumulation.
5. **Plant species composition:** Intactness of plant community based on presence and abundance of desirable and undesirable species.

Wetland condition metrics can be evaluated on their own, summarized by category, or summarized together to produce an overall condition score. Numeric scores can be converted to categories or ranks to ease interpretation. We use the letter grades A through D to denote wetland condition ranging from pristine or reference condition to severely altered wetlands that may have little conservation value and be extremely difficult to restore (table 1). Categories and descriptions of metrics used in URAP are shown in table 2.

Level III, Floristic Quality Assessment

Plant community composition data were appropriate to assess the severity of recent and ongoing stress to a wetland because plants species are relatively easy to observe in the field during a single site visit (compared to animal species) and because composition is likely to be due to a combination of recent past and current condition. A number of Floristic Quality Assessment (FQA) metrics have been used to aggregate compositional data into simpler indicators, many of which use coefficient of conservatism values, referred to as C-values (Rocchio, 2007; Rocchio and Crawford, 2013). C-values are assigned to species based on best professional judgment, literature review, or field observations. Values are assigned to species based on their association with disturbance; near 1 indicates almost always at disturbed sites, near 10 indicates almost always at pristine sites, and 5 indicates equally at either. The value of 0 is reserved for non-native species. C-values from all species present at a site can then be summarized in a variety of ways to estimate site integrity. We use several FQA metrics for our Level III assessment, shown in table 3. The simplest measure is simply the mean of the C-values for all species found at a site (Mean C). Cover-weighted Mean C is similar, but weights the C-value for each species by that species' cover at the site. Floristic Quality Index (FQI) metrics adjust Mean C or cover-weighted Mean C by the total number of species at a site, so a site with more species will have a higher score than a site with less species if all other site aspects are similar. Adjusted FQI metrics adjust Mean C based on the ratio of the number of all native species to the number of species. All of these measures besides adjusted FQI can be calculated from data for all species or data just for native species.

Table 1. *Definition of assessment ranks and associated point values used for scoring Utah Rapid Assessment Procedure. Definitions are taken from Lemly and others (2013).*

Rank	Score	Definition
A	5	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	4	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	3	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	1	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.

METHODS

Study Area

The study area for this project is three Rangeland Management Units for the Forest Service: Middle Fork (ID00403), East Fork Blacks Fork (ID00401), and Red Castle (ID00514) (figure 1). This area is approximately 218 km^2 and about 75% is within the High Uintas Wilderness Area. Approximately 5.3 km of road exists along the edges of the study area and motorized vehicle use is prohibited in the Wilderness Area. The trail system includes 24.9 km of minimally developed, 67.8 km of moderately developed, and 9.5 km of developed trail. Elevation in the area ranges from approximately 2700 to 4000 meters, and the highest of the mapped wetlands are found at around 3500 m. The study area includes wetlands within the following 12 digit HUCs: West Fork Blacks Fork (140401070101), East Fork Blacks Fork (140401070102), East Fork Smiths Fork (140401070201), and West Fork Smiths Fork (140401070203). The mean annual precipitation for the area from 1984 to 2013 is 912 mm, and temperatures are as low as -16.7°C in the winter and as high as 18.5°C in the summer. The area contains three Level IV ecoregions (Omernik, 1987), including 19a Alpine Zone (57%), 19b Uinta Subalpine Forests (40%), and 19c Mid-Elevation Uinta Mountains (3%).

Study Design

The target population for this study was jurisdictional wetlands as defined by the USACE. Because we have no mapped layer that shows these wetlands, we used a layer of wetlands mapped by the Forest Service as our sample frame. These wetlands were mapped by the Forest Service hydrologist in 2006 and 2007 using 2004 imagery and loosely using mapping guidelines established by Cowardin and others (1979) with more focus on wetland vegetation and landform than hydrology and soil indicators. The Forest Service mapped 206 polygons in the study area that were all classified as palustrine and had a total area of 843.7 ha. The majority of wetlands were classified as scrub-shrub, and only 6.4% and 2.5% were classified as emergent and unconsolidated bottom, respectively. For the sake of comparison, current NWI data for the study area contains 1605 palustrine wetland polygons covering 1362.9 ha, as well as 148.0 ha mapped as lacustrine or riverine, though some of these latter polygons may represent deepwater habitat instead of wetlands.

We used the spsurvey package (Kincaid and Olsen, 2012) in R 3.0.0 statistical software (R Core Development Team, 2013) to select survey sites using a Generalized Random Tessellation Stratified (GRTS) survey design. GRTS is a statistical method to select random sample locations that are spatially balanced and ordered so that any consecutive sets of sample points are spatially balanced (Stevens and Olsen, 2004). We used an unstratified, equal probability area design to select survey points. Survey points were placed randomly across all mapped wetlands, all wetlands were treated as a single unit, and all areas were equally likely to receive a survey point. We selected points instead of individual wetland polygons as the basis of our survey because URAP evaluates fixed area plots rather than whole wetlands and due to limitations in the

Table 2. *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	Percent 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]	Percent 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)
Connectivity–Whole Wetland Edge	Hydrologic connection between wetland edge and surrounding landscape
Hydrologic Condition	
Hydroperiod[2]	Naturalness of wetland inundation frequency and duration
Timing of Inundation[2]	Naturalness of timing of inundation to wetlands
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–AA Edge	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.

[2]Evaluated with respect to similar wetlands within hydrogeomorphic class.

[3]Only evaluated when water is present at sites.

[4]Only included in scoring for some Ecological Systems.

[5]Evaluted with respect to similar wetlands within Ecological System.

[6]Only evaluated when woody debris and/or woody species are expected at sites.

accuracy of the mapped data. We selected a total of 30 sample points and an additional 20 oversample points to be used if the main sample points had to be removed for any reason (no suitable wetland at sample point, wetland inaccessible, etc.).

Field Methods

Training

Field crews usually consisted of two teams of two surveyors. In each team, one surveyor had one previous season of field experience conducting condition assessments of Utah wetlands and had completed a wetland delineation training course. All surveyors received field training on URAP in June 2014, which consisted of working through the field protocol as a group at several sites and talking through difficult metrics. Surveyors were also shown photographs of sites that had received A, B, C, and D ratings in some metrics, such as algae growth, litter accumulation, and substrate and soil disturbance, so they could better understand the range of conditions they could encounter. One surveyor per team was responsible for collecting plant community composition data. These individuals were given additional training on plant identification resources, proper plant collection techniques, and plant cover estimation. The second surveyor on each team was responsible for collecting soil profile data. These individuals were given additional training on collecting soil profile data. Before conducting surveys for this project, all surveyors had completed at least 15 surveys using URAP at other sites.

Wetland Determination

We collected geospatial data on wetland boundaries by creating linear tracks in GPS units. While both the USACE and NWI require most wetlands to have hydrophytic plants, wet-

Table 3. *Floristic Quality Assessment metrics used to analyze plant community composition data.* C_x *and* Cov_x *refer to the C-value and cover estimate for species x, where species x is a single species in the set of all species (x∈all), all native species (x∈native), all non-native species (x∈non-native), or all designated noxious species (x∈noxious).* N_{all} *and* N_{native} *refer to the total number of all species and all native species, respectively, per site. Only species with known nativity are used in calculations; only species with known C-values are used in calculations that make use of C-values. Formulas are adopted from Rocchio (2007).*

Abbreviation	**Description**	**Formula**
Species Richness	Number of unique species	N_{all}
Pct. Non-native	Percent of all recorded species of known nativity that are introduced	$N_{Native} \div N_{all}$
Abs. Cover Non-native	Absolute cover of non-native species	$\sum_{x\in non\text{-}native} Cov_x$
Abs. Cover Noxious	Absolute cover of noxious weeds	$\sum_{x\in noxious} Cov_x$
Rel. Pct. Native Cover	Percent cover of all native species divided by the total cover of all recorded species with known nativity	$\sum_{x\in native} Cov_x \div \sum_{x\in all} Cov_x$
Mean C	Mean C value across all species	$\sum_{x\in all} C_x \div N_{all}$
Native Mean C	Mean C value across all native species	$\sum_{x\in native} C_x \div N_{Native}$
Max C	Highest C value across all recorded species	$Max_{x\in all}(C_x)$
CW Mean C	Mean C adjusted by the cover of each species	$\sum_{x\in all} (C_x * Cov_x) \div \sum_{x\in all} Cov_x$
Native CW Mean C	Native Mean C adjusted by the cover of each native species	$\sum_{x\in native} (C_x * Cov_x) \div \sum_{x\in native} Cov_x$
FQI	Mean C adjusted so that otherwise similar sites with more total species score higher	$Mean\ C * \sqrt{N_{all}}$
Native FQI	Native Mean C adjusted so that otherwise similar sites with more native species score higher	$Native\ Mean\ C * \sqrt{N_{Native}}$
CW FQI	CW Mean C adjusted so that otherwise similar sites with more total species score higher	$CW\ Mean\ C * \sqrt{N_{all}}$
Native CW FQI	Native CW Mean C adjusted so that otherwise similar sites with more native species score higher	$Native\ CW\ Mean\ C * \sqrt{N_{Native}}$
Adj. FQI	Mean C adjusted so that otherwise similar sites with a higher proportion of native species compared to total species score higher	$\left(\frac{Mean\ C}{10} * \frac{\sqrt{N_{Native}}}{\sqrt{N_{all}}}\right) * 100$

land hydrology, and hydric soils, only the USACE specifies exactly how those indicators can be determined in the field and specifically defines how long an area must be wet to be considered wetland. We sometimes differentiated between areas that met the specific USACE wetland definition and areas that may be considered wetland under the potentially broader NWI definition. We therefore collected boundary data between USACE wetland and NWI wetland, USACE wetland and upland, and NWI wetland and upland. In some cases, we did not specify whether a boundary separated USACE wetland from upland or from potential NWI wetland.

Approximate boundaries were determined based on a combination of best professional judgment and easily observed indicators in the field related to hydrology, hydric soils, and hydrophytic plants, based on indicators listed in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region, Version 2.0* (U.S. Army Corps of Engineers, 2010). We generally started by looking for obvious breaks in topography and obvious shifts in plant communities and then used a soil auger on either side of the break to look for hydric soils and wetland hydrology indicators. For wetland hydrology, we frequently looked for saturation (indicator A3), which requires saturated soil within 30 cm of the soil surface, with a water table immediately below, by auguring to a depth of at least 30 cm along a potential boundary. We also sometimes used hydrogen sulfide odor (C1), oxidized rhizopheres along living roots (C3), or a combination of the secondary indicators geomorphic position (D2) and FAC-neutral test (D5), to assess wetland hydrology. We generally did not have time to complete full soil profiles at multiple locations per site, but used augered soil cores to look for easily observed features such as organic layers, depletions, gleying, and redox features. We also did not have time to identify all plant species along edges or make cover estimates, but we did nonetheless determine wetland indicator ratings of species we considered probable dominants. *Due to the limitations listed above as well as gen-*

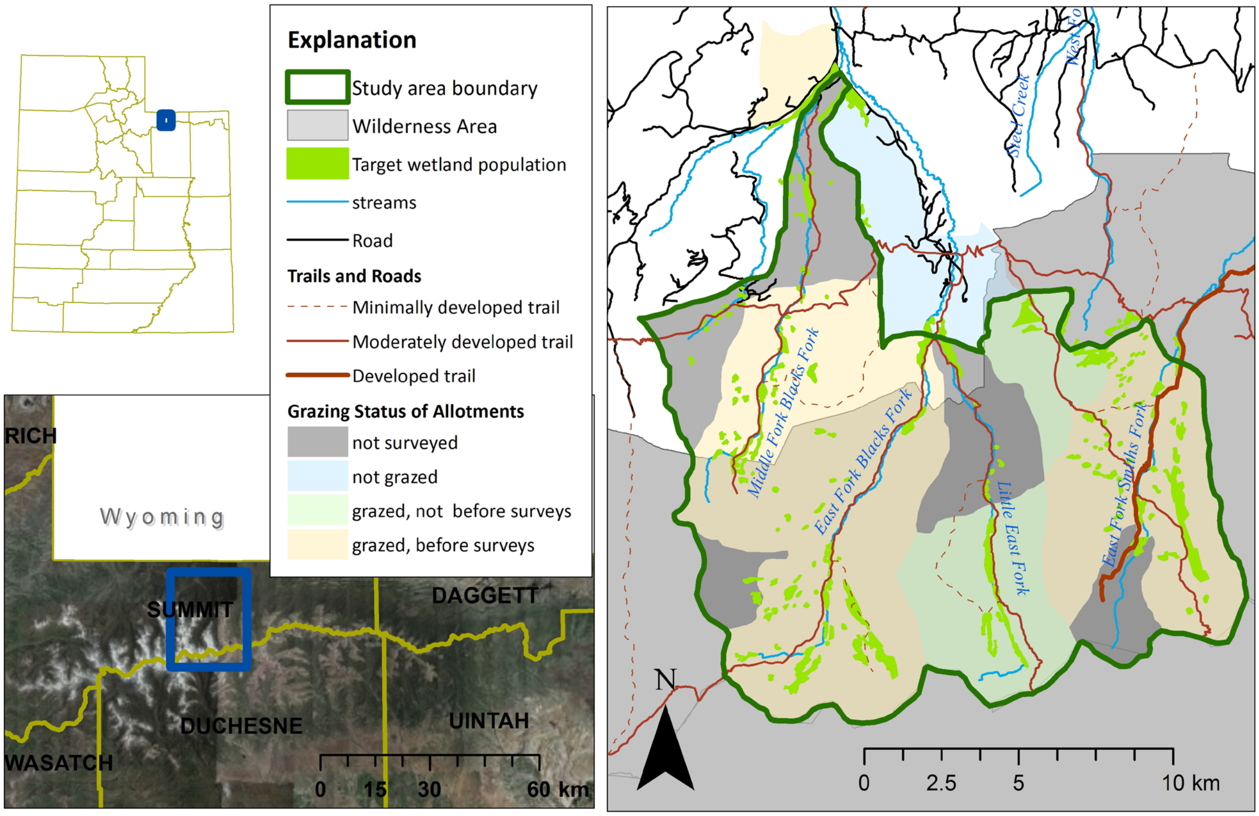

Figure 1. *Study area and target wetland population on the north slope of the Uinta-Wasatch-Cache National Forest.*

*eral time constraints, wetland boundaries should **not** be considered exact regulatory USACE boundaries without further verification.* In this report, we refer to wetlands that appeared to meet USACE jurisdictional requirements during the rapid field delineation as USACE wetlands.

Establishment of Assessment Area

For URAP, wetland data is collected within a set assessment area (AA), rather than across an entire wetland, in order to increase comparability between individual sites and decrease disagreement on determining individual wetland boundaries. Whenever possible, AAs are 40-m-radius circular survey units centered on the randomly selected sample point. To avoid inclusion of non-target areas, AAs can also be 40-m-radius units with shifted centers or rectangular or free form units as long as they are between 0.1 and 0.5 ha in area. For this project, we shifted or reshaped AAs to ensure that they contained at least 90% USACE wetland.

Rapid Assessment Metrics and Stressor Data

We collected wetland condition data using the metrics described in *Utah Rapid Assessment Procedure: Method for Evaluating Ecological Integrity in Utah Wetlands—User's Manual, Version 1.0—Draft* (appendix A, Menuz and others, 2014). Metrics are divided into five categories, including landscape context, hydrologic condition, physical structure, vegetation structure, and plant species composition, as described above and shown in table 2. Plant species composition metrics were calculated in the office using plant community data collected in the field. For the other metrics, surveyors used maps and information obtained from walking around AAs and AA buffers to score each metric according to the observed condition. Photos and notes were frequently taken in order to better capture condition, especially when sites were difficult to evaluate.

Data on stressors observed in the field were also collected. Stressor data included information about features within 200 m of each AA as well as features within the AA itself. For each stressor present, we recorded the extent of the evaluated area where the stressor was present as well as the degree of severity as one of three qualitative categories (low, moderate, high). We evaluated buffer stressor severity in specific categories, including general severity, hydroperiod, water contaminants, sedimentation, and vegetation stress. For example, a highway downstream from a wetland is more likely to affect the wetland's hydroperiod than water contaminants due to the position in the landscape.

Additional Site Data

We collected data for two metrics auxiliary to the main URAP metrics that were related to the types of structural patches (snags, channels, beaver dams, animal tracks, seeps, floating mats, etc.) and amount of topographic complexity present at sites. We also collected percent cover data on ground cover (bare ground, litter, surface water, etc.) and vertical strata (presence and overlap of plant layers). All of this supplemental data can be used to make generalizations about expected features within specific wetland classes or to better understand habitat or other functional characteristics of wetlands, though the data were not analyzed for this report. Plant community data were collected by spending no more than one hour walking the AA to record an estimate of percent cover, species height class, and phenological state for every plant species found. Unknown plant specimens were collected in the field for later identification. Plant community data were used to calculate two URAP metrics and also FQA values.

Surveyors dug at least one soil pit at a representative location within the dominant vegetation type at the site and sometimes an additional pit if there was more than one dominant vegetation type or if no hydric soil indicators were found in the first pit. Soil pits were dug to 0.5 m or more in depth whenever possible. For each soil layer, surveyors recorded the layer depth, the color of the matrix and any dominant and secondary redox features (based on a Munsell Soil Color Chart), soil texture, and percent of coarse material (>2mm). Hydric soil indicators were recorded using *Field Indicators of Hydric Soils in the United States* (U.S. Natural Resources Conservation Service, 2010) and *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region, Version 2.0* (U.S. Army Corps of Engineers, 2010). Water chemistry data were taken with handheld meters from Hanna Instruments (HI98129) within the soil pit and at one or more surface water locations when water was available. Water chemistry data included information on pH, electroconductivity (EC), and temperature of the water sample.

Calculation of Landscape Data

We calculated 30-year (1984–2013) water year (October 1 to September 30) mean maximum, minimum, and mean temperature and mean daily precipitation data using PRISM Climate Group Data (Daly and others, 2008). We calculated site elevation using a 10-m resolution digital elevation model (http://gis.utah.gov/data/elevation-terrain-data). We calculated distance to the nearest trail and distance to the nearest road using road and trail geospatial data obtained from the Forest Service (http://www.fs.usda.gov/detail/uwcnf/landmanagement/gis, obtained December 18, 2014). We also looked at distances to trails within individual classes, including minimally and moderately developed trails and developed trails. Only one trail in the area was considered highly developed. Since this trail functions as a road in the summer and snowmobile trail in the winter, we only considered the feature a road and not a trail. We determined whether land was wilderness or non-wilderness using a statewide ownership layer from AGRC (http://gis.utah.gov/data/sgid-cadastre/land-ownership).

We were not able to obtain compiled data on grazing history within our project area. Grazing instructions from 2014 may represent similar numbers of animals grazed per allotment in recent years, though not necessarily following the same subunit rotation order or grazing dates (R. Schuler, U.S. Forest Service, written communication, 2015). We compared 2014 and 2015 grazing instructions and found that the number of authorized sheep per allotment and the planned number of grazing days per allotment subunit did not change between years, except that one of the four grazing allotments within our study area had no planned grazing in 2015. We used data from the 2014 annual operating instructions (http://www.fs.usda.gov/resources/uwcnf/landmanagement/resourcemanagement to calculate the planned number of grazing days in each subunit, which we multiplied by the number of sheep to indicate overall sheep-days. Grazing may occur as sheep move through the subunit and in areas where animals bed, though sheep are only allowed to bed in the same area for one night. We divided the sheep-days by the subunit size based on the assumption that the likelihood of a location within a subunit being grazed in a given year is higher if a subunit is smaller with more sheep-days. This calculation ignores the possibility that grazing may be concentrated in particularly favorable grazing areas and that some subunits may have more or less of these preferred areas. For each site, we calculated two grazing measures based on the 2014 operating instructions, number of planned sheep-days per subunit area, and number of planned sheep-days per subunit area that were supposed to have occurred before a particular site was surveyed. In this report, we refer to these measures as sheep-days and prior sheep-days, respectively, for the sake of simplicity.

Analysis of Mapped Data

We created a polygon feature for each site in ArcGIS to represent the analytical area within which we could compare wetlands mapped by NWI, the Forest Service, and the UGS (appendix B). These analytical areas were either approximately 4.7 ha or 18.8 ha, depending on the size of the originally mapped wetlands and the amount of information we had available to help us determine wetland boundaries. We used the linear wetland determination features described under *Section 2.3.2 Wetland Determination*, the boundary of the AA, and field notes to guide us in creating a new boundary representing the likely USACE wetland boundary. We then clipped the new boundary, NWI boundary, and the Forest Service boundary to the analytical area polygon to compare the total mapped wetland area. *An important note is that a considerable amount of office judgment had to be used to create the new wetland boundary since field data were rarely complete, so the new boundary* ***does not*** *represent a field-determined USACE delineation*. We compared the results of the three mapping methods using paired t-tests in R 3.0.0 (R Core Development Team, 2013) to determine whether there were any consistent differences in the amount of area mapped as wetland (i.e., whether a method consistently showed more or less wetland area).

We also compared Cowardin classifications applied to wetlands by NWI, the Forest Service, and the UGS. Wetland classification data from the UGS only included information within the AA, not the surrounding wetland area. We therefore clipped NWI and Forest Service data to the boundary of the AA. Each AA only had a single Cowardin class applied to by the UGS and the Forest Service. However, the UGS's field data also had information on major plant zones present within the AA. We used information about the dominant species in each zone to determine the percent of each AA that was emergent, scrub-shrub, forested, or other (including channel or upland).

Analysis of Field Condition Data

Rapid Assessment and Stressor Results

A draft version of URAP was used for this project and for an EPA-funded project in the Weber watershed in the summer of 2014. The draft version did not have a finalized method for creating category and overall site scores. Data exploration was conducted to test different scoring methods, generally by comparing the results of scoring methods with the strength of correlations with site stressors and FQA metrics. Data exploration sometimes included data from both projects, sometimes data only from the Weber project, and sometimes a subset of data from the Forest Service project. The entire dataset from the Forest Service project was not always used in order to avoid creating scoring methods more applicable to only the Forest Service sites (high elevation, low stress, certain Ecological Systems) rather than all sites overall. A full discussion of data exploration will be written up in the report for the Weber watershed; this report makes use of the final data calculation methods determined by that work. While the method of calculating an overall site score should be considered final for this version of URAP, the method is likely to be slightly adjusted in the next few years as additional data from a broader variety of sites are collected.

Metric ranks are converted to scores in the following manner: A = 5, A- = 4.5, B = 4, C = 3, C- = 2, D = 1. Ranks of AB were also scored as 5 points. The mean value across all metrics within a category is generally the overall category score. However, the buffer percent, width, soil condition, and vegetation condition scores are combined to produce a single buffer score using the following equation:

$$\text{overallBuffer}=(\text{percentBuffer}*\text{bufferWidth})^{0.5}*([\text{bufferConditionSoil}+\text{bufferConditionVeg}]/2)^{0.5}$$

Buffers were evaluated in the field to 200 m, but buffer width was only analyzed up to a maximum width of 100 m. The algae growth metric was evaluated separately for algae in water and dried algae, but only the wet algae metric was used for calculating the overall algae score for this project. If a particular metric is missing from a site (e.g., due to lack of woody vegetation or lack of water), the mean values are calculated across only those metrics that were scored. An overall URAP score is obtained by taking the mean of all category scores. Mean values of ≥4.5, ≥3.5, and ≥2.5 are used as the cut-offs between A, B, C, and D sites, respectively, for category and overall score ranks.

Characterization of Wetland Vegetation

Plant species that were not identified in the field were pressed in newspaper, brought to the office, and dried in a drying oven set to approximately 38°C for at least 24 hours. We used a dissecting microscope, standard set of plant dissection tools, and several plant treatments to aid with identification, including *A Utah Flora* (Welsh and others, 2003), all volumes of the *Intermountain Flora* series (see introductory volume, Cronquist and others, 1972), V*ascular Plants of Northern Utah* (Shaw and others, 1989), *Field Guide to Intermountain Sedges* (Hurd and others, 1998), and *Flora of North America* (http://floranorthamerica.org). Specimens that were particularly difficult to identify were taken to Utah State University's Intermountain Herbarium for comparison with known specimens and for consultation with herbarium staff.

Plant community composition data from this study are a first step towards better understanding the distribution of wetland plant species and their relationship to different wetland and landscape conditions. We provide summary information on the distribution and abundance within our study area of common plant species and species of management concern. We also calculated FQA values for all sites, which rely on C-values as explained above. Ideally, C-values are developed for individual states or regions to capture the regional variability in how species respond to disturbance. However, the development of state-specific C-values requires substantial time and effort from a panel of experts and is ideally supported by qualitative field data that spans the whole area of interest across a broad range of conditions. There are no C-values currently developed for the state of Utah. We instead contacted botanists and wetland scientists in surrounding states to determine which states had assigned C-values to species. We received C-value lists from Colorado (Rocchio, 2007), Montana (Jones, 2005), and Idaho (C-values used by the state of Idaho are from values developed for eastern Washington's Columbia Basin region [Rocchio and Crawford, 2013]). We assigned Utah species the average C-value of the three states' lists. We then made sure that every non-native species, and no native species, had a C-value of 0. Seven species with a total of 17 occurrences were not assigned C-values and, of these, one occurrence had 2% cover and the remaining had less than 1% cover. We used cut-offs between Mean C values presented in Colorado Natural Heritage Program's draft field manual (Lemly and Gilligan, 2013) to evaluate degree to which plant communities exhibited "expected" values, keeping into consideration that these cut-offs were developed for Colorado's wetlands, not Utah's. In the Colorado manual, values of Mean C greater than 6.0

indicate A condition and greater than 5.5 indicate B condition. For riparian areas and fens, greater than 5.0 indicates C condition and greater than 4.5 indicates C- condition, whereas for wet meadows, greater than 4.0 indicates C condition and greater than 3.0 indicates C- condition.

We used non-metric multidimensional scaling (NMDS) with the R package vegan package (Oksanen and others, 2013) to explore plant community composition data. NMDS can be used to reduce complex multivariate data, such as plant abundance values, to a few primary axes that describe most of the variation found among sites. Axes can then be overlain with vectors showing the strength (represented by vector length) and direction (represented by vector orientation) of correlation between environmental variables of interest and species composition data. We used the wrapper function metaMDS within the R package vegan to transform and standardize data, calculate a dissimilarity matrix using Bray-Curtis distance, run NMDS multiple times with random starts to avoid local optima, and rotate the axes of the final configuration so that the variance of points was maximized on the first dimension. Plant abundance data were transformed using a Wisconsin-style double standardization where taxa are normalized to percent abundance, and then abundances are normalized to the maximum for each species. Species that occurred at only one site and most species only identified to genus were dropped from analysis. We determined the appropriate number of axes to use by obtaining stress values for ten replicate NMDS runs for each number of dimensions between one and four. We set the maximum number of random starts for each run at 500. For the final number of dimensions, we selected the lowest number of axes that had a stress value ≤0.20, based on rules of thumb for the threshold of usable results (McCune and Grace, 2002).

We fit site attribute data to the species NMDS axes using the envfit function in the R package vegan. The attribute data included overall and categorical URAP site scores, AA area, and summarized site buffer and AA stressor data. We calculated buffer stressor as extent (as the midpoint of the extent class standardized between 0 and 1) multiplied by general severity (where low=1, medium=2, and high=4). We calculated AA stress in the same manner except that we first took the maximal value of all stress related to livestock grazing, whether recorded as stress to vegetation, hydroperiod, or physical, to avoid counting the same stressor multiple times. We also included the variables distance to the nearest road, distance to the nearest trail, sheep-days, and prior sheep-days. Because temperature, precipitation, and elevation data were all highly correlated, we reduced these variables to uncorrelated axes using principal components analysis (PCA) with the princomp function in the R base package. We used the first axes in the analysis, which captured over 80% of the variation in the data, as an environment vector in the NMDS. We analyzed four categorical variables, including Ecological System (coded as meadow, fen, or shrubland), hydrogeomorphic class (either riverine or slope), presence within wilderness area, and HUC12 membership. We tested the strength of evidence for each site attribute variable and each species using 10000 permutations in envfit.

Extrapolation of Study Results

We used the R package spsurvey to estimate the extent of the USFS mapped wetlands that were indeed wetland using the cat.analysis function. Original design weights did not need to be adjusted because all of the original 30 study sites were evaluated, including one site that was not visited due to remoteness and one site that was non-target. Estimates were made for extent of surveyed wetland, extent of non-target mapped wetland, and extent unknown (i.e., site not visited). We also used the cat.analysis function to estimate the percent of total wetland area in each overall URAP wetland condition category. Last, we used the cat.analysis function to estimate the percent of wetlands in different floristic quality categories based on thresholds for Mean C adapted from Colorado as described above. For all sites regardless of Ecological System, we considered values greater than 6 to be A, greater than 5.5 to be B, and all other sites to be C.

Relationships Among Levels and Landscape Data

Correlations Among Levels

We conducted a preliminary analysis of the relationships between stressors and wetland condition, stressors and FQA metrics, and FQA metrics and wetland condition by examining Pearson correlations between variables (Stein and others, 2009). Our assumptions are that stressors affect both wetland condition and wetland vegetation and that true wetland condition affects wetland vegetation. Plant community composition is assumed to be an accurate indicator of wetland condition and can be used to help calibrate condition scores. Correlation analysis cannot provide information about cause and effect, but can provide insight into the degree to which stressors, plant community composition, and wetland condition are interrelated. Analysis is somewhat circular, since, for example, metrics in the landscape category are heavily influenced by observations of stressors in the buffer, and plant community composition data were a component of wetland condition scores. Nonetheless, this comparison can provide a check to determine whether wetland condition scores are sensitive to a gradient of stressors on the landscape or FQA metrics.

We calculated Pearson correlations between overall URAP site scores, URAP category scores, FQA metrics, and summarized site stressor data. We explored several ways to summarize stressor data to the AA, to the buffer, and overall. We did this exploration separately from exploration with the Weber data because the Uinta sites had so few overall stressors. For all calculations, the severity categories of low, moderate, and high were scored as one, two, and four points, respectively. For calculations that included stressor extent, extent classes were converted to the midpoint of the cover class and then normalized to between 0 and 1. Impacts from livestock grazing within AAs were measured separately for stress to hydroperiod, stress to vegetation, and stress to physical structure. We created some AA stressor summaries that took the maximum value of these three measures to determine whether we were overweighting grazing impacts by counting them in three different ways. We calculated the following metrics:

1. *All buffer stressors–severity only*: Added severity values for buffer stressors per site.
2. *All buffer stressors*: Multiplied severity by extent for buffer stressors and then summed all results per site.
3. *All buffer stressors–roads weighted*: Multiplied severity by extent for buffer stressors, then multiplied resulting score by 3 *only* for stressor of "Gravel Road", and then summed all results per site. Calculation was based on the assumption that roads were much more severe of a stressor than any others recorded in the study.
4. *All AA stressors individual*: Multiplied severity by extent for AA stressors and then summed all results per site.
5. *All AA stressors–3 combined*: Multiplied severity by extent for AA stressors, selected the maximum value of the hydroperiod, physical structure, and vegetation measures of domesticated grazing impacts, and then added that value to all other AA stressor values per site.
6. *All AA stressors–2 combined*: Multiplied severity by extent for AA stressors, selected the maximum value of the hydroperiod and physical structure measures of domesticated grazing impacts, and then added that value to all other AA stressor values per site.

We added AA and buffer stressor values together to create a final overall stress score. We tested all possible unique combinations of summarized AA and summarized buffer data and sometimes doubled either the AA or the buffer values to create weighted overall scores. We determined the most appropriate stressor summary methods through evaluation of the strength of correlation between the summarized stressor values and URAP and FQA values.

Regression Model Analysis

We used linear regression to model the relationship between landscape data and, as response variables, overall site scores and FQA metrics. We created 44 competing models using different combinations of sheep-days, prior sheep-days, distance to the nearest road, distance to the nearest trail, distance to the nearest road or trail, distance to the nearest highly developed trail, distance to the nearest moderately developed trail, distance to the nearest moderate or highly developed trail, and land type (whether or not a site was located in wilderness). Models had up to four predictor variables and were constructed using the following rules: 1) sheep-days and prior sheep-days were never in the same model due to strong correlation, 2) land type and distance to the nearest road were never in the same model due to strong correlation, 3) distance to the nearest road or trail was not in any models that had other measures of distances to roads or trails, 4) distance to the nearest trail and distance to the nearest moderately or highly developed trail were never combined with any other distance to trail metrics, and 5) distance to moderately developed trail and distance to the nearest highly developed trail were always used in the same model. Models were assessed using Akaike's information criterion modified for small sample sizes (AICc), as is recommended when the ratio of samples to fitted parameters is less than 40 (Symonds and Moussallii, 2011). We report the selected parameters and direction of the relationship between parameters and the response variables for all models within 2 AICc of the top model (i.e., model with the lowest AICc). These models are all considered essentially equivalent; models between 4 and 6 AICc of the top model are also plausible (Symonds and Moussallii, 2011), but we chose to limit reporting due to the vast number of similar models within that range and due to our primary interest in understanding the direction of relationships rather than specific models. Models were created with the lm function in the R base package.

Comparison of Grazing Plans and Field Data

We evaluated whether URAP scoring and stressor evaluation differed between sites that may have been grazed by sheep before our field survey and those that should not have been grazed, based on the range annual operating instructions and field survey dates. We first converted prior-sheep days to 1 for sites potentially grazed before surveys and 0 for sites not planned on being grazed before surveys. We converted the URAP water quality and soil disturbance metrics to 1 (stress present) for sites that scored below A and 0 otherwise. Using field-recorded data on AA stressors, we calculated separate measures of livestock grazing stress to hydroperiod, physical structure, and vegetation by multiplying extent by severity as described above. We converted the result to 1 (stress present) when calculated values were at least 0.1 and 0 otherwise. The value of 0.1 is equal to at least 10% of the AA experiencing the stressor at low severity or at least 1% of the AA with moderate or higher severity of the stressor. We used a chi-square analysis to test for differences between prior sheep-days and each of the metrics and stressor categories listed above, using the function chisq.test in the R base package.

RESULTS

Sites Surveyed

General Attributes of Surveyed Sites

We visited a total of 29 survey sites, though one site was excluded due to lack of target wetlands. The excluded site had suitable hydrophytic vegetation but did not appear to have hydric soils or wetland hydrology, though assessment was hampered by rocky soil and a heavy rainstorm that made soil saturation difficult to determine. An additional site not visited in the field was excluded due to inaccessibility and time constraints; the site was located a considerable hiking distance from other sites. We conducted full URAP surveys at 28 sites visited between July 29 and August 21, 2014. Surveyed AAs included 18 40-m-radius circular, 8 freeform, and 2 rectangular plots and ranged in area from 3043 to 5371 m^2. Center points of the final AAs were moved between 3 and 128 m from the original sample points, and 9 of the 28 AAs contained the original sample point. Sites were classified as predominately slope (n=20) and riverine (n=8) HGM classes and palustrine emergent (n=12) or palustrine scrub-shrub (n=16) Cowardin classes with saturated (n=16), seasonally flooded/saturated (n=10), or seasonally flooded (n=2) water regimes. The majority of sites were Rocky Mountain Subalpine-Montane Riparian Shrubland (n=16), and six each were Rocky Mountain Alpine-Montane Wet Meadow and Rocky Mountain Subalpine-Montane Fen sites. Fen designations were made based on amount of accumulated organic matter in the soil, though NMDS analysis revealed that only one fen site had vegetation distinctive from wet meadow sites.

Observed Wetland Indicators

Hydrophytic vegetation, wetland hydrology, and hydric soil indicators were preliminarily evaluated in the field, but final determination of indicators present at each site occurred through evaluation of field data in the office. We took a cautious approach in calculating plant dominance values; if species were missing wetland indicator values, we generally assumed that they were upland species. Even with this precaution, all 28 sites passed the USACE dominance test for hydrophytic vegetation.

We used data collected on cover of water, plant species, and algae mats and in soil pits to evaluate sites for wetland hydrology indicators. We checked sites for inundation on aerial imagery (B7), oxidized rhizospheres (C3) and geomorphic position (D2) using soil core and GIS data only if the sites did not already meet wetland hydrology requirements, though D2 was sometimes also recorded in the field. We did not evaluate sites for shallow aquitard (D3) or saturation on aerial imagery (C9). All sites had indictors of wetland hydrology present. The FAC-neutral test (n=27), soil pit saturation (n=26), and high water table (n=18) were the most common indicators present (table 4). Sites had a mean of 2.0 primary indicators and 1.4 secondary indicators; one site had only secondary indicators present.

Out of 35 soil pits, all but six had hydric soil indicators present. Histosols (A1) and depleted matrix (F3), each found at 12 sites, were the most common indicators (table 5). No hydric indicators were present at five sites where only one soil pit was dug, though pits at all of these sites appeared saturated at the soil surface and three had a water table within 30 cm of the soil surface. Lack of hydric soils in pits at sites does not necessarily indicate that sites were not USACE wetlands. Soils sometimes need to be dried to a moist condition before redox features can be seen. Soil drying was difficult to impossible at many sites due to frequent rain showers. Furthermore, soil pits were typically dug within the AA, while the regional supplement states that, because hydric soil indicators were developed to determine wetland boundaries, indicators may not always work in wetter interior portions of a wetland (U.S. Army Corps of Engineers, 2010). The supplement states that the interior of a wetland should be assumed to have hydric soils if hydric soils are found on the wetland edge. As described above in *Section 2.3.3 Wetland Determination*, we used a cursory approach to evaluate soils, hydrology, and vegetation at the wetland edge before initiating the full survey.

Mapping Comparison Results

Mapping by the Forest Service resulted in the greatest amount of wetland area followed by mapping by NWI and then the UGS (table 6). Compared to the UGS's mapping, NWI mapped a mean of 6.2% more wetland area and the Forest Service mapped a mean of 13.1% more wetland area (paired t-test $p<0.001$ for both comparisons). Seven percent less wetland area was mapped by NWI than by the Forest Service ($p=0.02$).

The predominant Cowardin classes recorded by NWI, the UGS, and the Forest Service for all sites were emergent or scrub-shrub, except for one site recorded as unconsolidated bottom by the Forest Service. Agreement of the predominant Cowardin class was 71% between the UGS and NWI, 57% between the UGS and the Forest Service, and 43% between NWI and the Forest Service (table 7). Assuming that the UGS's field data represents the true values, NWI classified 85% of emergent sites and 60% of scrub-shrub correctly, whereas the Forest Service classified 8% of emergent and 100% of scrub-shrub sites correctly.

Most AAs contained more than one Cowardin class. Ten sites had 20% or more of both emergent and scrub-shrub wetland, according to field data from the UGS. Less than 10% of some AAs were classified by the UGS as forested (n=1), unvegetated channel (n=1), or upland (n=4). Data from NWI had less area mapped as a mixture of emergent and scrub-shrub, with only four sites with over 20% of each class. Parts of two sites were classified as aquatic bed and parts of one site as riverine unconsolidated bottom. Some AAs also had some area that was not mapped at all by NWI, indicating that they would likely be considered upland. Most AAs had little (<5%) to no area not mapped by NWI, but four sites had between 11 and 18% unmapped area and four sites had between 30 and 41% unmapped area.

Rapid Assessment Results

All sites received A or B scores for the majority of metrics, no sites received a score below C in any metrics, and only

Table 4. *Wetland hydrology indicators observed at sites. Indictors with names in italics were not uniformly evaluated across all sites and thus total number of sites with indicators is unknown. Secondary indicators are shaded grey; sites need two secondary or one primary indicator to have wetland hydrology. Indicators are from the U.S. Army Corps of Engineers (2010).*

Site ID	A1	A2	A3	B3	C1	C2	C3	D2	D5	Total
	Surface Water	High Water Table	Saturation	*Drift Deposits*	Hydrogen Sulfide Odor	Dry-Season Water Table	*Oxidized rhizospheres*	*Geomorphic Position*	FAC-Neutral Test	
UWC-01		X	X	*X*					X	**4**
UWC-02	X	X	X						X	**4**
UWC-03		X	X				*X*		X	**4**
UWC-04		X	X					*X*	X	**4**
UWC-05		X	X						X	**3**
UWC-06	X	X	X						X	**4**
UWC-07								*X*	X	**2**
UWC-08		X	X						X	**3**
UWC-09	X	X	X						X	**4**
UWC-10		X	X		X				X	**4**
UWC-11			X						X	**2**
UWC-12	X		X					*X*	X	**4**
UWC-13		X	X						X	**3**
UWC-14		X	X						X	**3**
UWC-15			X						X	**2**
UWC-16		X	X					*X*	X	**4**
UWC-18			X			X			X	**3**
UWC-19		X	X		X				X	**4**
UWC-20	X		X			X		*X*	X	**5**
UWC-22		X	X		X				X	**4**
UWC-23		X	X		X				X	**4**
UWC-24		X	X			X		*X*	X	**5**
UWC-25			X			X			X	**3**
UWC-26		X	X		X				X	**4**
UWC-27			X			X		*X*	X	**4**
UWC-28		X	X					*X*	X	**4**
UWC-29							X			**1**
UWC-30			X						X	**2**
Total	**5**	**18**	**26**		**5**	**5**			**27**	

one site received a C in any category score (table 8). One site received an overall score of B and the remaining sites scored as A (figure 2). Observed effects of livestock grazing was the main cause of sites receiving scores below A for several metrics, including both AA and buffer Soil and Substrate Disturbance and Water Quality. One site received a C in all three metrics and twenty sites received a B in at least one of the three metrics. Only two other metrics, relative cover of native species and horizontal interspersion, frequently had scores below A, whereas at least 25 sites were scored as A for each of the remaining metrics.

Stressors on the Landscape

Stressors Recorded in the Field

A mean of 1.8 and a maximum of 3 stressors were in the 200-m buffer surrounding each site, and three sites had no stressors recorded (sites UWC-05, UWC-09, and UWC-24). Rangeland was the most common stressor, recorded at 79% of sites, followed by cover of non-native species (36%), extensive tree herbivory (recorded for areas with beetle kill, 29%), and trails (21%) (table 9). A high severity stressor, extensive tree her-

Table 5. *Hydric soil indicators observed at sites. Number listed under each soil indicator is the number of soil pits at the site exhibiting that particular indicator. Total number of indicators is summed across all pits at each site. Indicators are from the U.S. Army Corps of Engineers (2010).*

Site ID	Number of pits	Number of pits with indicators present	A1	A2	A4	A11	F1	F2	F3	F6	TF2	Totals Indicators
			Histosol	Histic Epipedon	Hydrogen Sulfide	Depleted Below Dark Surface	Loamy Mucky Mineral	Loamy Gleyed Matrix	Depleted Matrix	Redox Dark Surface	Red Parent Material	
UWC-01	2	2							1	1		**2**
UWC-02	1	1	1									**1**
UWC-03	2	2								1	1	**2**
UWC-04	1	1		1								**1**
UWC-05	1	1							1			**2**
UWC-06	2	2	1			1			1			**3**
UWC-07	1	1						1				**1**
UWC-08	1	0										**0**
UWC-09	2	2	2									**2**
UWC-10	2	2	2		2							**4**
UWC-11	1	0										**0**
UWC-12	1	1	1									**1**
UWC-13	1	1				1			1			**2**
UWC-14	1	1							1			**1**
UWC-15	1	1				1			1			**2**
UWC-16	1	0										**0**
UWC-18	2	1						1	1			**2**
UWC-19	1	1			1	1			1			**3**
UWC-20	1	0										**0**
UWC-22	1	1	1		1							**2**
UWC-23	2	1	2		1							**3**
UWC-24	1	1	1	1								**2**
UWC-25	1	1	1							1		**2**
UWC-26	1	1			1	1	1		1			**4**
UWC-27	1	1		1					1			**2**
UWC-28	1	0										**0**
UWC-29	1	1				1			1			**2**
UWC-30	1	1				1			1			**2**
Totals	**35**	**29**	**12**	**3**	**6**	**7**	**1**	**2**	**12**	**3**	**1**	

bivory, was only recorded at one site, and only five moderate severity stressors were recorded. On average, most stressors did not contribute heavily to hydroperiod, water contaminations, sedimentation, or vegetation stress, and the mean severity ratings in these categories were all 1.13 or below (with 1 equal to low severity).

We recorded stressors present directly in the AA in three categories: hydroperiod, vegetation, and physical structure stressors. We recorded stressors to hydroperiod at 13, physical structure at 16, and vegetation at 17 sites (table 10). Twelve sites had stressors recorded in all three categories, and eight sites had no stressors recorded. The mean number of stressors per site was 1.7, and a maximum of four stressors was recorded at one site. No stressors were of high severity, and 43 out of 48 recorded stressors were low severity. Livestock trampling and grazing affected hydroperiod (n=13), physical structure (n=16), and vegetation (n=15) and was by far the most common stressor with the broadest extent of impact within the sites. Sites at higher elevations in the watershed tended to have more grazing stress recorded than lower sites (figure 2).

Potential Stressors Captured in Landscape Data

Twenty-one of 28 sites were located in the High Uinta Wilderness Area. Sites were located in 13 unique grazing allotment subunits except for two sites located outside the grazing allotments. Most subunits had one or two sites, though one

Table 6. *Comparison of mapped wetland data classification and area. Classifications are for dominant Cowardin classes, including scrub-shrub (SS), emergent (EM), and unconsolidated bottom (UB). Total mapped wetland area within a given evaluation area is compared between mapping completed by the UGS for this project and older mapping from NWI and the Forest Service (FS).*

Site ID	Dominant Classification			Evaluation Area (ha)	Wetland Area (ha)		
	FS	UGS	NWI		FS	UGS	NWI
UWC-01	SS	SS	SS	4.71	2.45	2.83	2.91
UWC-02	SS	EM	SS	4.71	1.1	1.56	1.63
UWC-03	SS	EM	EM	4.71	3.57	1.34	1.48
UWC-04	SS	SS	EM	4.7	4	3.2	3.69
UWC-05	SS	EM	SS	18.83	3.09	2.53	2.93
UWC-06	SS	SS	EM	18.79	15.99	11.27	12.8
UWC-07	SS	EM	EM	18.84	14.25	4.99	7.95
UWC-08	SS	SS	EM	18.82	2.03	2.23	1.28
UWC-09	SS	EM	EM	18.83	6.48	5.87	6.82
UWC-10	SS	EM	EM	18.81	8.45	9.21	10.29
UWC-11	SS	SS	SS	4.71	2.57	1.26	1.7
UWC-12	SS	EM	EM	18.83	13.91	13.54	13.97
UWC-13	SS	EM	EM	4.71	1.38	1.29	1.64
UWC-14	SS	SS	SS	4.71	3.48	1.35	2.93
UWC-15	SS	SS	SS	18.82	5.99	7.39	8.88
UWC-16	SS	SS	EM	18.81	9.31	4.8	6.15
UWC-18	SS	SS	SS	18.85	7.77	6.01	6.82
UWC-19	SS	SS	EM	4.71	2.31	2.31	2.38
UWC-20	UB	EM	EM	4.71	1.38	1.15	1.29
UWC-22	SS	EM	EM	18.8	14.86	12.91	14.86
UWC-23	SS	SS	SS	18.81	13.76	9.88	11.23
UWC-24	EM	EM	EM	4.71	1.47	1.47	1.58
UWC-25	SS	EM	EM	4.71	1.9	1.81	2.02
UWC-26	SS	SS	SS	4.71	1.76	1.25	1.77
UWC-27	SS	SS	SS	4.71	1.8	1.08	1.22
UWC-28	SS	SS	EM	4.71	3.78	1.82	2.04
UWC-29	SS	EM	EM	4.71	1.09	1.28	0.99
UWC-30	SS	SS	SS	4.7	2.76	0.76	1.29
				Total	**152.7**	**116.4**	**133.2**

Table 7. *Agreement between field classification of sites by the UGS and data previously mapped by NWI and the Forest Service. Classifications are for dominant Cowardin classes, including scrub-shrub (SS), emergent (EM), and UB (unconsolidated bottom).*

		NWI		% correctly classified	Forest Service			% correctly classified
		EM	SS		EM	SS	UB	
UGS (field)	**EM**	11	2	**84.6%**	1	11	1	**7.7%**
	SS	6	9	**60%**	0	15	0	**100%**

Table 8. *Rapid condition scores by category and metric. Metrics in italics were not used in calculation of category or overall scores, though they may have been used to calculate derived metrics.*

Metric Name	A	A-	B	C	C-	D
Landscape Overall	***27***	*NA*	***1***	***0***	*NA*	***0***
Percent Buffer	27	1	0	0	*NA*	0
Buffer Width	*27*	*1*	*0*	*0*	*NA*	*0*
Buffer Soil Condition	*20*	*NA*	*7*	*1*	*NA*	*0*
Buffer Vegetation Condition	*28*	*NA*	*0*	*0*	*NA*	*0*
Overall Buffer Score	27	*NA*	1	0	*NA*	0
Percent Intact Landscape	26	*NA*	1	1	*NA*	0
Wetland Edge Connectivity	27	*NA*	1	0	*NA*	0
Hydrologic Overall	***28***	*NA*	***0***	***0***	*NA*	***0***
Hydroperiod	25	*NA*	3	0	0	0
Timing of Inundation	28	*NA*	0	0	0	0
Turbidity and Pollutants[1]	26	*NA*	1	0	*NA*	0
Wet Algae Growth[1]	*24*	*NA*	*3*	*0*	*NA*	*0*
Dry Algae Growth[1]	*10* (scored as AB)			*0*	*NA*	*0*
Overall Algae Score[1]	24	*NA*	3	0	*NA*	0
Water Quality	13	*NA*	14	1	0	0
AA Edge Connectivity	28	*NA*	0	0	*NA*	0
Physical Structure Overall	***18***	*NA*	***9***	***1***	*NA*	***0***
Soil and Substrate Disturbance	18	*NA*	9	1	*NA*	0
Vegetation Structure Overall	***25***	*NA*	***3***	***0***	*NA*	***0***
Horizontal Interspersion	2	11	12	3	*NA*	0
Litter Accumulation	28 (scored as AB)			0	*NA*	0
Woody Debris[1]	27 (scored as AB)			0	*NA*	0
Woody Species Regeneration[1]	25	*NA*	0	1[2]	*NA*	0
Vegetation Composition	***26***	*NA*	***2***	***0***	*NA*	***0***
Relative Cover Native Species	19	*NA*	8	1	0	0
Absolute Cover Noxious Species	27	*NA*	1	0	*NA*	0
Overall Site Score	***27***	*NA*	***1***	***0***		***0***

[1]Sites without water or woody species may not have been scored for this metric.

[2]Site scored as C1 not C2, meaning site had mature individuals but lacked seedlings or saplings.

subunit each had three, four, and six sites. Sites in the subunits had a mean of 12.0 and range of 1.9 to 29.5 sheep-days. One sheep-day is equal to one sheep grazing for one day in an area one hectare in size. If actual grazing followed the 2014 range management plans, 8 sites were ungrazed, 15 fully grazed, and 5 partially grazed at the time of the UGS survey.

Two sites were within 160 m of a road and two sites were approximately 1000 m from roads; the remaining sites were all over 2000 m from roads. Six sites were within 100 m of trails, 11 sites between 100 m and 450 m of trails, 7 sites between 550 and 800 m of trails, and 4 sites between 1200 and 1550 m of trails. The nearest trail was minimally developed for 7 sites, moderately developed for 19 sites, and developed for 2 sites.

Wetland Vegetation

We recorded 1005 encounters with 195 unique plant species, including 75 species found only at one site. We were not able to identify 47 of the plant species we encountered, generally because individuals were not in flower or fruit. *Viola* spp. (n=13), *Carex* spp. (n=7), and members of the Asteraceae family (n=12) were the most frequently unidentified species encountered. Number of species recorded per site ranged from 10 to 61, and the mean was 35.9 species. Eighteen species were found at over half of all sites (table 11). Species including *Salix planifolia* (diamondleaf willow), *Deschampsia cespitosa* (tufted hairgrass), *Calamagrostis canadensis* (bluejoint), *Carex scopulorum* (mountain sedge),

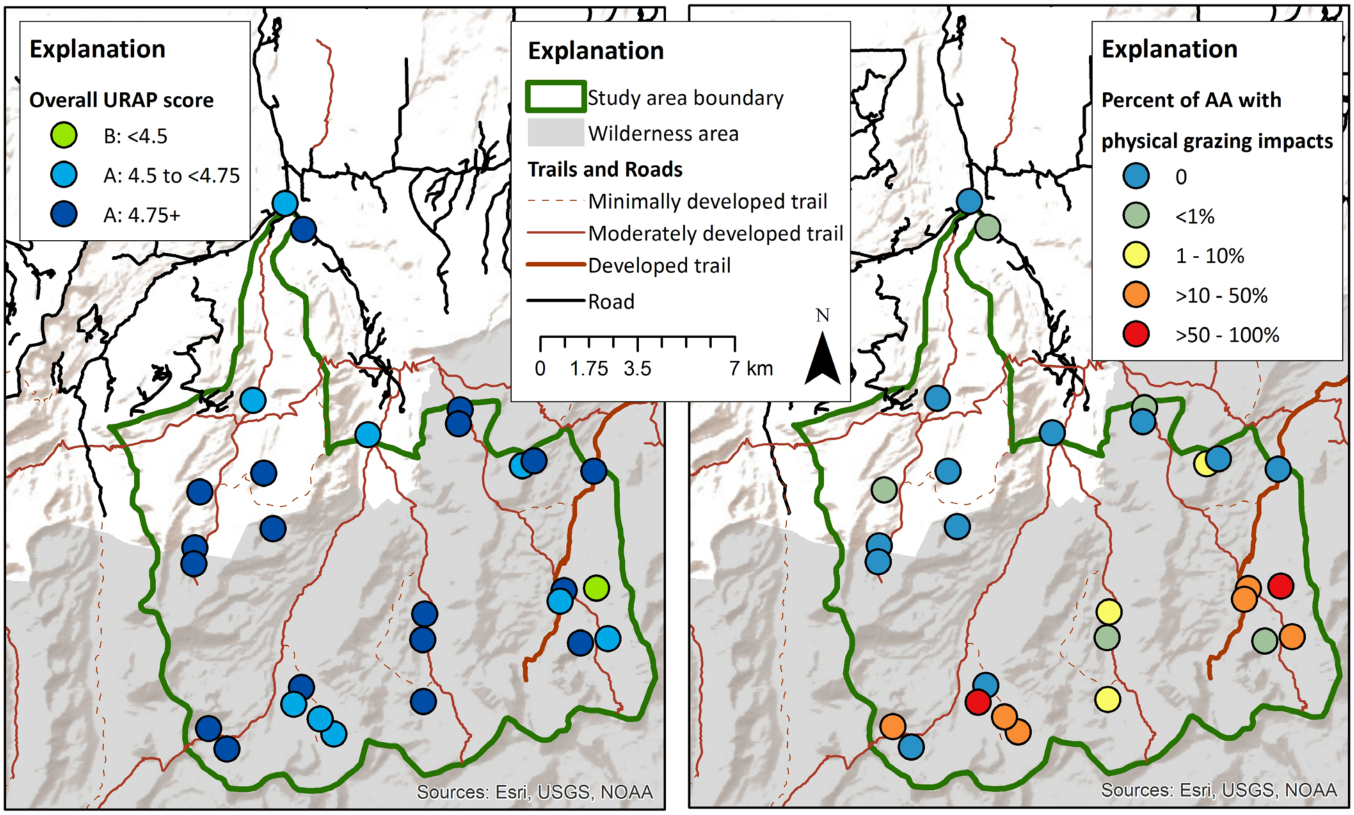

Figure 2. *Overall Utah Rapid Assessment Procedure (URAP) scores (left) and percent of assessment area (AA) with soil disturbance from livestock grazing (right) at survey sites.*

Table 9. *Stressors present in the 200-m buffer around wetland assessment sites. The number of sites with each overall stressor severity rating (low and moderate) is listed along with the mean severity rating by category of stress. Values for categories not evaluated for particular stressors are listed as NA.*

Stressor	Number of Sites with Overall Severity Class				Mean Severity Rating (from 0, none or trace, to 3, high) for each Category of Stress			
	Low	Mod.	High	Total	Hydroperiod	Water Contaminants	Sedimentation	Vegetation Stress
Cover of non-native plant species	10	0	0	10	0	*NA*	*NA*	0
Extensive tree herbivory	5	2	1	8	*NA*	*NA*	*NA*	1.13
Heavy cover of filamentous algae	1	1	0	2	*NA*	*NA*	*NA*	0.50
Pasture, rangeland, managed grazing	20	2	0	22	0.32	0.77	0.27	0.64
Gravel road	2	0	0	2	0.50	*NA*	1	0
Trails (e.g., hiking paths, bike trails)	6	0	0	6	0.17	*NA*	0.33	0.33
Trash, dumping	1	0	0	1	*NA*	*NA*	*NA*	*NA*
Total	**45**	**5**	**1**	**51**				

and *Carex utriculata* (Northwest Territory sedge) were common and abundant where found, but other common species had less than 3% cover. Many of these common species had high C-values; six had C-values of between 7 and 9. *Poa pratensis* (Kentucky bluegrass) and *Taraxacum officinale* (common dandelion) were the most common non-native species detected at sites, and *Cirsium arvense* (Canada thistle) was the only detected noxious weed species (figure 3, table 12). Only three sites, UWC-03, UWC-07, and UWC-29, had any non-native species besides the two most common. Mean C at sites ranged from 4.9 to 6.8 (figure 3). Of the six wet meadow sites, one was scored A, two as B, and three as C based on Colorado Natural Heritage Program's Mean C thresholds. Of the six fen sites, three each were scored as A and as B. Of the 16 riparian shrubland sites, 11 scored as A, 4 as B, and 1 as C.

The optimal NMDS solution with two axes had a stress value of 0.208, just slightly higher than the rule of thumb established by McCune and Grace (2002). We selected the two axes solution for our analysis of the NMDS results due to

Table 10. Stressors present within the assessment area and associated severity (low or moderate) and extent, as percent cover of the assessment unit. Number following each stressor category indicates the number of sites with at least one stressor recorded in the indicated category.

Stressor	Number of Sites with Severity Class			Extent (Percent Cover of AA)					
	Low	Mod.	Total	Trace	1–10	>10–25	>25–50	>50–75	>75
Hydroperiod (n=13)									
Livestock pugging and entrenchment from paths	11	2	13	4	5	0	3	0	1
Physical (n=16)									
Trampling, digging, wallowing by domestic animals	15	1	16	4	3	2	4	1	1
Vegetation (n=17)									
Excessive insect herbivory of trees or shrubs	0	1	1	0	0	1	0	0	0
Excessive wildlife herbivory	1	0	1	0	0	0	0	1	0
Grazing and browsing by domestic animals	14	1	15	2	2	1	7	1	2
Moderate to heavy formation of filamentous algae	1	0	1	0	1	0	0	0	0
Upland plant species encroaching into AA	1	0	1	0	1	0	0	0	0
Total	**43**	**5**	**48**	**11**	**12**	**4**	**14**	**3**	**4**

Table 11. Plant species found at >50% of sites. All of these species are native to Utah. C-values range from 0, for non-native plant species to between 1 and 10, with 1 indicating a high degree of disturbance tolerance and 10 strong association with pristine, undisturbed areas. Wetland indicator ratings evaluate degree of association with wetlands. Species can be rated as upland (UPL), facultative upland (FACU, more common in uplands), facultative (FAC, equally likely in wetlands or upland), facultative wetland (FACW, more common in wetlands), and obligate (OBL, found almost exclusively in wetlands). Some species have not been evaluated for wetland indicator ratings.

Scientific Name	Common Name	# of Sites	Mean % Cover Where Found	Growth Habit	C-Value	Wetland Indicator Rating
Salix planifolia	Diamondleaf willow	26	17.8	Shrub	7	OBL
Pedicularis groenlandica	Elephanthead lousewort	26	0.5	Forb	7	OBL
Phleum alpinum	Alpine timothy	25	0.9	Graminoid	6	FAC
Ligusticum tenuifolium	Idaho licorice-root	25	1.9	Forb	8	FACW
Deschampsia cespitosa	Tufted hairgrass	24	5.4	Graminoid	5	FACW
Caltha leptosepala	White marsh marigold	24	2.5	Forb	6	OBL
Veronica wormskjoldii	American alpine speedwell	22	0.5	Forb	6	FACW
Calamagrostis canadensis	Bluejoint	21	5.2	Graminoid	5	FACW
Swertia perennis	Felwort	20	0.5	Forb	8	FACW
Rhodiola rhodantha	Redpod stonecrop	20	0.6	Forb	8	FACW
Carex scopulorum	Mountain sedge	20	6.2	Graminoid	6	OBL
Hierochloe hirta	Northern sweetgrass	17	0.3	Graminoid	9	FACW
Carex utriculata	Northwest Territory sedge	16	13.3	Graminoid	4	OBL
Achillea millefolium	Common yarrow	16	0.5	Forb	3	FACU
Carex microptera	Smallwing sedge	16	1.9	Graminoid	4	FACU
Castilleja miniata	Giant red Indian paintbrush	16	0.4	Forb	6	FACW
Potentilla diversifolia	Varileaf cinquefoil	15	0.7	Forb	5	FACU
Antennaria microphylla	Littleleaf pussytoes	15	1.0	Graminoid	5	

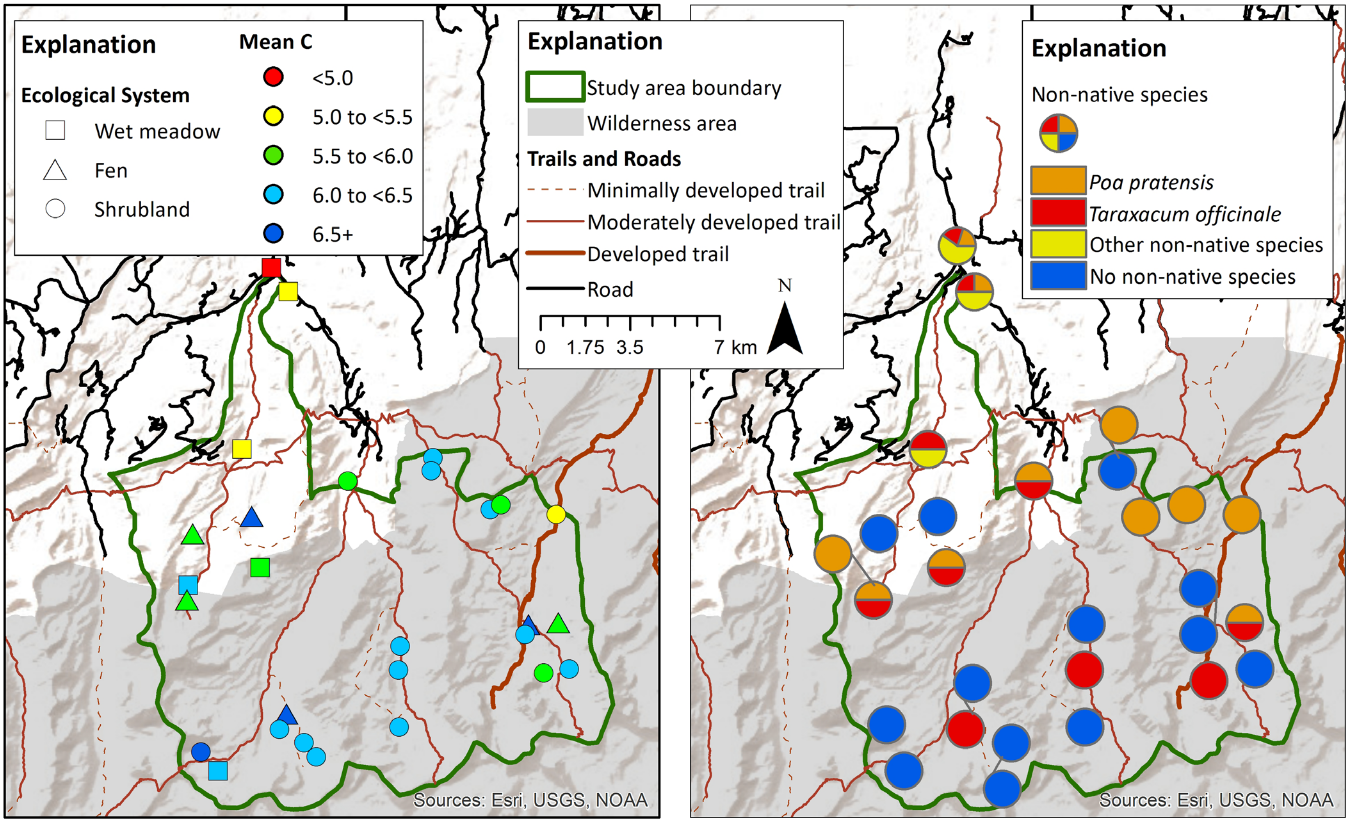

Figure 3. *Plant community composition data from survey sites. Mean C (left) is a measure of species' tolerance to disturbance; high Mean C values indicate low tolerance. Pie charts (right) show the proportion of all non-native species found at sites that were* Poa pratensis *and/or* Taraxacum officinale*, the two most common non-native species.*

Table 12. *Non-native plant species recorded at field sites. See table 11 for explanation of wetland indicator ratings.*

Scientific Name	Common Name	# of Sites	Mean % Cover Where Found	Growth Habit	Wetland Indicator Rating
Poa pratensis	Kentucky bluegrass	11	1.09	Graminoid	FAC
Taraxacum officinale	Common dandelion	10	0.6	Forb	FACU
Alopecurus geniculatus	Water foxtail	2	0.5	Graminoid	OBL
Vulpia bromoides	Brome fescue	1	0.5	Graminoid	FACU
Polygonum arenastrum	Oval-leaf knotweed	1	0.1	Forb	FAC
Cirsium arvense[1]	Canada thistle	1	0.5	Forb	FAC
Agrostis stolonifera	Creeping bentgrass	1	1	Graminoid	FAC

[1]Noxious weed for the state of Utah.

ease of graphical interpretation and because the cutoff is only a rule of thumb, not a well-defined rule. Each axis represents one major continuum in species composition space, and sites that are plotted close to one another on both axes have similar plant community composition (figure 4). The axis values themselves are not readily interpretable because they represent summarized data across all species. However, they can be overlain with species' scores to determine which species are associated with high and low values of each axis. Strong evidence ($p<0.05$) exists for the relationship between the axes and 29 of the 113 species based on permutation testing, suggesting that these species were the primary indicators of differences in composition between sites (table 13). Negative values on both axes were associated with a mix of native and non-native graminoid and herbaceous species with a broad range of C-values (from 0 to 9) and wetland indicator ratings (from upland to obligate wetland). Positive loadings on both axes were associated with only facultative and obligate native graminoid, herbaceous, and woody species with C-values between 5 and 8.

Environmental data can also be overlain on the graphs (figure 4). URAP overall, landscape, and vegetation composition scores, AA area, the first axis of the climate PCA, distance to

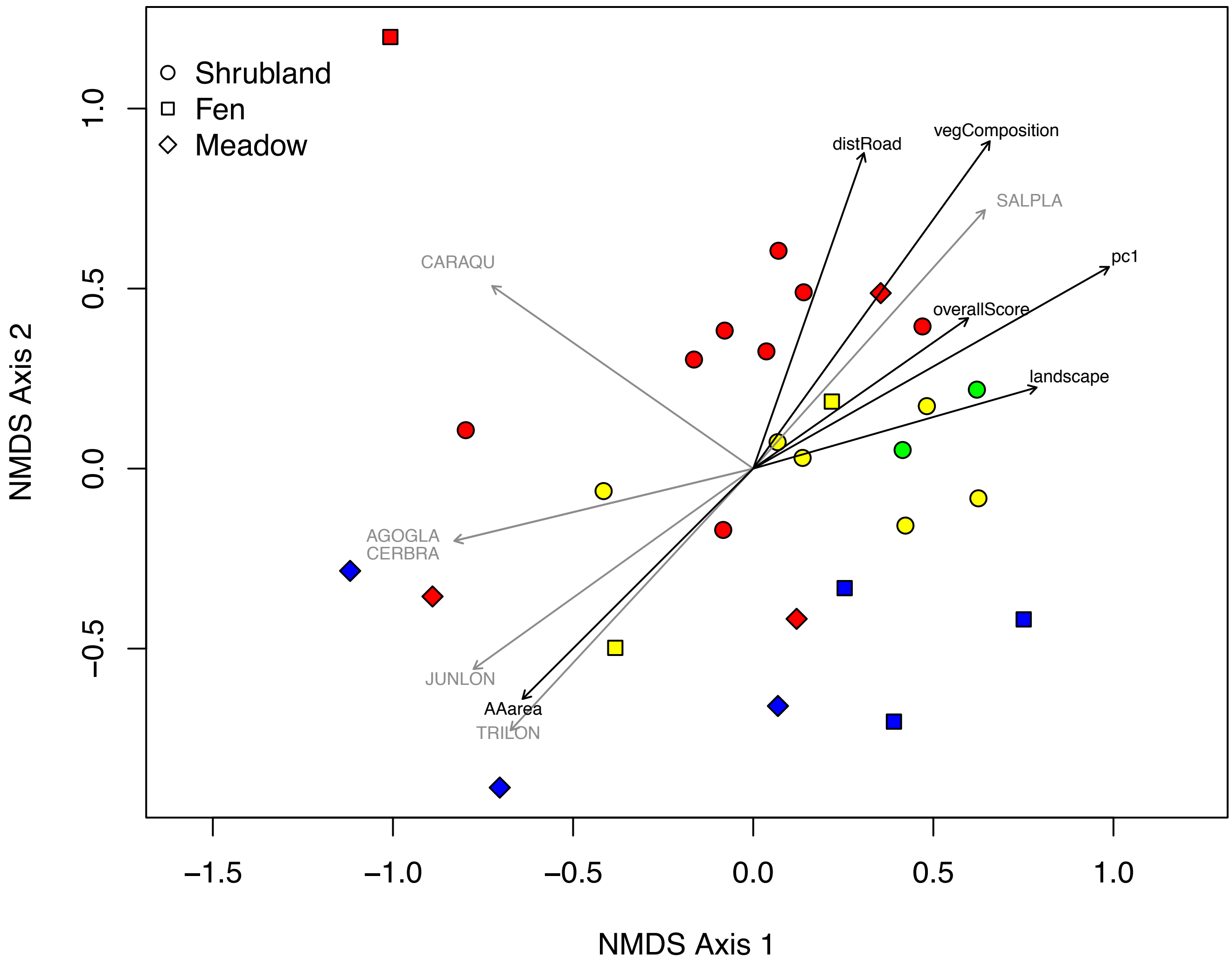

Figure 4. *Plot of sites, species scores (in grey, for species p ≤0.003) and site variables (bottom, for variables p ≤0.05) for the plant community composition NMDS. Species and site variables are plotted as vectors proportional to their strength of correlation with the axes. Sites are plotted as points colored by their HUC12 watershed, with different shapes representing their Ecological System. Species identities and variable names are shown in tables 13 and 14.*

the nearest road, Ecological System, land type, and HUC12 location all exhibited strong relationships (p<0.05) with plant community composition (table 14). Sites only weakly clustered by Ecological System; meadows had negative values on both axes, shrublands had positive values, and fens had slightly negative values on the second axis. One fen site had very distinctive plant community composition compared to all other sites. Higher values on both axes were associated with the first axis of the climate and elevation PCA, which corresponds with wetter, colder, higher elevation sites. These higher elevation sites tended to be shrublands further from roads that received higher overall and vegetation composition scores. The higher elevation sites also appear more clustered by watershed.

Extrapolation of Study Results

Of the wetland area mapped by the Forest Service, 93.3% (SE 4.09, 95% CI 85-100%) was target wetland and 3.3% (SE 3.01, 95% CI: 0-9.2%) was non-target and the remaining area not sampled and thus unknown (3.3%, SE 2.77, 95% CI 0-8.8%). Of the sampled target wetland area, the majority is estimated to be in A or reference condition based on URAP scores, though only slightly over half of the wetland area is estimated to score as A for Mean C (table 15).

Relationships Among Levels and Landscape Data

Stressor Summarization

No single method of summarizing stressor data clearly performed better than other methods. Almost all combinations of buffer and AA stressor summaries were significantly correlated (p<0.05) with URAP overall site scores except when buffer stressors were weighted more heavily than AA stressors. This finding suggests that conditions within the AA were more important than those in the surrounding landscape for determining URAP scores.

Table 13. *Plant species used in nonmetric multidimensional scaling analysis of plant community composition, with species traits and axes scores. R^2 values and p-values indicate strength of association with axes; species with p-values ≤0.05 are bold. See table 11 for explanation of C-values and wetland indicator ratings.*

Symbol	Species	C-value	Nativity	Wetland Indicator	Plant Layer	Axis 1 Score	Axis 2 Score	R^2	p-value
ACHMIL	***Achillea millefolium***	**3**	**Native**	**FACU**	**Forb**	**-0.90**	**-0.44**	**0.25**	**0.030**
AGOGLA	***Agoseris glauca***	**5**	**Native**	**UPL**	**Forb**	**-0.97**	**-0.24**	**0.43**	**0.003**
AGRHUM	*Agrostis humilis*	8	Native	FACW	Graminoid	-0.70	0.71	0.00	0.972
AGRIDA	*Agrostis idahoensis*	7	Native	FACW	Graminoid	-0.79	0.61	0.09	0.257
AGRSCA	*Agrostis scabra*	3	Native	FAC	Graminoid	0.03	-1.00	0.06	0.417
AGRVAR	***Agrostis variabilis***	**6**	**Native**		**Graminoid**	**-0.12**	**0.99**	**0.22**	**0.045**
ALOAEQ	*Alopecurus aequalis*	4	Native	OBL	Graminoid	-0.89	-0.45	0.06	0.456
ALOGEN	***Alopecurus geniculatus***	**0**	**Introduced**	**OBL**	**Graminoid**	**-0.93**	**-0.38**	**0.35**	**0.014**
ALOMAG	*Alopecurus magellanicus*	7	Native	FACW	Graminoid	-0.47	-0.88	0.04	0.554
ANTCOR	*Antennaria corymbosa*	6	Native	FAC	Forb	-0.11	0.99	0.17	0.097
ANTMIC	***Antennaria microphylla***	**5**	**Native**		**Forb**	**0.66**	**-0.75**	**0.25**	**0.031**
ARGANS	*Argentina anserina*	3	Native	OBL	Forb	0.91	0.41	0.08	0.275
ARNMOL	*Arnica mollis*	6	Native	FAC	Forb	0.88	0.47	0.06	0.439
BETGLA	*Betula glandulosa*	9	Native	OBL	Woody shrub	-0.49	0.87	0.17	0.088
BETNAN	*Betula nana*	6	Native		Woody shrub	0.86	-0.51	0.06	0.434
CALCAN	*Calamagrostis canadensis*	5	Native	FACW	Graminoid	1.00	0.07	0.00	0.992
CALLEP	*Caltha leptosepala*	6	Native	OBL	Forb	0.97	-0.26	0.19	0.078
CARAQU	***Carex aquatilis***	**5**	**Native**	**OBL**	**Graminoid**	**-0.82**	**0.58**	**0.46**	**0.001**
CARAUR	*Carex aurea*	7	Native	FACW	Graminoid	-0.83	-0.56	0.10	0.205
CARBRU	*Carex brunnescens*	9	Native	OBL	Graminoid	0.27	0.96	0.05	0.518
CARCAN	*Carex canescens*	7	Native	OBL	Graminoid	0.74	0.67	0.17	0.089
CAREBE	*Carex ebenea*	4	Native		Graminoid	1.00	0.08	0.07	0.376
CARECH	*Carex echinata*	8	Native	OBL	Graminoid	0.96	-0.26	0.01	0.839
CARGYN	*Carex gynocrates*	9	Native	OBL	Graminoid	0.99	0.11	0.15	0.117
CARILL	*Carex illota*	7	Native	FACW	Graminoid	0.93	-0.36	0.16	0.105
CARMAG	*Carex magellanica*	9	Native	OBL	Graminoid	-0.40	-0.92	0.07	0.377
CARMIC	***Carex microptera***	**4**	**Native**	**FACU**	**Graminoid**	**-0.53**	**-0.85**	**0.32**	**0.010**
CARNEL	*Carex nelsonii*	8	Native	FAC	Graminoid	0.35	0.94	0.20	0.063
CARNOR	*Carex norvegica*	8	Native	FAC	Graminoid	-0.60	-0.80	0.18	0.078
CARPAC	*Carex pachystachya*	6	Native	FAC	Graminoid	-0.90	0.43	0.10	0.267
CARSAX	*Carex saxatilis*	7	Native	OBL	Graminoid	0.90	-0.44	0.15	0.125
CARSCI	*Carex scirpoidea*	9	Native	FAC	Graminoid	0.83	0.55	0.08	0.322
CARSCO	*Carex scopulorum*	6	Native	OBL	Graminoid	1.00	0.10	0.11	0.223
CARSIM	***Carex simulata***	**7**	**Native**	**OBL**	**Graminoid**	**-0.98**	**-0.19**	**0.28**	**0.036**
CARUTR	*Carex utriculata*	4	Native	OBL	Graminoid	-0.67	-0.75	0.15	0.133
CASMINIA	***Castilleja miniata***	**6**	**Native**	**FACW**	**Forb**	**0.23**	**0.97**	**0.24**	**0.029**
CERBRA	***Cerastium brachypodum***		**Native**	**FAC**	**Forb**	**-0.97**	**-0.24**	**0.43**	**0.003**
CIRSCA	*Cirsium scariosum*	6	Native	FAC	Forb	-0.83	-0.56	0.23	0.058
DANINT	*Danthonia intermedia*	6	Native	FACU	Graminoid	-0.33	-0.94	0.23	0.054
DASFRU	*Dasiphora fruticosa*	4	Native	FAC	Woody shrub	-0.99	0.15	0.20	0.066
DESCES	*Deschampsia cespitosa*	5	Native	FACW	Graminoid	0.13	-0.99	0.05	0.493
DODALP	*Dodecatheon alpinum*		Native	FACW	Forb	0.40	0.92	0.09	0.277
DODPUL	*Dodecatheon pulchellum*	6	Native	FACW	Forb	-0.77	-0.64	0.01	0.838

Table 13. *Continued.*

Symbol	Species	C-value	Nativity	Wetland Indicator	Plant Layer	Axis 1 Score	Axis 2 Score	R^2	p-value
DODSPP	*Dodecatheon spp.*		Native		Forb	0.70	-0.71	0.18	0.089
ELEQUI	***Eleocharis quinqueflora***	**6**	**Native**	**OBL**	**Graminoid**	**-0.32**	**0.95**	**0.26**	**0.028**
ELESPP	*Eleocharis spp.*	5	Native		Graminoid	0.88	0.48	0.00	0.950
ELYGLA	*Elymus glaucus*	5	Native	FACU	Graminoid	-0.54	0.84	0.02	0.762
ELYTRA	*Elymus trachycaulus*	5	Native	FAC	Graminoid	-1.00	0.01	0.11	0.194
EPICIL	*Epilobium ciliatum*	3	Native	FACW	Forb	-0.06	-1.00	0.17	0.092
EPIHOR	***Epilobium hornemannii***	**6**	**Native**	**FACW**	**Forb**	**0.30**	**0.95**	**0.27**	**0.018**
EPISAX	*Epilobium saximontanum*	6	Native	FACW	Forb	-0.46	0.89	0.05	0.530
EQUARV	*Equisetum arvense*	3	Native	FAC	Forb	-1.00	0.01	0.12	0.159
ERIDIV	*Erigeron divergens*	5	Native		Forb	0.25	-0.97	0.10	0.213
ERISCH	*Eriophorum scheuchzeri*	10	Native		Graminoid	0.81	0.58	0.04	0.600
ERIUIN	*Erigeron uintahensis*		Native		Forb	0.59	0.81	0.13	0.159
EURINT	***Eurybia integrifolia***	**5**	**Native**		**Forb**	**0.37**	**0.93**	**0.25**	**0.023**
FRAVIR	*Fragaria virginiana*	3	Native	FACU	Forb	-1.00	0.10	0.18	0.082
GALBOR	*Galium boreale*	5	Native	FACU	Forb	-0.99	0.11	0.12	0.154
GALTRI	***Galium trifidum***	**7**	**Native**	**FACW**	**Forb vine**	**-0.97**	**-0.24**	**0.38**	**0.010**
GENAMA	*Gentianella amarella*	6	Native	FACW	Forb	0.06	1.00	0.11	0.210
GENCAL	*Gentiana calycosa*	7	Native	FACW	Forb	0.91	-0.42	0.19	0.069
GENPRO	*Gentiana prostrata*	8	Native	FACW	Forb	-0.89	-0.45	0.13	0.141
GEUMAC	***Geum macrophyllum***	**5**	**Native**	**FAC**	**Forb**	**-0.97**	**-0.26**	**0.36**	**0.010**
HIEHIR	***Hierochloe hirta***	**9**	**Native**	**FACW**	**Graminoid**	**-0.76**	**-0.65**	**0.25**	**0.022**
HORBRA	***Hordeum brachyantherum***	**4**	**Native**	**FACW**	**Graminoid**	**-0.70**	**-0.71**	**0.41**	**0.005**
JUNALB	*Juncus albescens*	10	Native	OBL	Graminoid	0.90	0.44	0.05	0.519
JUNARC	*Juncus arcticus*	3	Native	FACW	Graminoid	-0.95	-0.32	0.22	0.055
JUNCAS	*Juncus castaneus*	9	Native	FACW	Graminoid	0.89	-0.46	0.09	0.280
JUNDRU	*Juncus drummondii*	7	Native	FACW	Graminoid	0.42	0.91	0.21	0.063
JUNLON	***Juncus longistylis***	**6**	**Native**	**FACW**	**Graminoid**	**-0.81**	**-0.59**	**0.54**	**0.000**
JUNMER	***Juncus mertensianus***	**7**	**Native**	**OBL**	**Graminoid**	**0.75**	**0.66**	**0.34**	**0.006**
LIGTEN	*Ligusticum tenuifolium*	8	Native	FACW	Forb	0.33	0.94	0.19	0.074
LUZPAR	*Luzula parviflora*	6	Native	FAC	Graminoid	0.24	0.97	0.07	0.400
MERCIL	*Mertensia ciliata*	6	Native	FACW	Forb	0.94	0.33	0.03	0.671
MITPEN	*Mitella pentandra*	7	Native	FAC	Forb	-0.07	1.00	0.08	0.324
PEDGRO	*Pedicularis groenlandica*	7	Native	OBL	Forb	0.99	-0.14	0.15	0.131
PHLALP	*Phleum alpinum*	6	Native	FAC	Graminoid	0.57	-0.82	0.16	0.104
PICSPP	*Picea engelmannii*	4	Native	FAC	Woody tree	0.96	-0.26	0.11	0.234
PINCON	*Pinus contorta*	4	Native	FAC	Woody tree	-0.96	-0.29	0.17	0.096
POAALP	*Poa alpina*	6	Native	FAC	Graminoid	0.74	-0.68	0.02	0.784
POAPRA	*Poa pratensis*	0	Introduced	FAC	Graminoid	-0.01	-1.00	0.15	0.112
POLBIS	*Polygonum bistortoides*	7	Native	FACW	Forb	0.89	-0.45	0.08	0.351
POLOCC	***Polemonium occidentale***	**7**	**Native**	**FACW**	**Forb**	**-0.94**	**-0.34**	**0.34**	**0.010**
POLPOL	*Polygonum polygaloides*	7	Native	FACW	Forb	-0.54	-0.84	0.15	0.114
POLVIV	*Polygonum viviparum*	7	Native	FAC	Forb	0.39	0.92	0.13	0.167
POTDIV	*Potentilla diversifolia*	5	Native	FACU	Forb	1.00	0.00	0.07	0.402
POTGRA	***Potentilla gracilis***	**4**	**Native**	**FAC**	**Forb**	**-0.65**	**-0.76**	**0.34**	**0.029**
RANESC	*Ranunculus eschscholtzii*	7	Native	FACW	Forb	0.52	0.85	0.09	0.246

Table 13. *Continued.*

Symbol	Species	C-value	Nativity	Wetland Indicator	Plant Layer	Axis 1 Score	Axis 2 Score	R^2	p-value
RHORHO	***Rhodiola rhodantha***	**8**	**Native**	**FACW**	**Forb**	**0.90**	**0.44**	**0.22**	**0.041**
RORCUR	***Rorippa curvipes***	**5**	**Native**	**FACW**	**Forb**	**-0.93**	**-0.38**	**0.35**	**0.014**
SALPLA	***Salix planifolia***	**7**	**Native**	**OBL**	**Woody shrub**	**0.67**	**0.74**	**0.54**	**0.000**
SALWOL	*Salix wolfii*	8	Native	OBL	Woody shrub	-0.97	-0.25	0.11	0.193
SAXODO	*Saxifraga odontoloma*	7	Native	FACW	Forb	0.76	0.65	0.14	0.150
SENSPH	*Senecio sphaerocephalus*	6	Native	FACW	Forb	-0.87	-0.49	0.22	0.060
SENTRI	*Senecio triangularis*	6	Native	FACW	Forb	0.96	-0.29	0.08	0.363
SPIROM	*Spiranthes romanzoffiana*	6	Native	FACW	Forb	-0.41	-0.91	0.18	0.074
STECAL	*Stellaria calycantha*	5	Native	FACW	Forb	0.06	1.00	0.08	0.268
STELON	***Stellaria longipes***	**7**	**Native**	**FACW**	**Forb**	**-1.00**	**0.05**	**0.33**	**0.012**
SWEPER	*Swertia perennis*	8	Native	FACW	Forb	-0.60	0.80	0.12	0.180
SYMCIL	*Symphyotrichum ciliatum*		Native	FACW	Forb	1.00	-0.10	0.04	0.579
SYMFOL	*Symphyotrichum foliaceum*	5	Native	FACU	Forb	-0.05	1.00	0.05	0.526
SYMSPA	***Symphyotrichum spathulatum***	**5**	**Native**	**FAC**	**Forb**	**-0.90**	**-0.43**	**0.40**	**0.004**
TAROFF	***Taraxacum officinale***	**0**	**Introduced**	**FACU**	**Forb**	**-0.97**	**-0.26**	**0.26**	**0.044**
THAALP	***Thalictrum alpinum***	**9**	**Native**	**FACW**	**Forb**	**-0.97**	**-0.25**	**0.27**	**0.041**
TRILON	***Trifolium longipes***	**7**	**Native**	**FAC**	**Forb**	**-0.68**	**-0.74**	**0.58**	**0.000**
TRIPAR	*Trifolium parryi*	8	Native	FAC	Forb	0.56	0.83	0.08	0.319
TRIWOL	*Trisetum wolfii*	7	Native	FACU	Graminoid	-0.81	0.59	0.04	0.587
TROLAX	*Trollius laxus*	8	Native	OBL	Forb	0.88	0.48	0.13	0.150
VACCES	*Vaccinium cespitosum*	6	Native	FAC	Woody shrub	0.34	0.94	0.13	0.164
VACULI	*Vaccinium uliginosum*	8	Native	FACW	Woody shrub	0.96	0.29	0.03	0.652
VERSER	*Veronica serpyllifolia*	5	Native	FAC	Forb	-0.96	0.28	0.07	0.368
VERWOR	*Veronica wormskjoldii*	6	Native	FACW	Forb	1.00	-0.01	0.18	0.086
VIOMAC	*Viola macloskeyi*	7	Native	OBL	Forb	-0.98	-0.18	0.22	0.065

Few FQA metrics were strongly correlated with any combination of stressor data. Cover-weighted Mean C, for all species and native species, sometimes had marginally significant ($0.10>p>0.05$) *positive* relationships with stress. These relationships occurred when stressor combinations included more AA stressor data, either by combining no more than two of the AA measures of grazing or by doubling the AA stress value before adding it to the buffer stress value. Two FQA metrics, the maximum C-value and Mean C of native species, had marginally significant ($0.10>p>0.05$) negative correlations with stress when stressor combinations included more emphasis on buffer stress, either by doubling the buffer score or by combining all three AA measures of grazing into a single value.

Our results suggest that FQA metrics do not respond in a uniform manner to stressors, and some metrics are more sensitive to buffer stressors while others are more sensitive to AA stressors. We selected five different stressor summaries for reporting final correlations. All buffer summaries included both severity and extent in the calculations and did not weight gravel roads more heavily than other stressors. Final summaries include:

1. Buffer stress: Used only buffer stressors.
2. AA stress: Used only AA stressors, with two grazing measures combined.
3. Total stress: Add buffer stressors to AA stressors, with each AA measure of grazing kept separate.
4. Buffer-weighted total stress: Doubled buffer stress and added it to AA stressors, with two AA grazing measures combined.
5. AA-weighted total stress: Doubled all AA stressors, with all three AA grazing measures combined into one, and added to all buffer stressors.

Correlation Among Values

Sites with more recorded stress data had lower hydrologic, physical structure, and overall URAP scores ($p<0.05$), but no significant differences in vegetation structure, vegetation

Table 14. *Survey site variables fit to axes from nonmetric multidimenstional scaling analysis of plant community composition, with axes scores. R^2 values and p-values indicate strength of association with axes; variables with p-values ≤0.05 are bold.*

Symbol	Description	Axis 1 Score	Axis 2 Score	R^2	p-value
Continuous Variables					
AAarea	**total area of assessment area**	**-0.71**	**-0.71**	**0.36**	**0.004**
pc1	**first axes of PCA of climate and elevation variables**	**0.87**	**0.50**	**0.56**	**<0.001**
distRoad	**distance to the nearest road**	**0.33**	**0.94**	**0.37**	**0.002**
distTrail	distance to the nearest trail	-0.15	-0.99	0.06	0.488
sheepDays	Number of sheep times number of grazing days per allotment area	0.30	-0.96	0.01	0.912
sheepDaysBeforeSurvey	sheepDays that occurred before field surveys	-0.54	-0.84	0.06	0.492
aaStressors	AA stressor score	-0.99	0.17	0.01	0.868
bufferStressors	buffer stressor score	-0.96	0.27	0.13	0.175
overallScore	**Overall Utah Rapid Assessment Procedure (URAP) score**	**0.79**	**0.61**	**0.26**	**0.032**
Hydrologic	URAP score for hydrologic metrics	0.97	-0.23	0.03	0.690
Landscape	**URAP score for landscape metrics**	**0.96**	**0.29**	**0.30**	**0.036**
PhysicalStructure	URAP score for physical structure metrics	-0.12	-0.99	0.02	0.783
vegComposition	**URAP score for vegetation composition metrics**	**0.58**	**0.81**	**0.54**	**<0.001**
vegStructure	URAP score for vegetation structure metrics	0.34	0.94	0.14	0.143
Categorical Variables					
Ecological System - Meadow		**-0.36**	**-0.36**	**0.18**	**0.033**
Ecological System - Fen		**0.04**	**-0.10**		
Ecological System - Shrubland		**0.12**	**0.17**		
HGM Class - Riverine		-0.29	0.09	0.079	0.115
HGM Class - Slope		0.12	-0.04		
Land Type - Non-wilderness		**-0.33**	**-0.46**	**0.2343**	**0.001**
Land Type - Wilderness		**0.11**	**0.15**		
HUC12 Watershed - 140401070101		**-0.06**	**-0.55**	**0.2965**	**0.007**
HUC12 Watershed - 140401070102		**-0.15**	**0.28**		
HUC12 Watershed - 140401070201		**0.14**	**-0.04**		
HUC12 Watershed - 140401070203		**0.52**	**0.14**		

Table 15. *Population-wide estimates of the percent of wetland area in each condition class, for overall Utah Rapid Assessment Procedure (URAP) score and Mean C scores.*

Evaluation Category	# Sites	Estimated Percent of Wetland Area			
		Mean	S.E.	Lower 95% CI	Upper 95% CI
Overall URAP Score					
A	27	96.4	3.1	90.3	100.0
B	1	3.6	3.1	0.00	9.7
Mean C Score					
A	15	53.6	7.0	39.9	67.2
B	9	32.1	7.2	18.1	46.2
C	4	14.3	4.4	5.6	23.0

composition, or landscape scores (table 16). Stress within the AA stress was more important than buffer stress for determining URAP scores; the strongest correlations generally occurred when AA stress was not combined with buffer stress and the weakest (often non-significant) correlations occurred when buffer stress was more heavily weighted than AA stress.

FQA metrics had both negative and positive correlations with stressors (table 17). The maximum C-value, Mean C of native species, and adjusted FQI metrics were weakly negatively correlated with buffer stress, buffer-weighted total stress, or both measures. Cover-weighted Mean C of all species and of native species only were both weakly positively correlated with total stress and AA-weighted total stress.

Overall URAP scores and all URAP categorical scores, except for vegetation structure, were at least weakly (0.10>p>0.05) and frequently strongly (p<0.05) correlated with one or more FQA metrics (table 18). Vegetation composition and landscape scores had the most prevalent and strongest correlations with FQA metrics, whereas hydrologic scores were only weakly negatively correlated with one metric, the percent recorded species that were non-native(p=0.10). In general, sites that received higher URAP scores had healthier plant communities, as shown through both negative correlations with the presence and abundance of non-native plant species and positive correlations with the abundance of native species and metrics calculate from Mean C values. However, physical structure scores showed the opposite pattern. Sites with higher absolute cover of non-native species and lower cover-weighted Mean C values (calculated in four different ways) were scored as having more intact physical structure.

Table 16. *Pearson correlation coefficients for significant (p<0.05) correlations between summarized stressor data and Utah Rapid Assessment Procedure (URAP) overall and category scores. Data included stressors within the assessment area (AA) and stressors within a 200-m buffer surrounding the AA. In some overall stressor calculations, either AA or buffer stressors were more heavily weighted. Grazing stress within the AA was sometimes counted separately for stress to vegetation, stress to physical substrate, and stress to hydroperiod and sometimes combined by including the highest single or highest two grazing stress values within the AA. The number of times grazing stress was included in the AA calculation is indicated by 1, 2, or 3.*

Combined Stressors/ URAP Scores	Overall URAP Score	Hydrologic	Physical Structure
AA (3) + Buffer	-0.52	-0.67	0.51
Weighted AA (2) + Buffer	-0.61	-0.72	-0.59
AA (1) + Weighted Buffer		-0.46	
AA (2) only	-0.65	-0.68	-0.69

Regression Model Results

Though response variables had up to six top models, patterns in the regression analysis results were clear (table 19). Prior sheep-days was included in at least one top model for every response variable except for models of four cover-based FQA metrics and always indicated that sites with more planned sheep grazing prior to surveys had lower URAP scores and poorer plant community composition. Only three models included total planned sheep-days as a variable and these models always performed worse than models with prior sheep-days. Variables related to distance to trails were included in 23 of the 34 top FQA models and in one of the three top URAP score models. In all but one model, sites closer to trails had higher URAP scores and healthier plant community measures. Models also almost always showed that sites within the wilderness area had healthier plant community measures. Sites closer to roads had higher numbers of plant species and higher values for two FQA metrics that incorporate species richness in their calculations, cover-weighted FQI for all species and for native species. However, five other FQA metrics showed the opposite pattern, indicating poorer plant community composition closer to roads.

Field Results and Grazing Plan Comparison

Chi-squares tests showed no relationship between whether a site was within a subunit with planned sheep grazing before surveys and field-recorded site vegetation (χ^2=0.03, p=0.58)

Table 17. *Pearson correlation coefficients for correlations between summarized stressor data and Floristic Quality Assessment metrics (see table 3). P-values for all correlations were between 0.05 and 0.10 except for coefficient in bold, p<0.05. Data included stressors within the assessment area (AA) and stressors within a 200-m buffer surrounding the AA. In some overall stressor calculations, either AA or buffer stressors were more heavily weighted. Grazing stress within the AA was sometimes counted separately for stress to vegetation, stress to physical substrate, and stress to hydroperiod and sometimes combined by including the highest single or highest two grazing stress values within the AA. The number of times grazing stress was included in the AA calculation is indicated by 1, 2, or 3.*

Combined Stressors/ FQA Metrics	Max C	Native Mean C	CW Mean C	Native CW Mean C	Adj. FQI
AA (3) + Buffer			0.33	0.33	
Weighted AA (2) + Buffer			0.35	0.35	
AA (1) + Weighted Buffer	-0.37	-0.33			
Buffer only	-0.37	**-0.38**			-0.34

Table 18. *Pearson correlation coefficients for correlations between Utah Rapid Assessment Procedure (URAP) scores and Floristic Quality Assessment (FQA) metrics (see table 3). P-values for coefficients in bold were <0.05; other shown correlations were between 0.05 and 0.10. FQA metrics in italics were used to calculate vegetation composition and overall URAP scores and thus are not independent.*

URAP Category/ FQA Metrics	Overall URAP Score	Hydrologic	Landscape	Physical Structure	Vegetation Composition
Pct. Non-native	**-0.45**	-0.32	**-0.63**		**-0.76**
Abs. Cover Non-native			-0.33	0.34	**-0.87**
Abs. Cover Noxious	*-0.37*		***-0.94***		***-0.50***
Rel. Pct. Native Cover					***0.81***
Mean C	0.37		**0.51**		**0.65**
Native Mean C			**0.40**		**0.52**
CW Mean C			**0.41**	**-0.50**	**0.64**
Native CW Mean C			**0.43**	**-0.48**	**0.53**
CW FQI				-0.33	
Adj. FQI	0.34		**0.47**		**0.61**
CW Adj. FQI			**0.47**	**-0.47**	**0.60**

and hydroperiod (χ^2=0.59, p=0.44) grazing stress values and water quality and soil disturbance metric scores (χ^2=0, p=1 for both). Sites with planned sheep grazing before surveys were somewhat more likely to have physical grazing stress (χ^2=2.7, p=0.098). Seven of the eight sites with no planned prior sheep-days had at least some AA grazing stress recorded, though severity and extent of recorded stress was minimal for all but two sites. Nine of the 20 sites with some planned prior sheep-days within their grazing subunit had no AA grazing stress recorded.

DISCUSSION

Comparison of Mapping Efforts

Wetland boundary determination was inexact due to time constraints in the field and partial reliance on aerial imagery; the degree of accuracy varied between sites. Some sites had wetland-upland boundaries marked by distinct changes in elevation and plant community composition. These sites often had rocky soils along the upland edge that made it difficult to dig soil pits to assess hydrology and hydric soil indicators, but also had distinctive plant communities that made it easy to determine the approximate wetland edge. Boundaries delineated in GIS at these sites are probably within a few meters of the true boundary. Other sites, particularly those located in wide valleys along stream channels, had gradual transitions between wetland and upland. At these sites, we dug soil pits along transects perpendicular to the wettest part of the wetland. Pits were often saturated at or near the surface, but we could not always determine whether saturation was due to a high water table or persistent rain. We only considered sites to have the primary hydrology indicator of saturation when the saturated layer was followed by the water table, as specified in the USACE regional supplement (U.S. Army Corps of Engineers, 2010). At locations where pits lacked primary wetland hydrology indicators, we looked for the presence of at least two of the following three secondary indicators: dry-season water table, geomorphic position, and FAC-neutral test. However, we were not always able to identify all dominant plant species in the field for the FAC-neutral test. Boundary determinations at these sites may be off by tens of meters.

Despite some difficulty in assessing wetland boundaries, we found clear differences in wetland area between mapping methods. Wetland boundaries determined in the office by the UGS showed less wetland area than wetland maps from NWI and the Forest Service. Perhaps we did not appropriately adjust field expectations of wetland hydrology to account for the fact that the 2014 field season was a drier than average year. Nonetheless, boundaries determined using USACE guidelines are likely to be narrower than other boundaries. The USACE has specific rules for determining what constitutes a wetland, whereas NWI guidelines are more vague and can include areas that would not be USACE wetlands. Differences in area between the Forest Service and NWI mapping may be due to differences in mapping resolution between efforts; the Forest Service's mapping is generalized and probably does not exclude many small upland inclusions. The more inclusive mapping by NWI and the Forest Service is useful for identifying areas that do not meet jurisdictional wetland definition, but nonetheless serve as transition areas between wetland and upland.

Agreement in the dominant wetland class between the UGS's field data and NWI and National Forest classifications was 71% and 4%, respectively. Emergent cover was overestimated and scrub-shrub cover was underestimated by NWI compared to what was observed in the field. These errors may indicate that the common wetland shrub species in our study, *Salix planifolia*, is difficult to interpret in aerial imagery, possibly because it is frequently short in stature and often inter-

Table 19. *Landscape regression models of Utah Rapid Assessment Procedure (URAP) scores and Floristic Quality Assessment metrics (see table 3). Model metrics, including AICc, delta AICc, and adjusted R^2 values are shown for all models within two AICc of the top model for each response variable. Landscape variables included in each model are shown with + indicating positive and – indicating negative relationships with the response variables.*

Response	AICc	Delta AICc	Adj. R^2	Subunit Grazing Before Surveys[1]	Subunit Grazing for Summer[1]	Land Type: Wilderness[2]	Dist. Road[3]	Dist. Any Trail[3]	Dist. Mod./Dev. Trail[3]	Dist. Mod. Trail[3]	Dist. Dev. Trail[3]
URAP Score	-27.6	0.00	0.17	-				-			
URAP Score	-27.1	0.52	0.10	-							
URAP Score	-26.0	1.61	0.06		-						
Species Richness	211.2	0.00	0.07				-				
Species Richness	212.9	1.70	0.02	-							
Species Richness	213.1	1.91	0.07				-		-		
Pct. Native Cover	114.9	0.00	0.28			+					
Mean C	36.0	0.00	0.30	-			+				
Mean C	36.7	0.72	0.33	-			+	-			
Native Mean C	21.5	0.00	0.22	-			+				
Native Mean C	22.6	1.07	0.14			+					
Native Mean C	23.3	1.78	0.11				+				
Native Mean C	23.4	1.91	0.16	-		+					
CW Mean C	38.6	0.00	0.62			+				-	-
CW Mean C	40.4	1.78	0.57			+			-		
Native CW Mean C	36.7	0.00	0.59			+				-	-
Native CW Mean C	38.3	1.56	0.57				+			-	-
FQI	170.3	0.00	0.11	-							
FQI	170.9	0.67	0.14	-					-		
Native FQI	170.2	0.00	0.11	-							
Native FQI	171.2	0.94	0.13	-					+		
CW FQI	178.8	0.00	0.27				-			-	-
CW FQI	178.8	0.08	0.32	-			-			-	-
CW FQI	179.0	0.24	0.32	-		+				-	-
CW FQI	179.1	0.32	0.26			+				-	-
CW FQI	179.6	0.83	0.20			+			-		
CW FQI	180.4	1.65	0.28		-		-			-	-
Native CW FQI	178.4	0.00	0.33	-			-			-	-
Native CW FQI	178.6	0.19	0.33	-		-				-	-
Native CW FQI	178.6	0.24	0.28				-			-	-
Native CW FQI	179.2	0.79	0.26			+				-	-
Native CW FQI	179.8	1.47	0.30		-		-			-	-
Native CW FQI	180.1	1.70	0.19			+			-		
Adj. FQI	157.6	0.00	0.27	-			+				
Adj. FQI	159.1	1.54	0.28	-			+	-			
CW Adj. FQI	169.1	0.00	0.59			+				-	-
CW Adj. FQI	169.2	0.13	0.59				+			-	-

[1] Grazing values were calculated from the planned number of sheep to be grazed in each allotment subunit per day and per subunit area, either before field surveys were conducted or for the entire summer.

[2] Land type was coded as wilderness or non-wilderness.

[3] Distance values included distance to the nearest road (Dist. Road), distance to the nearest trail (Dist. Any Trail), and distance to the nearest moderately developed (Dist. Mod. Trail) and/or developed trail (Dist. Dev. Trail).

mixed with herbaceous vegetation. Differences may also be due to differences in class definition. Shrub-scrub areas must have at least 30% areal coverage of shrub species according to NWI mapping standards whereas the UGS did not set an exact cover definition. Differences in classification may also be caused by the fact that NWI geospatial mapping appears shifted approximately 10 to 15 m in GIS compared to underlying aerial imagery. Differences in classification are probably also attributable to differences in the mapping resolution. Mapping from the Forest Service appears to be the coarsest data with almost all sites lumped into the scrub-shrub class.

Condition of Wetlands in Project Area

The vast majority of wetlands in the project area are in good condition and over 90% is predicted to be in "A" or reference condition. Only a few metrics frequently rated below an A. Several such metrics were related to sheep grazing, including buffer soil condition, soil and substrate disturbance, and water quality. Grazing impacts to soil in buffers and AAs were visibly apparent and among the most commonly recorded stressors, but impacted soils were still generally considered only minimally impacted and only one site rated as C for the soil metrics. Over half of the sites were scored as B or C for water quality based on the assumption that sheep droppings were likely to impact site water quality. However, laboratory analyses of water samples are needed to help validate this metric.

Besides the metrics discussed above, horizontal interspersion and relative cover of native species were the only other metrics where four or more sites scored below A. Horizontal interspersion is an evaluation of the number and complexity of arrangement of distinct vegetation patches within a site. Each patch must be at least 10 m^2 and each patch type must, in aggregate, cover at least 5% of the AA. Analysis of data from the EPA-funded Weber project showed that this metric should be dropped from scoring for certain Ecological Systems, but results were less conclusive for alpine-montane wet meadows and shrublands (common systems in this Uinta study) and so for now this metric is being included in overall score calculations. Systems in the study area may naturally be simpler than in other studied areas or, conversely, the complexity of systems in the study area may occur at smaller scales than 10 m^2. This metric will need to be further calibrated and validated before its utility will be fully understood.

Eight sites were scored as B for relative cover of native species and one as C, indicating that these sites had less than 99% and 95% relative cover of native species, respectively. *Poa pratensis* (Kentucky bluegrass) and *Taraxacum officinale* (common dandelion) were the most common non-native species encountered in the field. Both of these species are so ubiquitous in the western United States that USDA Plants considers them both native and introduced to the lower 48 states, though recent taxonomic sources indicate that they are in fact introduced to the western United States (Flora of North America, http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=220013281 and the Grass Manual on the Web, http://herbarium.usu.edu/webmanual). As a facultative upland (FACU) species, *T. officinale* should be more common along wetland edges and at small upland inclusions within wetlands, though it was recorded with 3% cover at one of our study sites. *P. pratensis* is a naturalized facultative (FAC) species that has been introduced to some areas of the U.S. for lawns, soil stabilization, and forage (http://herbarium.usu.edu/webmanual), though intentional plantings are somewhat limited due to its slow establishment and high soil fertility requirements (Uchytil, 1993). *P. pratensis* is highly resistant to grazing, often comes to dominate areas that are overgrazed, and may persist for years after grazing pressure is removed (Uchytil, 1993). The species is commonly found in wet meadows that experience a lower water table during the drier part of the summer. *P. pratensis* was found at one site with 5% cover, but generally occupied less than 1% of sites where found.

Few stressors not related to grazing or non-native species cover were recorded at sites, likely due to the remote setting and wilderness restrictions. None of the six sites within 200 m of trails had any trash recorded within the buffer or AA, though one other site did have some evident trash. The only other stressor recorded at more than two sites was excessive tree herbivory related to mountain pine beetle kill, recorded as a stressor in six buffers and one site AA. The impacts of beetle kill to water quantity and water quality are difficult to predict, inconsistent across studies, and may vary regionally, but at least some studies have reported that beetle kill is related to increases in dissolved organic carbon, total phosphorus, total nitrogen, and nitrate in nearby seepage water or stream water (Mikkelson, 2013). Detailed wetland water level data and laboratory water quality analysis could help determine what, if any, effects beetle kill is having on study area wetland hydrology.

In contrast to overall URAP scores, site Mean C values suggest that only about half of the wetlands in the study are in reference, or A, condition. However, this assessment is based on Mean C thresholds established by Colorado and uses species' C-values not developed specifically for Utah. Mean C values for sites in this study should be recalculated if Utah-specific C-values are developed and if Utah-specific Mean C thresholds are developed.

Validation of Survey Method

Overall URAP scores and hydrologic and physical structure category scores were strongly correlated with AA and buffer stressors (except when the buffer score was doubled). Surveyors frequently scored sites lower in the water quality, hydroperiod, and soil disturbance metrics when evidence of livestock grazing stress at sites was visible, leading to the lower category and overall scores.

The relationships between stressors and FQA metrics show contradictory results, depending on the metric and how stressor data were summarized. When buffer stressors were weighted more heavily than AA stressors, sites with more stress had lower measures of plant community health. When AA stressors were more heavily weighted than buffer stressors, sites with more stress had higher measures of plant community health. Similarly, sites that received higher scores in the URAP physical structure category (which varied depending on amount of soil disturbance within sites) had lower measures of plant community health, whereas other categories and overall URAP scores had the opposite relationship with FQA metrics. Closer analysis reveals that only FQA metrics that incorporate plant cover into the calculation showed a positive relationship with stress. Livestock grazing at sites may increase the relative contribution of less common plant species to FQA calculations if grazing lowers the cover of common dominant plant species and has little effect on less common species. Four of the five most common and abundant graminoid species in our study had C-values of 5 or less, lower than the Mean C value of all but one study site. Cover-based FQA metrics such as cover-weighted Mean C could increase if livestock preferentially grazed these abundant graminoid species. Second, high levels of grazing-related stress and high FQA metrics may both be related to a third unmeasured variable that is causing the relationship. Sites with the most recorded grazing stress are all clustered near the top of the study watersheds. These sites are highest in elevation and the furthest from roads and the wilderness area boundary. Cover weighted FQA metrics could be correlated with these factors rather than with livestock grazing.

Validation of URAP for this project is challenging due to the narrow range of site conditions and limited number of stressors in the study area. However, even within this limited range, we were able to find relationships between stressors and URAP scores and between FQA metrics and URAP scores. Furthermore, URAP shows a strong relationship to FQA metrics and stressors when applied across a watershed with a broader range of conditions, as was done in the Weber project. Future refinements to URAP may need to make adjustments to the horizontal interspersion metric and to limit the number of times a stressor like livestock grazing is counted within the AA.

Consideration of Landscape Factors

Sites further from roads and sites within the wilderness boundary generally had healthier plant community composition whereas sites closer to roads tended to have more species. Roads may facilitate spread of species within the study. However, AAs closer to roads tended to be larger and may incorporate more species due to their greater size.

Sites in subunits that had more grazing planned prior to field surveys had poorer measures of plant community composition. Our measure of prior sheep-days evaluates *potential* rather than actual impact because not all sites within a subunit are likely to be grazed in a given year. Our measure of *actual* impact, field-recorded grazing stressors, sometimes showed the opposite relationship to FQA metrics. The observed relationship between prior sheep-days and FQA metrics could be spurious and caused by spatial clustering of grazed sites since some subunits contained multiple sites. Alternatively, grazing immediately before surveys may make some plant species difficult to detect or identify which could lead to lower species richness values and potentially lower C-values if cryptic species have high C-values.

Models results indicate that trails do not have a negative impact on sites and, in fact, sites generally had higher FQA values when closer to trails. This relationship occurred in all of the top models that had adjusted R^2 values of 0.57 or higher, including models of all-species and native-species cover-weighted Mean C and cover-weighted adjusted FQI. Distance to trails was not correlated with elevation or other obvious factors that could explain the relationship. Range operating instructions state that, “All camps are to be located away from trails, lakes, and other high use recreational areas.” If this restriction has been in place for many years, areas along trails may have experienced less intense grazing pressure than areas that are frequently used as camps, though they probably receive some grazing pressure when sheep are moved during the day. Areas with more intense grazing (i.e., sheep camps) may therefore have poorer plant community composition. Other potential explanations for why sites closer to trails have higher FQA metric values are possible; perhaps more management activities take place along trails. We need additional information about grazing patterns and other activities along trails to determine the most likely causes of this pattern.

Conclusions and Future Recommendations

Mapping data from the Forest Service is the least detailed and most generalized; this mapping may be helpful for identifying general areas where USACE and transitional wetlands may occur. Data from NWI is the only data that has been consistently and completely mapped across the entire study area and is the best source for identifying wetland location. Wetland polygons from NWI could be generalized by adding a buffer to the mapped wetland polygons to protect more transitional areas and to be more conservative in the identification of wetlands. Alternatively, NWI could be used as a base to identify areas that should be subject to a complete USACE wetland delineation to determine exact jurisdictional wetland boundaries. Data from NWI could be improved through better differentiation between emergent and scrub-shrub wetland types and through better spatial alignment of the data.

Wetlands in the study area are overall in good condition, though some evidence suggests that grazing has a deleterious effect on plant community composition based on Mean C thresholds, landscape models, and presence of *P. pratensis*. Assessing this potential effect is difficult due both to the incomplete data on site grazing intensity and the probable lack of sensitivity of FQA metrics to detect small differences in condition. FQA metrics should be an effective way to measure true wetland condition because plant communities are responsive to current and recent past disturbances that are not always visibly evident during a single survey, such as degraded water quality and past grazing pressure. However, FQA metrics depend on the use of C-values, which are somewhat subjectively assigned to species based on tolerance to disturbance and can be regionally specific. In our study, plant community composition also appeared to be spatially dependent; sites close to one another and within the same watershed had similar communities. Sites close to one another may have similar climates and be connected through dispersal; these sites are also more likely to have been surveyed by the same field crew. Small discrepancies in C-value assignments will not affect study results when trends are larger and conclusive. In this study, however, small discrepancies and a small disturbance gradient coupled with the tendency of sites close to one another to resemble one another could make trend detection difficult. Furthermore, we observed that livestock grazing occurring immediately before surveys may artificially affect plant composition measures by making some species difficult to find or identify or by altering the relative cover of common, low C-value species and less common, higher C-value species. Plant community composition measures should continue to be developed and refined for use in Utah and measures least sensitive to seasonal changes should be identified to better quantify disturbance in montane wetlands. We also recommend recalculating FQA metrics for this study if C-values for the state or region are ever updated.

We have *some* measure of pre-survey grazing pressure based on tabulation of stressors, though some sites with recorded livestock-related stress were not supposed to be grazed according to the range management plans. Grazing stress might have been recorded at these sites because sheep were passing through to another subunit, because plans were shifted, or because wildlife grazing was mistaken for livestock grazing. Regardless, pre-survey grazing pressure is inadequate to evaluate site impacts from grazing because it does not capture even one year of grazing pressure and completely misses the historical trends that are necessary to understand actual grazing intensity.

We have two recommendations for follow-up research. First, monitor the spread of non-native plant species, particularly *P. pratensis*. This species is difficult to remove once established and could become more of an issue in wetlands that experience a moderate level of drying. Second, monitor wetland condition at handpicked sites with relatively well-understood levels of grazing intensity. Some sites should be at locations used annually as livestock camps, some at locations infrequently or never used as livestock camps, and some at locations with frequent low-intensity livestock grazing (i.e., areas where sheep frequently pass through but do not camp). Sites with high, medium, and low intensity grazing should be grouped together based on spatial proximity and wetland type to account for potential spatial autocorrelation between sites. Plant community composition could be monitored at the end of the grazing season to ensure that sites were grazed at the expected intensity and to reduce differences in plant community measures caused by temporary changes in species immediately post-grazing. Water quality or soil nutrient sampling may also be useful for determining whether short-term sheep grazing leads to noticeable differences in nutrient levels between sites. This follow-up work would provide a better understanding of the long-term effects of livestock grazing on wetlands and allow for improvement of plant-based tools for measure wetland condition, including identification of those measures least affected by short-term grazing impacts.

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APPENDICES

Appendix A.

URAP Protocol and Field Forms

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

User's Manual, Version 1.0- DRAFT

UTAH DNR GEOLOGICAL SURVEY

Utah Rapid Assessment Procedure: Method for Evaluating Ecological Integrity in Utah Wetlands
User's Manual, Version 1.0- DRAFT

Diane Menuz, Jennifer Jones, and Ryhan Sempler
Utah Geological Survey
Salt Lake City, UT 84114

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Utah Rapid Assessment Procedure: Method for Evaluating Ecological Integrity in Utah Wetlands User's Manual, Version 1.0- DRAFT

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INTRODUCTION

The Utah Rapid Assessment Procedure (URAP) is a survey protocol designed to evaluate the ecological condition of wetlands in the state of Utah. Ecological condition can be defined as "the ability of a wetland to support and maintain its complexity and capacity for self-organization with respect to species composition, physico-chemical characteristics, and functional processes as compared to wetlands of a similar type without human alterations" (Fennessy and others, 2007). Condition is often evaluated in terms of degree of deviation from what is known or expected to occur at sites without any anthropogenic alteration (i.e., reference standard sites).

Condition assessments can be used to identify priority sites for restoration projects (those with lower scores) or conservation actions (those with higher scores). With repeat sampling, condition assessments can evaluate the success of restoration projects or the effects of new stressors on wetland condition. When applied to a random selection of wetlands, condition assessments can be used to make generalizations about the health of all wetlands in an ecoregion, management area, watershed, or other area of interest. This baseline data can be used to identify rare and/or threatened wetland types and common regional causes of wetland degradation and to inform management or conservation actions. The application of a single condition 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.

Background on Wetland Assessments

Environmental Protection Agency 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 (GIS) 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. 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 include either a time-constrained search for all plant species within the surveyed wetland or collection of more intensive Level 3 plant species composition data in subplots. 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 is collected.

Functional Versus Condition Assessments

Wetland assessments are commonly conducted to evaluate either condition or function of wetlands. Condition assessments, including URAP, 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 (see *Reference Standard,* below). 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.

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 (CNHP-EIA), 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 (http://el.erdc.usace.army.mil/wetlands/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 the area of the state.

Wetland classification is used in three different ways with URAP metrics. First, several metrics are specific only to wetlands within the riverine HGM class. Second, some metrics require observers to evaluate condition in relation to what is expected for a reference standard site of the given wetland class. These metrics require either classification based on HGM class (for hydrologic metrics) or Ecological System (for metrics related to litter). Last, some metrics measured quantitatively or semi-quantitatively in the field receive final scores based on class-specific thresholds. These metrics require classification based on Ecological Systems, and may require additional calibration when new systems or regions are surveyed. Keys to the three classification systems being used for Utah, Cowardin, Ecological Systems, and HGM are provided in appendix A.

Utah Rapid Assessment Procedure

Method 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. Utah Wetlands Ambient Assessment Method (UWAAM) was developed for the state through adaptation primarily of methods used by California and Ohio (Hoven and Paul, 2010), though it has not been extensively tested or widely applied in the state. The EPA developed a rapid assessment protocol (USA-RAM) used in conjunction with more detailed surveys carried out as part of the 2011 National Wetland Condition Assessment (www.epa.gov/wetlands/survey). Colorado Natural Heritage Program (CNHP) developed a rapid condition assessment protocol (CNHP-EIA, [Lemly and Gilligan, 2013]) based on the Ecological Integrity Assessment developed by NatureServe (Faber-Langendoen and others, 2008). UWAAM and USA-RAM were field-tested in Snake Valley in 2010, and all three protocols were field-tested in Snake Valley and around Great Salt Lake in 2013.

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. Appropriateness of overall site condition scores was evaluated by looking at the relationships between scores and both more intense vegetation data and nearby and within-site stressors. URAP metrics and scoring will continue to be refined as a broader variety of sites are evaluated, and we receive additional input from outside partners.

URAP Structure

URAP is composed of 16 core metrics and three additional metrics specific only to wetlands in the riverine HGM class (table 1). One of the metrics, the buffer metric, is composed of five individually scored subcomponents that are combined to produce a final value. Metrics are divided into five categories, including landscape context, hydrologic condition, physical structure, vegetation structure, and plant species composition.

Table 1. Metrics included in the URAP method, listed under their relevant category. Metrics in italics only apply to riverine wetlands with channels within the AA. Metrics with an X in the Office Eval. column can be preliminary evaluated in the office and then confirmed in the field. Class calibration refers to whether metrics need to be evaluated (e.g., metric states considered in terms of other wetlands in a site's class) or scored (e.g., separate thresholds developed for different classes) with respect to either a sites hydrogeomorphic (HGM) class or general Ecological System.

Metric	Office Eval.	Class Calibration
Landscape Context		
Percent Intact Landscape	X	
Riparian Corridor Continuity	X	
Percent Buffer[1]	X	
Buffer Width[1]	X	
Buffer Condition- Soil and Substrate[1]		
Buffer Condition-Vegetation[1]		
Hydrologic Condition		
Hydroperiod	X	Evaluated-HGM
Timing of Inundation	X	Evaluated-HGM
Turbidity and Pollutants		
Algae Growth		
Water Quality	X	
Connectivity	X	
Channel/Bank Stability		
Entrenchment Ratio		
Physical Structure		
Substrate and Soil Disturbance		
Vegetation Structure		
Horizontal Interspersion		Scoring- System
Litter Accumulation		Evaluated- System
Woody Debris[2]		Evaluated- System
Woody Species Regeneration[2]		Evaluated- System
Plant Species Composition		
Relative Cover Native Species		
Absolute Cover Invasive Species		
Mean C		Scoring- System
Auxillary Metrics		
Structural Patch Richness		Scoring- System
Topographic Complexity		Scoring- System

[1]Buffer components are scored separately and then combined into a single metric.
[2]Only scored at sites with a woody species component.

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 grades from A to D; table 2 shows a conceptualization of the differences among the grades in terms of degree of degradation, example conditions, and management priorities. Grades correspond with point values; A=5, B=4, C=3, and D=1. Some metrics have more than four states to account for a greater diversity of recognized states. These metrics include A- (4.5 points) or C- (2 points) states.

Table 2. CNHP-EIA definition of assessment ratings from Lemly and Gilligan (2013).

Value	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.

Reporting for URAP should include data on individual metrics as well as category and overall site scores. Scoring for URAP will be developed at the conclusion of the 2014 field season. Category and overall site scores may be the mean score for all sub-components or weighting may be applied to individual metrics to indicate their relative contribution to overall site condition.

The sixteen metrics are the essential components of URAP that allow for site scores to be calculated and compared to other sites. If a trained botanist is unavailable to collect plant species identity and cover data, the Mean C metric will need to be excluded and the other plant species composition metrics will be estimated in the field instead of calculated from plant species data. In addition to the metrics, additional data should be collected at sites whenever possible to assist with metric evaluation and provide more baseline information about Utah wetlands. Stressor checklists provide information about proximal landscape and site alterations and can help validate wetland condition scores. Data from soil pits are useful to better understand site hydrology and to help determine whether the site is truly wetland. Data on the types of structural features (e.g., mudflats, riffles) and ground cover (e.g., litter, bare soil) present at sites may be used to inform future metric development.

Criteria and Assumptions

The URAP is based on the overall assumption shared by many rapid assessment procedures that ecological condition in a wetland can be determined using measurable indicators that respond predictably along a disturbance gradient. We also presume that reference or minimally disturbed condition is a state that can be determined and that the condition of a site can be determined along the defined condition gradient. In addition to this general assumption, there are assumptions concerning the structure of the method that are described below. Assumptions made by URAP for scoring, metrics, and structure will be refined as additional data are collected and disturbance gradients are defined for specific ecoregions and wetland classes.

General Rapid Assessment Method Criteria

Development of URAP follows general criteria suggested for developing a rapid condition assessment method (Fennessy and others, 2007). Criteria suggest that a rapid condition assessment method:

1) can be used to measure condition rather than function
2) is rapid, taking less than a day to complete, including the office component
3) includes an on-site evaluation
4) can be validated using quantitative data
5) should assess extant conditions without consideration of past or anticipated conditions

SET-UP AND GENERAL SITE EVALUATION

This section describes the guidelines for plot set-up and collection of general site information for URAP. The information is presented for all potential URAP users, but also includes instructions specific to the Weber watershed project. Other projects using URAP may differ in how sites are selected and thus how sites are included or excluded in the field and also may have project-specific data that must be collected in addition to the data listed below.

Establishment of Study Site

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 stressor and site hydrology information; and 3) creation of field surveys maps. Full documentation of office evaluation methods used for the Weber watershed project can be found in *The Utah Rapid Condition Assessment User's Guide for Site Office Evaluation- 2014.* 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 (table 1). Look for potential stressors within 500 m of each site, and make a note to examine in the field those stressors and land cover types that are unclear in the imagery. You may also want to examine the area at least 2 km upslope from sites for those sites that do not primarily receive water input via precipitation or groundwater discharge. 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 and a landscape map showing the site surrounded by 200 m and 500 m buffers. You may also want to prepare a map showing the upslope hydrology within at least 2 km of the site.

Determine Whether Site is Wetland

For the Weber watershed project, surveyors must first determine whether a site meets the USFWS definition of a wetland by exhibiting at least one of the following characteristics: wetland hydrology, hydric soils, or a predominance of hydrophytic plant species. 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 n wetlands), and OBL (almost always occurs in wetlands) by the 2013 National Wetland Plant List (http://rsgisias.crrel.usace.army.mil/NWPL). For increased efficiency, surveyors will try to determine the easiest characteristic to observe at a given site and evaluate the site for that characteristic first. For example, if a site is composed almost entirely of *Phragmites australis* (FACW), the site will easily meet the hydrophytic vegetation component. If a site currently has standing water on the soil surface, it will easily meet the wetland hydrology component. It will usually be easiest to evaluate sites for the presence of wetland hydrology first unless a site is dominated by one or a few species that have wetland indicator statuses of FAC, FACW, or OBL. If many of the dominant species are not able to be identified to species, you will not be able to use the hydrophytic vegetation component.

Evaluation of each wetland characteristics will loosely follow the Army Corps of Engineers wetland delineation and regional supplement guidelines (U.S. Army Corps of Engineers, 1987; U.S. Army Corps of Engineers, 2008; U.S. Army Corps of Engineers, 2010). 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. When in doubt, look for a second characteristic to confirm that the site is wetland.

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 the Dutch 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 meterological stations (see http://www.wcc.nrcs.usda.gov/climate/wetlands.html). Using the Indicators of Site Hydrology in appendix A, determine whether there are 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 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. 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 3). 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 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.
c. Determine the cover values that correspond with 50% and 20% relative cover within the strata. For example, if the 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.
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 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.
e. 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).

Table 3. 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

Establishment of Assessment Area in the Field

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.

The location of AAs for the Weber River watershed project will be randomly selected using National Wetland Inventory (NWI) data. 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. Wetland for this project is any area that meets the definition used by the U.S. Fish and Wildlife Service (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) No more than 10% upland should be included 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).
4) The AA should be established in a single wetland. Features that denote wetland boundaries included above-grade roads, major water control structures, dikes, and major channel confluences.
5) The majority of an AA should be placed within a single Ecological System, though wetlands can have up to 20% inclusions of other Ecological Systems. If there is a firm boundary between two Ecological Systems, move the AA edge so that it only encompasses a single Ecological System. A mosaic of herbaceous and shrubby vegetation does not necessarily mean multiple ecological systems.
6) The edge of the AA must be within 60 m of 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.

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 (<20% upland and 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 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. 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.

2) *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. 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.

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. For Level 3 sites, flag the corners of the plots along the AA axes while setting up the AA. Plot setup is described in more detail in the Vegetation and Ground Cover Sampling Procedure section.

Recording tracks with the OREGON 450 GPS

Stand at the location where you want to begin recording a track. Scroll on the main menu of the GPS unit until you can select the Track Manager. Select Current Track, then Clear Current Track. This creates a new, empty track. Walk around the AA boundary until you return to the location where you started. Select Current Track again, then Save Track. Save the track as UniqueSiteID_TRACK. The device will ask you if you want to clear the current track; you can select yes. Now if you select the name of the saved track and View Map, you will see the track that you just created. Touch the screen at the top where it says the track name in order to see the area. An area of about 5000 m² is equal to 0.5 ha.

Data Collection

General Site Information

For the Weber watershed project, surveyors will receive a cover sheet for each site that contains information on the general site location (such as a creek name or other USGS landmark), ownership information, directions, and access information. Update this information as needed once at the site, such as modifying directions or updating with additional contacts met in the field. If the site is not able to be sampled (e.g., no target wetland, wetland too small, access to wetland too dangerous), update the site cover sheet with the reason for site rejection and make any additional notes as needed. Record the following information on the first two pages of the field forms:

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.

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.

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

AA Dimensions: Select whether AAs are 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, below. 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 elevation, 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 dimensions of the AA will dictate the type of spatial data that will be collected at each site. For circular AAs, record GPS coordinates at the center and points to the north, east, south, and west along the AA boundary. The waypoint ID for these points in both the GPS and on the field form should be *UniqueSiteID*_C for the center, with the C replaced by N, E, S, or W for points along the cardinal directions. For rectangular AAs, record GPS coordinates at each of the rectangle corners. Assign these waypoints as *UniqueSiteID*_R1 through *UniqueSiteID*_R4. For freeform AAs, record a GPS track of the AA boundary and assign the track name as *UniqueSiteID*_TRACK. *For every AA, record the coordinates for one point on the dataform; this is to ensure that we will have spatial data for the AA in the event of GPS failure. The remaining coordinate data will be obtained from the GPS unit and does not need to be separately transcribed.*

Record GPS coordinates at the locations where the four AA photos are taken for rectangular and freeform AAs unless they are at the same locations as other recorded waypoints (see below, circular AA photos will be taken at the boundary points recorded above). Also record waypoint information for soil pits and water quality data locations if outside the soil pit. Assign waypoint IDs for photos as *UniqueSiteID*_P1 (P2, etc.), for soil as *UniqueSiteID*_S1, etc., and for water quality as *UniqueSiteID*_W1, etc. At Level 3 assessment sites, take at least one photo of each intensive plot from the SW corner, facing NE into the plot for the photo. Assign IDs for photos as *UniqueSiteID*_Plot1 for each plot 1-4.

Take at least four photos of the AA from along the AA boundary looking in towards the site. For circular AAs, these photos should be taken at the north, east, south, and west boundary points. For freeform and rectangular AAs, take photos at any four well-spaced locations that capture different views of the AA. Record a waypoint at each photo point location if there has not already been a waypoint recorded at that location. Record the aspect in the direction into the AA that the photographer is facing. Also, record the uniquely assigned camera photo number. On the Nikon CoolPix camera, this is the four-digit number followed by .jpg at the top left when you view the photo on the camera, not the number listed on the bottom right that indicates the current number of photos stored in the camera's memory. Each of the AA photos will include a photo placard that lists the site ID, date (mm/dd/yyyy), waypoint ID, and aspect. The photo should be taken so that the placard is in the corner of the photo taking up as little of the frame as possible with little army or body visisble.

Take additional photos to capture an overview of the site (e.g., looking down on entire site from a high point) or document noteworthy features. You do not have to take a waypoint or record the aspect at each place where additional photos are taken unless the photo captures a feature that should be revisited or the photo would be useful for photo monitoring. Do record the photo number or range of numbers and a brief description when it may not otherwise be clear what the photo is capturing. At the end of the site visit, make sure that you record the unique identifier of the camera (record as camera make, either Olympus or Nikon) as well as the total number range of the photos taken at the site.

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 in regards to determining the water regime of the site. Collect the riverine-specific classification data for those sites classified as the HGM riverine class. 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. For the Weber watershed project, distinguish between upland and wetland using the guidelines outlined above. 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 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 recreated 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 at the space at the bottom of the form.

Ecological system: Use the key in the reference cards (appendix A) to select the Ecological System(s) present within the AA and their percent cover. 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, class, water regime, and modifiers as needed for the dominant type within the AA, based on information in the reference cards (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. Select the appropriate fidelity to classification based on the description of fidelity options from above.

HGM class: Select the appropriate hydrogeomorphic (HGM) class using the key in the reference cards (appendix A). There should only be one HGM class per AA, with the exception of minor inclusions that make up less than 10% of the AA. 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.

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 (see *name of entrenchment ratio section* for further description on identification of bankfull width. 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 stream 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 non-wadable (≥ 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 comprises/ contains the entire wetland and, if not, determine whether the AA has a low, moderate, or high degree of similarity to the surrounding wetland.

Wildlife observations: Make note of any wildlife observed during the site visit. If species cannot be identified, they can be noted more generally (e.g., dozens of small fish swimming in pools, a few tadpools, etc.).

Vegetation and Ground Cover Sampling Procedure

We will collect data on vegetation and ground cover (e.g., litter, algae, sediments, etc.) at every site. Quantitative data will be collected in plots at a subset of sites designated as Level 3 Assessment Sites; information on this procedure is presented below. At both Level 2 and 3 sites, we will record a list of all plant species found within the AA during a search that will last no more than one hour. At Level 3 sites, this search will be conducted after plots have been evaluated. 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. 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 at Level 2 sites and additionally in plots at Level 3 sites. Estimate the cover of exposed 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 canopy will be divided between canopy where the litter extends to the wetland surface and canopy 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 potential cover of water. 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 epiphytic algae covering submerged vegetation and 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 in four locations across the AA.

We will collect basic information on the vertical biotic structure at sites. We will not use this information as a condition assessment metric because we do not have enough information to determine the expected amount of vertical structuring in Utah wetlands; instead, we will compile baseline information on the type of structuring found at different wetland classes throughout Utah. 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 on mudflats. 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.

Level 3 Vegetation and Ground Cover Sampling

In addition to the data collected at the AA scale (Level 2, described above), in a subset of sites vegetation and groundcover data will be collected in defined-area plots. URAP will follow a flexible-plot layout adapted from the EPA's National Wetland Condition Assessment (NWCA, (www.epa.gov/wetlands/survey) that is being used by other regional condition assessment methods (Lemly and Gilligan, 2013). Absolute cover for vegetation and ground cover will be collected in four 10 m X 10 m plots placed at set locations along the cardinal axes of the standard 0.5 hectare circular plot (figure 1). Plot 1 is located on the northern axis, 15 m north of the center. Plot 2 is located on the eastern axis, 25 m from the center. Plot 3 is located on the southern axis, 5 m from the center. Plot 4 is located on the western axis, 15 m from the center. Plots are located on the left or counterclockwise side of the axis from the center facing in the cardinal direction of the axis.

Plot placement will vary based on the layout of the AA. When a layout other than the standard layout is used, place vegetation plots based on the following examples:

1a AA is a 0.5 ha polygon………2
1b AA <0.5 ha, but > 0.1ha or polygon equaling wetland boundary………………Wetland Boundary AA Veg Plot Layout

2a AA width and length > 30m……………………………………………………………………………..Wide Polygon AA Veg Plot Layout
2b AA is ≤ 30m wide ……………………………………………………………………………………..…..Narrow Polygon AA Veg Plot Layout

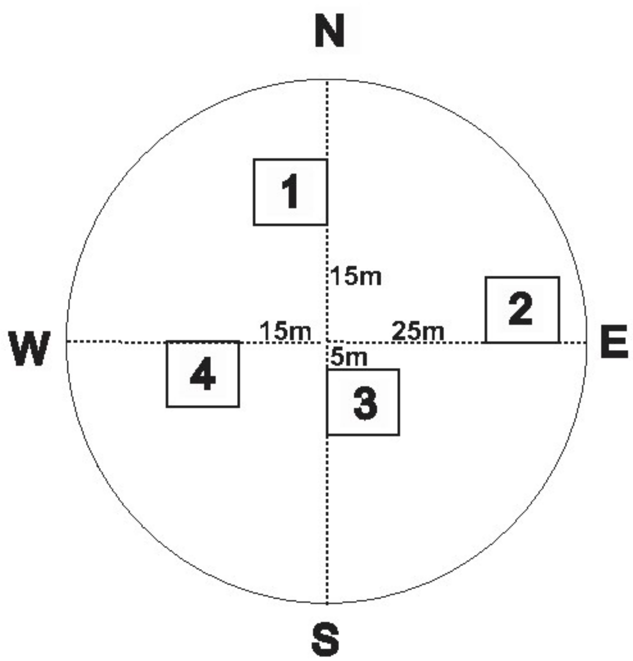

Figure 1. Level 3 plot layout for standard 0.5 hectare circular plot.

Setup and Documentation of Vegetation Plots

Markers placed at the AA boundary will be used to guide the 1 hour search for species at the AA scale for both Level 2 and Level 3 sites. For Level 3 sites, the cardinal axes of the AA will be used to mark quantitative vegetation plots during plot setup. Care should be taken not to trample vegetation in these areas by always walking on the right side of the axis when traveling through the AA and during setup. Plots will be located on the left or counter clockwise side of the axis when walking from the center of the AA. When setting up the AA boundaries, place a flag at 15 and 25 meters on the northern and western axes, at 25 and 35 meters on the eastern axis, and at 5 and 15 meters on the southern axis to mark one side of the Level 3 vegetation plots. Using a measuring tape or a measured 10 m rope, lay out the 10 m X 10 m plot perpendicular to the axis and flag the boundaries as much as necessary to mark the edge of the plot or use rope to demark the edge of the plot.

Prior to surveying each plot, at least one photo should be taken from the SW corner of each plot, face NE into the plot. No GPS coordinates will be collected for Level 3 vegetation plots unless plots are located in non-traditional locations.

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. No more than three percent of individuals in a population and no more than five cutting from perennial species will be collected to ensure the longevity of a species at sites. Collections will be numbered sequentially starting at one each day of sampling. If the same species is seen at two different sites during the same day, the same collection number can be used for both observations. Observers will fill out a collection slip (appendix A) for each specimen, including the same information listed on the newspaper as well as notes about the species height, flower color, presence of unusual odors, and any other features of note. This collection slip will be folded around the stem of specimen to aid with later identification. 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 and Water Chemistry Measurements

For both Level 2 and Level 3 assessments, surveyors will dig one soil pit in the dominant vegetation patch of the AA. A plant zone is considered dominant 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. If water chemistry data is taken elsewhere, record a GPS point at these locations as well.

Soil samples are collected using a sharpshooter shovel and an auger. Whenever possible, dig the soil pit to a depth of 50 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 Enginners, 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 cores 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, 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), and percent of coarse material if present. Coarse material are sediments larger in size than sand (> 2 mm). Refer to table 4 for a description of the redox feature types. If known, record the horizon of the layer. 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 (U.S. 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).

Table 4. Features that may be present within soil pits.

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

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 free water table is not present, record whether if the soil pit appears dry or is slowly filling. 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 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.

Whenever possible, water chemistry data will be collected in at least two locations per vegetation patch. If water is evident after the settling period in the soil pit, use a bailer 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 to minimize electromagnetic interference when measuring electroconductivity and total dissolved solids. Use a handheld multiparameter meter to measure pH, electroconductivity (EC), and temperature of the water sample. Rinse tips of meters with some of the water before collecting measurements and rinse with fresh water before storage. The total-dissolved-solids (TDS) value can be obtained based on the default meter conversion factor of 0.5 between EC and TDS. An important note: periodically test meter accuracy in known EC and pH solutions and calibrate them as needed and proper storage requirements need to be met. 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.

Collect at least one surface water chemistry measurement per vegetation patch if water is available. Circle whether the surface water sample is from within a stream channel, a pool, immediately adjacent to a location of groundwater discharge, 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 (see table 5 for an explanation of what different water colors may indicate). 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).

1. Carefully lower the cleaned tube into the water trying not to stir up any sedimentation 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 glasses, 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 at which you can first distinguish the two colors 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.

Stressor Checklist

Background: A stressor checklist can be an easy way to identify features on the landscape that may have adverse effects on wetlands. Most of these stressors are caused by anthropogenic activities or processes, which are affecting or have affected the natural system of the wetland through modifications and degradation. Several examples are: development, diking and ditching, waste water treatment facilities, and run-off from impervious surfaces. These "threats" are graded on how they affect the AA directly and not the wetland as a whole. While this checklist will not be part of the URAP metrics, it will be used to examine the correlation between stressors present and the condition site score of the AA.

Table 5. Water colors and their potential causes as described by Utah Water Watch Tier 1 Monitoring, Utah State University's Water Quality Extension (http://extension.usu.edu/utahwaterwatch/).

Color	Potential Causes
Clear	Usually associated with healthy waters. However, clear waters may be polluted with colorless substances. Very clear water without any living organisms indicates a pollution problem.
Brownish	Often results from decaying organic matter or lots of sediment.
Greenish	Slightly greenish water results from the presence of microscopic plants or algae and usually indicateshealthy conditions. Deep green, or pea soup color, often results from an overabundance of algae (phytoplankton). Heavy nutrient loads from fertilizers, animal waste, and poor sewage treatments often promote heavy amounts of algae.
Reddish	May result naturally from drainage through soils rich in iron and tannins.
Blue	Clear cool waters often have a blue color. Strong blue colors can result from glacial runoff.
Orange	May indicate runoff from mines or oil well; may result naturally from drainage through soils rich in iron and tannins.

200 Meter Stressor Checklist: This stressor checklist focuses on a 200 m buffer surrounding the AA. Prior to the field visit, mark the stressors in that buffer that can be seen in the aerial imagery on the site map. Verify these stressors in the field and make the appropriate changes if needed and add any new stressors found. For every stressor identified, record the extent of the area it occupies within the 200 meter buffer and whether it is hydrologically connected to the site. Then examine the severity the stressor has ***directly*** on the AA in the following categories: hydroperiod, water contaminants including nutrients and toxins, sedimentation, and vegetation stress. Also, assess the general severity of the feature- a highway will usually have a higher general severity than a low-use road. *Pay close attention to the stressor direction (slope) from the AA as the severity can vary (e.g., a gravel road down slope might not have any effects on sedimentation or water quality but it could still affect wildlife use).* When assessing for browse and herbivory, exclude normal damages by native wildlife. Extensive damage by native wildlife should be noticeable without having to spend an extended period of time searching for it. A helpful way to assess the effects of stressors such as roads, trails, and development have on vegetation in the AA is to think how they are potentially introducing invasive plant species. Examine the edges of those stressors and identify if invasive plant appear to be approaching towards the AA. The severity of timber harvest and the removal of other vegetation should be based on how well the site appears to have recovered from the disturbance. For example, if there is still evidence of soil compaction and erosion caused by machinery and lack of the expected new growth for the habitat type, then a site will be listed as more severe. If the disturbance occurred years ago and the site seemed to have recovered and is now stable, the severity will most likely be low to none. Wild/ prescribed fire severity should only be based on the effects it had at ground level and to the soil, not the woody vegetation. For example, the organic matter and mineral soil will be lightly charred ~ 1 cm deep for a low severity fire, while a server burn will have deeply charred the organic matter at depths of >10cm. Refer to table 6 for a brief description and examples of the different stressor categories the checklist assess

Table 6. Categories of stress for evaluating buffer stressors.

Category	Description and examples
Hydroperiod	Features that affect the frequency and duration of inundation and drawdown to the AA (e.g., ditching up-slope that's diverting water off-site, roads blocking natural run-off to sites)
Water Contaminates- Nutrients Enrichment/toxins	Hypertrophication to the AA (e.g., livestock defecating, fertilizers, waste treatment discharge into the AA water source leading to algae blooms and pollutants) (e.g., petroleum products, pesticides, metals and other toxic chemicals) that are released directly or indirectly in the AA water source e.g., petroleum enriched runoff from impervious surfaces or bio solid discharges into the AA water source
Sedimentation	The settling of suspended particles into the AA (e.g., soil and debris runoff from a recently plowed field)
Vegetation Stress	How the vegetation responds to the different stressors, (e.g., soil compaction limits the plants ability for root penetration and water permeability and how the stressor helps to spread invasive and noxious plants)

AA Stressors and Physical Habitat Evaluation: Walk through the AA to mark any stressors that are present directly within the AA. AA stressors to vegetation, physical habitat, and hydrology are evaluated. For each stressor, only consider how it affects the category you are assessing. For example, livestock grazing evaluated in the vegetation stress is only for grazing and browsing, while trampling and digging falls under physical habitat component and pugging would affect the hydrology.

RAPID ASSESSMENT METRICS

Landscape Context Metrics

Metric: 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 it 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 more species movement through the landscape. This movement is important for processes such as 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: In the office using GIS, draw a circle that extends 500 m out from the edge of the AA on an area map with the most up-to-date aerial imagery available. Spatial data such as land cover and road layers may help in evaluating features in the landscape. Print map of buffer for use in field assessments. In the field, verify or update land cover shown on the aerial imagery. Then sketch out 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 (see buffer land cover list in table 7), a hard boundary is formed even if natural land cover exists on the other side. The zone of a road's influence, such as trash and road fill along the road border, should also be considered as 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 the metric (table 8). This estimated percentage will be later verified in GIS by sketching out the new buffered land cover boundary and making changes to the estimated percentages as needed.

Table 7. 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.

Metric: 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.

Table 8. 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.

Deciding whether particular land cover classes qualify as buffer can be difficult because the impact of most land cover types varies depending on the potential stressor being evaluated. For example, low-use dirt roads may contribute sediment to a wetland but not impede movement for mammalian wildlife species. One way to evaluate contribution of land cover to wetland pollutants is via export coefficients and event mean concentration (EMC) values that are assigned to land cover classes based on the degree to which they release particular pollutants into a system. Export coefficients and EMC values can be difficult to calibrate and depend heavily on underlying conditions in a region. However, regional or national values can be useful for comparing and ranking sources of nutrient loads (Lin, 2004), and we used these values to help determine land cover types that should be considered buffer and non-buffer for this metric.

Measurement protocol: Determine the percent of the perimeter of the AA that has buffer land cover (table 9) using the definitions of buffer land cover provided in table 8. 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. When evaluating a land cover type not specifically listed, consider the extent to which that cover type contributes TSS, 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 9. 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.

Metric: 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 Kennedy and others (2003) found that effective widths for wetlands are 9 to 30 m for sediment and phosphorus removal and 30 to

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 and others, 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, draw eight transects extending 200 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. 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. Length estimates for each transect will be translated to mean buffer width (table 10). Estimate slope along the transect as <5%, 5-<15%, 15-<25% or >25%, overall surface roughness of the transect as low, moderate or high, whether the transect is upslope or downslope from the wetland, and whether transect is composed of open water at least 30 m in width directly adjoining AA. See Johnson and Buffler (2008) appendix A-6 for more detailed definitions of surface roughness and corresponding images. Last, record the land cover type of the first non-buffer land cover reached along the transect. If this land cover is less than 10 m wide, also record the next land cover type (whether buffer or not) along the transect. Surface roughness can be determined using the following key, adapted from Johnson and Buffler (2008), evaluated in aggregated 10-m wide cross sections on either side of buffer transects

1) Developed or managed area (e.g., intensively grazed, mowed, used for agriculture) or exposed mineral soil due to human use ....Low
2) Intact mineral surface and not a managed area
   a) Roughness features, including coarse-woody debris, herbaceous litter, vegetation, biological soil crusts, boulders, rock outcrops and complex undulating microtopography, cover less than 35% of buffer transect .... Low
   b) Roughness features cover more than 35% of buffer transect
      i) <5% of transect has roughness features other than herbaceous vegetation .... Low
      ii) >5% of transect has roughness features other than herbaceous vegetation
         (1) Between 35 and 65% of transect has surface roughness features .... Moderate
         (2) >65% of transect has surface roughness features .... High

Table 10. Metric rating for buffer width.

Ranks	2014 Arkansas Colorado Natural Heritage Program Ratings	2013 South Platte Colordao Natural Heritage Program Ratings	BAD transects (not meeting criteria)	BAD (with only UP transects
A	Average buffer width is 95-100 m	Average buffer width is >200 m	None	
A-	Average buffer width is 75–95 m	Average buffer width is >100–200 m	1	
B	Average buffer width is 50–75 m	Average buffer width is >50–100 m	2 or 3	1 or 2
C	Average buffer width is 25–50 m	Average buffer width is >25–50 m	>3	3 or 4
D	Average buffer width is <25 m OR no buffer exists	Average buffer width is ≤25 m OR no buffer exists		>4

Metric: 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 actually 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 also may provide less habitat for wildlife and be more prone to plant invasion.

Measurement protocol: Walk through enough of the 200 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 11 that best describes the condition of the buffer land cover. The percentages expressed in the states should be used for guidance only; use on-site judgment to determine the most appropriate score and make a note if the amount of disturbance of the buffer soil differs from that expressed in the selected state. For example, a site with 5% cover of severe disturbance located very far from the wetland edge and no other more proximal disturbances would probably be rated as B instead of C. Evaluate this metric by thinking about both the severity and spatial extent of disturbed soil conditions in the buffer.

Metric: 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 200 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 that best describes the condition of the buffer land cover (table 12).

Table 11. 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 inpact.
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.
NA	No buffer land cover present.

Table 12. 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.
NA	No buffer exists.

Hydrologic Condition Metrics

Hydropattern is a term used to describe the frequency, duration, timing, and aerial cover of inundation of a wetland (U.S. Environmental Protection Agency, 2008). Hydropattern is a defining characteristic of wetlands that exerts substantial control on their physical and biological properties. We use two metrics to evaluate components of hydropattern: hydroperiod (frequency and duration of inundation) and timing of inundation. Changes in site microtopography caused by soil disturbance within the site that may impact water distribution are captured in the soil and substrate disturbance metric and not specifically addressed in the hydrologic condition metrics. Hydropattern and timing of inundation are often interrelated; for example, a site that receives water inputs later in the year than is natural may have a shorter duration of inundation due to increased evapotranspiration. We are most 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 plants. 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 (Kadlec and Reddy, 2001; Picard and others, 2005). Changes to hydropattern outside the growing season can also affect functional services such as flood attenuation; this metric does not emphasize these potential changes.

Metric: Hydroperiod

Definition and background: Hydroperiod is the term used to describe the frequency and duration of inundation of a wetland (U.S. Environemental Protection Agency, 2008). Hydroperiod is a defining characteristic of wetlands that exerts substantial control on their functioning. Duration of wetland inundation has been shown to affect richness and community composition of invertebrate (Tarr and others, 2005) and amphibian (Snodgrass and others, 2000) species. Hydroperiod, including inundation frequency, also may affect nutrient cycling in wetlands (Tanner and others, 1999). A review by Webb and others (2012) found that changes in the duration of wetland inundation lead to changes in plant species composition and frequently (though not consistently) altered measures of plant establishment, plant growth, and species richness. The same review found insufficient evidence due to paucity of studies to evaluate most effects of inundation frequency on wetland vegetation, though they did find that changing frequency generally did not affect plant richness. Similarly, Robertson and others (2001) found that frequency of flooding (one annual flood versus two) did not affect macrophyte species richness and biomass in floodplain wetlands in Australia. 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). Large changes in inter-annual frequency are likely to change plant species composition because some species that require flood or dry conditions to germinate may not establish often enough to maintain a viable seed bank and absence from flooding for one or more seasons in sites that are naturally regularly flooded will allow less tolerant species to invade.

Measurement protocol: First, check of all ***major*** sources of water to the site based on the list below. 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, snow-melt created lakes). Alluvial aquifer refers to locations with elevated water tables adjacent to rivers and streams. Next, use the stressor checklist and description of site hydrology obtained during the office evaluation to assist in evaluation of this metric, making sure to consider each stressor's impact relative to the overall water budget at a site (table 13). The inundation duration can be longer or shorter due to increases or decreases in the amount of water reaching a site or due to modifications that affect the inflow and outflow at sites, including obstructions to flow, channelization, and geomorphic modifications like soil compaction or pugging. The frequency of inundation will sometimes change with the removal of natural water sources or the addition of new water sources. Sites that receive more controlled inputs of water (e.g., due to controlled release from dams) will often be inundated less frequently but for longer duration. Sites that receive more flashy inputs (e.g., due to large input of runoff from impervious surfaces rather than via groundwater infiltration) will often be inundated more frequently for shorter duration.

Select sources of water:

Natural Sources
___ overbank flooding from channel
___ overbank flooding from lake
___ groundwater discharge
___ alluvial aquifer (subsurface floodplain flow)
___ natural surface flow
___ direct precipitation
___ direct snowmelt

Unnatural Sources
___ irrigation via direct application (incl. managed ditch)
___ irrigation via seepage (e.g., leaking ditch)
___ irrigation via tail water run-off
___ discharge from impoundment release
___ urban run-off/culverts
___ pipes directly feeding wetlands
___ other (list)___________________________

Table 13. Metric rating for hydroperiod.

Rank	State
A	The hydroperiod, including frequency and duration of inundation and drawdown, within the AA is natural. There are no major hydrologic stressors that impact the hydroperiod. 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	Hydroperiod is predominantly controlled by natural hydrologic processes, but deviates slightly from natural conditions. The duration may be slightly longer or shorter due to decreases or increases in the amount of water reaching the AA or due to minor modifications affecting the inflow and outflow of water. The frequency of major inundation periods within a year is natural, though there might be one or two fewer or additional minor peaks of inundation. The site may be somewhat more susceptible to a change in inter-annual inundation frequency, but only in response to more severe drought or flood years. Potential deviations include: • small decrease in inundation duration (e.g., small diversions that remove water during peak inundation, small enlargement of channel exiting AA, small noticeable effects of nearby water withdrawals, slightly flashier floods due to cover of impervious surfaces in the contributing area) • small increase in inundation duration (e.g., minor inputs of tailwater irrigation, outflow slowed by small amount of sedimentation blocking channels, small increase in natural berm height, slightly more controlled water input due to dams on tributaries feeding the AA) • change in intra-annual frequency by one or two minor periods of inundation (e.g., secondary flooding in fall with duration and depth much less than primary flooding) • rare (only in extreme years) change in inter-annual flood frequency (e.g., due to impact of groundwater pumping or water withdrawals or management priorities).
C	The hydroperiod of the AA deviates moderately from natural conditions. The pattern of inundation and drawdown is still predominantly natural, but may be more noticeably shifted in duration or may occur in conjunction with more noticeable changes in frequency. Some potential deviations include more moderate examples of stressors to duration listed above as well as occasional (2 or 3 years out of 10) change in inter-annual flooding frequency.
C-	The hydroperiod of the AA deviates substantially from natural conditions. A natural pattern of inundation and drawdown is still evident, but may be more dramatically shifted in duration and frequency, or may be secondary to anthropogenically created hydropatterns. The hydropattern may be predominantly or entirely created, 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. Some potential deviations include more severe examples of stressors to duration listed above as well as frequent (every 3 or 4 years) change in inter-annual flooding frequency.
D	The hydroperiod is dramatically different from any natural wetland analogue. The duration and frequency of inundation may be completely artificially controlled. Natural hydrologic inputs to the wetland may be severely limited or eliminated. The wetland may be in steady decline and may not be a wetland in the near future. Sites are more likely to rate in this category when they experience drying conditions rather than simply because they receive artificial water inputs because the latter sites will often be at least tangentially analogous to a natural wetland. Sites in this category will often experiences extreme changes in the frequency of flooding. Examples of conditions that may lead to sites being rated in this category include: • extreme(relative to natural period) alteration of inundation duration (e.g., groundwater pumping causing spring to run dry except briefly in the spring) • extreme (almost every year or several times per year for sites that are flooded annually) change in flooding frequency (e.g., dikes blocking all flow to site except during years of extreme floods, groundwater pumping or water withdrawal that leave sites dry most years, detention basins that undergo short fill and release cycles following heavy precipitation events).

Metric: Timing of Inundation

Definition and background: This metric evaluates the degree to which wetlands receive water during seasonally appropriate times. 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. Environmental Protection Agency, 2008). A review of the effects of changes in hydropattern on wetland plants 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). For the sake of this metric, we assume that artificial flooding or drawdowns near the end of the growing season will have a smaller effect on sites than events at the beginning or middle of the growing season. These earlier periods are likely to be more critical for the reproduction and development of many avian, amphibian, and plant species.

Measurement protocol: Use the stressor checklist and description of site hydrology to assist in evaluation of this metric (table 14). Consider each stressor's impact relative to the natural timing of inundation at the site and the overall water budget. For example, a site that now only receives water from irrigation return flows during periods of the growing season that were normally dry would score lower than a site that receives a natural spring influx of water as well as an equal amount of return flows as the first site. When evaluating artificial sources of water, consider whether the site would have normally received any water during the time at which the artificial water source is inputting water into the AA. 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. Think of timing of inundation as related to the timing of pulses of water, not the overall amount of water, reaching a site.

Metric: 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 and staining in the water caused by the release of tannins from the breakdown of certain vegetation types. However, turbid waters can often be an indicator of anthropogenic stressors degrading water quality. Storm-water runoff and anthropogenic soil disturbance, such as certain agricultural practices and off-road travel, can potentially contribute to sedimentation that affects turbidity.

Table 14. Metric rating for timing of inundation.

Rank	State
A	Site inundation has no to very little deviation from natural timing. Sites that fall into this category generally have no or only very distant stressors to the water sources in their contributing area and no on-site stressors that affect water input, including artificial water sources.
B	Sites have a small shift in inundation timing of hours up to several days or inundation timing is natural for the majority of inflow to sites, but there are either small additional inputs of water during the growing season at times when the site would not normally receive water input or moderate additional inputs of water near the end of the growing season. Examples of potential deviations include: • accelerated timing of water input due to straightening of input channels • accelerated timing of water input due to small or distant areas of impervious surface in the contributing area • delayed timing of water input due to flow regulation on tributaries • small inputs of irrigation water via seepage or tailwater runoff in addition to naturally timed influxes of water • moderate levels of artificial fall inundation due to increased flow in channels at the end of irrigation season or moderate amount of water released from impoundments.
C	Sites have a moderate shift in inundation timing of several days up to three weeks or inundation timing is mostly natural (shifted up to hours or days) for the majority of inflow to sites, but there are either moderate additional inputs of water in the middle of the growing season at times when the site would not normally receive water input or large additional inputs of water near the end of the growing season. Examples of potential deviations include: • accelerated timing of water input due to moderate to large areas of impervious surface in the contributing area • delayed timing of water input due to water control structures that more directly control input to sites • water added to impoundments according to management schedule only somewhat in tune with seasonal patterns • moderate inputs of irrigation water via seepage or tailwater runoff in addition to naturally timed influxes of water • pumping of water into site at times when site would normally not receive input • large levels of artificial inundation in the fall for management purposes.
C-	Sites have a large shift in inundation timing of three weeks up to two months or inundation timing is somewhat natural (shifted up to days or weeks) for the majority of inflow to sites, but there are large additional inputs of water during the growing season at times when the site would not normally receive water input. Examples of potential deviations include: • naturally timed water input almost entirely absent (or naturally small) and majority of water influx is now from irrigation return-flows, irrigation seepage, or wastewater effluent pipes during times that site would normally be dry • site managed with very little regard to natural timing of water inputs (e.g., multiple large additional inundations throughout the dry season with only a little inundation during normal flood periods).
D	Sites have an extreme shift in inundation timing of over two months or there is a large shift of weeks to months in inundation timing as well as large additional inputs of water in the middle of the growing season during times when the site would not normally receive water. Sites that no longer receive natural water inputs due to anthropogenic stressors most years will also score in this category. Examples of potential deviations include: • site completely dry except when it rains because pumping has eliminated natural groundwater supply • site only flooded late in the growing season when water from up-gradient impoundments are released.

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 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 15. For sites that score C or D, take a photo of the water so it can be referenced later, and record 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 check off that contamination appears natural at these sites.

Table15. Metric rating for turbidity and pollutants.

Rank	State
NA	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.

Metric: 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. Similarly 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: See table 16.

Table 16. Metric rating for algae growth.

<table>
<tr><th>Rank</th><th>State-Wet Sites</th><th>Rank</th><th>State- Dry Sites</th></tr>
<tr><td>A</td><td>Water is clear with minimal algal growth and there is no visual evidence of degraded water quality.</td><td>AB</td><td>Site has little to no evidence of dried algal mats.</td></tr>
<tr><td>B</td><td>Algal growth is limited to small and localized areas of the wetland. Water may have a greenish tint or cloudiness.</td><td>C</td><td>Site has moderate to large patches of dried algal mats.</td></tr>
<tr><td>C</td><td>Algal growth occurs in moderate to large patches throughout the AA. Water may have a moderate greenish tint or sheen. Sources of water quality degradation are apparent (identify below).</td><td rowspan="2">D</td><td rowspan="2">Site has extensive dried algal mats. Mats may be relatively thick, cover much of the AA, and/or are matted around vegetation.</td></tr>
<tr><td>D</td><td>Algal mats are extensive, blocking light to the bottom. Water may have a strong greenish tint and the bottom is difficult to see. There are obvious sources of water quality degradation (identify below).</td></tr>
</table>

Metric: 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 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/or 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 may have very large contributing areas. When considering the severity of stressors in the contributing area to these latter AAs, consider the degree to which stressors are buffered from the sites by major changes in hydrology. For example, 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. Also look for the presence of oil and gas extraction close to the site. Determine whether there are Superfund sites (http://cumulis.epa.gov/supercpad/cursites/srchsites.cfm) or major clean water act permittees (http://echo.epa.gov) likely to influence your site. Also determine whether the major water source to the AA has been listed as impaired by the state of Utah (http://mapserv.utah.gov/SurfaceWaterQuality). See *The Utah Rapid Condition Assessment User's Guide for Site Office Evaluation- 2014* for additional guidance for conducting an office evaluation for this metric.

During the field survey, you will collect data on water quality stressors within 200 m of the site as part of the buffer stressor checklist. Evaluation of buffer water quality stressors should 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. In some cases, the AA and the entire 200 m buffer may encompass the same wetland. Surveyors may use their discretion to consider inputs directly on the wetland edge and how they may affect the AA water quality when they are overland inputs found just outside the 200 m buffer in these wetlands.

Determine the state that best describes the water quality of the AA (table 17). 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 all 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.

Metric: Connectivity

Definition and background: This metric is a measure 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 both on the immediate edge of the AA and for the actual wetland edge. The former value provides information on the percent of wetland area within a survey sample frame that is connected to adjacent land, and the latter value provides information on the actual connectivity of individual wetlands with surrounding land cover.

Measurement protocol: Score this metric at both the edge of the AA and the edge of the whole wetland (table 18). If wetlands are very expansive in size, assessment can be made at the edge of the area approximately 500 m from the AA instead of for the whole wetland. Wetland edge will be defined by major breaks in hydrology or transitions from wetland to upland or deepwater habitat (e.g., the edge of a wetland adjacent to water will be considered at the location where the water becomes deepwater habitat instead of wetland). Determine the percent of edge that consists of features, such as very steep banks, levees, concrete walls, rip-rap, and road grades, which could restrict the lateral movement of rising waters. When evaluating features to determine whether they interfere with connectivity, consider the extent to which they create gradual versus abrupt transition zones between edges and the surrounding landscape.

Table 17. Metric rating for water quality.

Rank	State
A	There are no water quality stressors within 200 m up-gradient of the site or potentially a few that are minor (e.g., small areas with bare ground or lightly grazed pasture, a few fertilized lawns, etc.) and unlikely to impact the site (e.g., at least 100 m from site or further with steep slopes or poorer quality buffer). The land cover of the contributing area to the site is predominantly natural with no oil and gas extraction, Superfund sites, or 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. Stressors may include: • up-gradient stressors within 200 m of site that are minor or somewhat buffered from site or well-buffered if more severe (e.g., run-off from dirt road with narrow buffer or expansive area of exposed sediment with 100 m vegetated buffer) • development or cropland in <20% of contributing area and inputs from these stressors are minor or diluted by tributaries • extensive rangeland or pasture with mostly intact soils • streams that feed site have unimpaired water and dischargers are distant from site and likely to be highly diluted by tributaries or attenuated by reservoirs before reaching the site • oil and gas extraction and Superfund sites are unlikely to influence site.
C	Site likely to receive moderate input of water quality stressors. Stressors may include: • up-gradient stressors that occur within 200 m of the site that are more moderate in extent or severity and less well-buffered from site (e.g., run-off from low-density development directly reaching site or nutrient input from a farm; consider both the buffer between the stressor and slope; very low slope may be B and very steep slope may be C-) • light to moderate livestock grazing may occur within site, though unnatural bare patches in sites are absent or uncommon. • development or cropland in ~20-60% of the contributing area • moderately grazed rangeland/pasture across much of the contributing area • oil and gas extraction and point source dischargers may have some influence on site, but are generally distance, not considered major, and heavily diluted before reaching site. • major water supply to the site is not listed as impaired under the state's most current 303(d) list unless the water quality is likely to improve before reaching the wetland (e.g., site is distant from impaired section, water flows through reservoirs or emergent vegetation that may help attenuate water quality stressors, etc.).
C-	Site likely to receive substantial water quality stressors, though the most severe stressors are at least somewhat buffered from sites. 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). Stressors may include: • high intensity livestock grazing, irrigation water return flow, fertilizer and pesticide application, and erosion from fires, construction, off-road vehicles, and dirt roads *directly discharging into sites.* These stressors may be considered C run-off from the features is likely to only occur infrequently or if slope is shallow. • heavy grazing within AA with large patches of bare earth and/or extensive additional of manure • site has reasonable likelihood of groundwater contamination from nearby Superfund site or other activities. • over 60% of the contributing area contains agriculture or development that is likely to impact the site's water supply • large concentration of CAFOs or point source dischargers that contribute to the AA's water supply that are somewhat attenuated before reaching site
D	Site receives severe inputs of water quality stressors with little to no buffer from the influence of these stressors. • overland run-off from nearby stressors is severe enough to be visibly evident within the AA (e.g., sedimentation runoff from a nearby burned area clearly covering vegetation and/or making water very turbid or manure run-off from animal feeding operation is large and shows clear unfiltered pathway between operation and AA). • evidence of recent severe spill at site, such as a large oil spill or release of contaminated water. • hydrology of site may be highly impacted by groundwater contaminants from Superfund or other sites. • major point source dischargers and dischargers in violation of permit standards may discharge directly into the water source near the site. • site's main water source may be listed as impaired under the state's most current 303(d) list and the site receives direct input of this water with very little potential attenuation of water quality.

Table 18. Metric rating for connectivity.

AA edge	Whole-wetland	State
A	A	Rising water has unrestricted access to adjacent areas 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 (see entrenchment ratio in optional riverine metrics).
B	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 <50% 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. If playa, surrounding vegetation does not interrupt surface flow.
C	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 50–90% 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. If playa, surrounding vegetation may interrupt surface flow.
D	D	The amount of adjacent transition zone or the lateral movement of flood waters is limited, relative to what is expected for the setting, by unnatural features for >90% of the boundary of the AA. 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 19).

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.

Table 19. 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. Damage is obvious, but not excessive. 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.

Measurement protocol: Evaluate the presence and distribution of patches of open water and vegetation within the AA, using figure 2 for guidance (table 20). 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. For example, a site can be rated as B if it has *either* three patches that not very interspersed or two very interspersed patches with a lot of edge area (figure 2).

Metric: Litter Accumulation

Definition and background: This metric evaluates the degree to which the abundance and distribution of herbaceous and/or 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. Fires, grazing, and haying frequently lead to lowered litter accumulation, invasive plant species frequently lead to excessive litter accumulation, and changes in hydroperiod can affect litter in either direction.

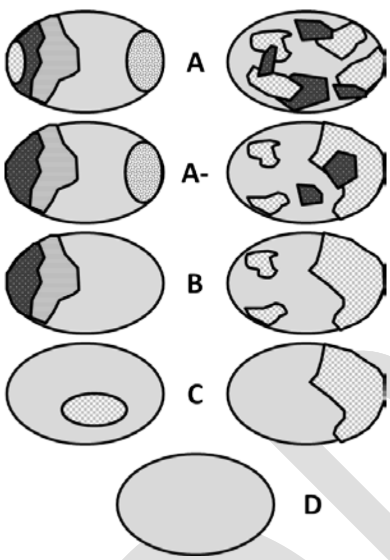

Figure 2. Diagram for rating horizontal interspersion.

Table 20. Metric rating for horizontal interspersion.

Rank	State
A	High degree of horizontal interspersion: AA characterized by a very complex array of nested or interspersed zones with no single dominant zone.
A-	Moderate to high degree of horizontal interspersion: AA is characterized by a complex array of nested or interspersed zones with no single dominant zone.
B	Moderate degree of horizontal interspersion: AA characterized by a moderate array of nested or interspersed zones with no single dominant zone.
C	Low degree of horizontal interspersion: AA characterized by a simple array of nested or interspersed zones. One zone may dominate others.
D	No horizontal interspersion: AA characterized by one dominant zone.

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 21). 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. Sites with small patches of abnormal litter can be considered AB, whereas sites with larger patches lacking litter or with extensive litter may be considered C instead of D if otherwise the litter is normal.

Table 21. 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.

Metric: 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 Ecological System and particular site (table 22). 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 22. Metric rating for woody debris.

Rank	State
NA	There are no obvious inputs of woody debris.
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. 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.

Metric: Woody Species Regeneration

Background and definition: Woody species regeneration 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 23). 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.

Table 23. Metric rating for woody regeneration.

Rank	State
NA	Woody species are naturally uncommon or absent.
A	All age classes of desirable (native) woody species present.
B	Age classes restricted to mature individuals and young sprouts. Middle age groups absent.
C1	Stand comprised of mainly mature species, with seedlings and sapling absent.
C2	Stand mainly evenly aged young sprouts that choke out other vegetation.
D1	Woody species predominantly consist of decadent or dying individuals.
D2	AA has >5% canopy cover of *Elaeagnus angustifolia* (Russian olive) and/or *Tamarix* (tamarisk) or other invasive woody species (list species below). If you select this state, select an additional statement that describes native regeneration in AA.

Plant Species Composition

Metric: Relative Cover Native Species

Definition and background: This metric is the measure of 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 more 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 24). 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 24. Metric rating for relative cover native species.

Rank	Colorado Natural Heritage Program Field Manual and 2014 Arkansas Manual ratings
A	AA contains >99% relative cover of native plant species.
B	AA contains 95–99% 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.

Metric: Absolute Cover Invasive Species

Definition and background: Certain non-native plant species are known to be particularly disruptive to natural processes. These species, which we term invasive species, generally are able to spread aggressively to take over native vegetation and usually have documented negative ecological impacts. Several methods can be used to determine which species should be considered invasive. 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; however, some species may not make the list due to political constraints (i.e., species is deemed too difficult to regulate) and the political process may be slow to list emerging threats. The Environmental Protection Agency developed a list of invasive species for the National Wetland Condition Assessment that included species with known ecosystem impacts that were readably identified in the field, and have national distributions. This list includes 24 species, including 18 known to occur in Utah. This list was developed specifically for wetland surveys, but is not meant to be regionally comprehensive. Regional planning documents and expert knowledge can be used to supplement invasive species lists with additional species of concern. For example, the Utah Division of Wildlife Resources action plan for addressing species of concern at Waterfowl Management Areas includes information for two species not listed as noxious weeds in Utah, *Cicuta douglasii* and *Cirsium vulgare* (Berger, 2009).

Measurement protocol: Estimate the total percent cover of all plants considered invasive species using either a species list or field ocular estimates (table 25). If not using a species list, surveyors will have to have a list of all invasive species with them in the field in order to make estimates. We will use species listed by USA-RAM as invasive and species on noxious weed lists in Utah and surrounding states (Arizona, Colorado, Idaho, Nevada, and Wyoming) as our designated invasive species. Additional species will be added based on expert recommendation.

Table 25. Metric rating for absolute cover invasive species.

Rank	Colorado Natural Heritage Program Field Manual and 2014 Arkansas Manual ratings
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.

Riverine-Specific Metrics

Placeholder for Riverine Metrics, need some clean-up

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 and the differences between wetland classes.

Metric: 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 class for each patch type present in the AA (see cover reference diagram in the appendix). For features that occupy at least 1 m^2 but less than 1% of the AA (50 m^2 for a standard 40 m radius AA), select cover class 1.5, and for features that occupy less than 1 m^2, select trace. 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 (e.g., most pools are filled with water at the time of the survey). Features have been organized into categories to facilitate selection in the field. Use patch descriptions and the CRAM photo dictionary (http://www.cramwetlands.org/documents) to properly identify each patch type.

Metric: 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 micro- and macro-topography at a site. Micro-topography refers to features such as the patches listed under the structural patch richness metric (above), whereas macro-topography refers to the larger-scale heterogeneity in structure caused by elevational features such as benches and slopes of varying steepness. The U.S. Natural Resources Conservation Service's Wetland Science Institute defines micro-topography 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" (U.S. Natural Resources Conservation Service, 2003). For the purposes of this assessment, macro-topography include any vertical, physical features greater than 15 centimeters and up to 30 centimeters, such as deep depressions, terraces, swales, or sloughs, but also include topographic elevation gradients that support distinctly different vegetation communities and/or hydrologic regimes. Both macro and micro-topographic features are important to moisture gradients and/or alter water flow paths across wetlands.

Measurement protocol: At two locations (preferably along the north-south and east-west axes for a 40 m radius AA), sketch the profile of the AA from edge to edge. In the drawing, include benches, major changes in slope, and generalized macro/micro-topographic features (i.e., draw wavy lines where micro-topography exists instead of individual features). Plant assemblages with different salinity and water-level tolerances can be used to indicate where topographic differences exist. Figure # provides an example of scoring based on combinations of macro and micro-topographic features. Use profile sketches, overall site evaluation, and descriptions to rank overall topographic complexity of the AA.

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Appendix A

Reference information to assist with field surveys.

Field Order of Operations and To Do Checklist

1) Determine whether site can be sampled (wetland present and at least 0.1 ha).
2) Determine placement of AA.
3) Flag out boundary and collect GPS coordinates and photos. Spatial data will be named in the GPS as *UniqueSiteID* followed by an underscore and unique identifier following the naming conventions below.

Feature Type	Identifer	Feature Type	Identifer
Center point	C	Photos (if not at cardinal pts or corners)	P1, P2, P3, etc.
Cardinal points	N, E, S, or W	Soil pit	S1, S2, S3, etc.
Rectangle corners	R1, R2, R3, R4	Water Quality (if not in soil pit)	W1, W2, W3, etc.
Freeform track	TRACKS	Vegetation plot	V1, V2, V3, V4

AA type	Spatial Data	Photos	Flag
Circular	Center and N, E, S, W points	N, E, S, W points	Center and N, E, S, W points, 40 m from center
Rectangular	Corner of rectangle and photo points	Four locations along boundary facing in	Corner of rectangle and in middle of long edges
Freeform	GPS track on edge plus photo points	Four locations along boundary facing in	Along boundary as needed

4) Classify wetland by Ecological System, Cowardin Class, and HGM and ensure AA does not cross Ecological System boundaries. Determine the number of vegetation patches within AA and which need to be sampled (those with ≥30% cover within AA). Fill out remaining descriptive fields on page 1 and 2 of field forms.
5) Take at least one surface water chemistry measurement per major patch.
6) Dig soil pits and describe soil profile. Record time so that total settling time of pit can later be determined.
7) Record plant species in AA for no more than 1 hour. This can occur simultaneously with steps 5 and 6, but should be done to minimize altering surface water chemistry samples. Record litter and water depth measurements during this process.
8) Estimate cover for listed plant species and for ground cover and vertical strata components
9) Draw site sketch and write site description, if site is well understood before sampling (can be done simultaneously with step 7).
10) Fill out EIA metrics and stressor data. Make a list of any features in the buffer area that need to be examined on the hike out of the site.
11) Collect water quality data in soil pits and final soil pit measurements.
12) Conduct gear check, remove all flagging, and ensure that all unknown plant species have been collected. Clean shovel and augur if water is available on site.
13) Look over datasheet to ensure that all data is complete and accurate (check off QC info)
14) Visit any uncertain features in the buffer on the hike out of the site. Label on site map and update metric data as needed.

Checklist Before Leaving the Field

□ QC all data sheets

□ Remove all flags

□ Make sure all spatial data is recorded in GPS

□ Take all necessarily site photos including:

1. Four site photos from AA edge facing towards center
2. Algae site scored below an A
3. Turbidity and pollutants, if site scored below an A
4. Litter accumulation, if site scored below an A
5. Photos to illustrate unusual features or features that cannot be identified
6. 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 have all field gear, especially

1. Camera
2. GPS
3. Water quality meters
4. 50-m tape
5. Handheld tapes
6. Compasses

□ Assess uncertain buffer features and update datsheets accordingly

Checklist of Field Equipment (items in italics are found in the Core Center)

<u>Paperwork In Folder (one folder per crew)</u>

- standard field forms
- waterproof field forms
- plant collection slips
- list of emergency contact numbers
- User's Manual
- Army Corps Regional Supplements
- laminated photo card
- site maps
- site office evaluation data

<u>Group Field Gear</u>

General

- GPS
- camera
- spare AA batteries
- spare camera battery
- compass
- flagging tape
- measuring tape (50 m)
- rope to measure out Level 3 plots
- dry erase marker for photo card
- *large tarp for keeping gear dry*

Plant collection

- *weeder to dig plant specimen*
- plant press with newspaper
- handheld measuring tape
- hand lens (or personal item)
- Vascular Plants of Northern Utah
- Field Guide to Colorado's Wetland Plants

Water quality

- plastic container for measuring water quality
- water quality meters (high and low)
- cooler with ice
- three plastic containers for water quality samples
- *transparency tube*
- *bailer*

Soils

- *sharpshooter or auger*
- *soil tarp*
- pocket knife
- Munsell or other soil color chart
- handheld measuring tape

Misc. (Leave in vehicle)

- *scrub brush for cleaning shoes*
- *Sparquat and container with spray nozzle and pump*
- *large water jug*
- first aid and car emergency kit

<u>Suggested Plant Identification Aids</u>

- Field Guide to Intermountain Rushes
- Field Guide to Intermountain Sedges
- A Utah Flora
- Desert Plants of Utah
- Vascular Plants of Northern Utah
- Field Guide to Colorado's Wetland Plants
- Grasses and Grasslike Plants of Utah

<u>Individual Field Gear</u>

Office gear assigned to individuals

- waders
- laminated reference guides
- pencils
- clipboard
- field notebook

Personal gear

- knee boots or other field shoes
- large backpack
- watch or other timer
- water bottle
- food for field
- insect repellent, head net
- sun screen
- cell phone (for emergencies)
- personal plant identification guides

Key to Ecological Systems

Ecological Systems in this key have been divided based on geographic location in the three main ecoregions in Utah, the Central Basin and Range or Inter-Mountain Basins, Colorado Plateau, and Wasatch/Uinta Mountains. If a site is located near the border of the Inter-Mountain and Mountain regions in the state, try both Key A and Key B. There has been limited time devoted to the use of the Ecological Systems classification for wetlands in Utah, specifically around Great Salt Lake, so there may be some wetland types that are not accounted for in this key.

Key A. WETLANDS AND RIPARIAN AREAS OF THE INTER-MOUNTAIN BASINS AND COLORADO PLATEAU
These regions cover the majority of the state of Utah, with the exception of the Uinta, Wasatch, and Rocky Mountains. Wetlands in this region often have alkaline or saline soils (alkalinity in water chemistry can be highly variable in the Emergent Marsh system) due to evaporative loss of water and concentration of salts in surface water and soils. One system localized to the Colorado Plateau Ecoregion keys here, Colorado Plateau Hanging Garden.

Key B. WETLANDS AND RIPARIAN AREAS OF THE WASATCH AND UINTA MOUNTAINS
This region includes mountain ranges in the central and northeastern corner of the state as well as a few small ranges in the Colorado Plateau Region.

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**

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 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**

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**

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**

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**

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**

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 (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 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*. Flooding is intermittant. 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**

7b. Total vegetation cover is moderate to dense (generally > 10% plant cover)…………………………..**8**

8a. Located in similar locations as the **Inter-Mountain Basins Playa**, but with generally higher herbaceous vegetation cover (>10%). Site are seasonally to semi-permanently flooded, usually retaining water into the growing season and drying completely only in drought years, around Great Salt Lake the water table may be more variable due to management. Can be associated with hot and cold springs, located in basins with internal drainage. Soils are alkaline to saline 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**

8b. Herbaceous wetlands with standing water at or 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**

Key B. WETLANDS AND RIPARIAN AREAS OF THE ROCKY MOUNTAINS

1a. Wetland defined by groundwater inflows and organic soil (peat) accumulation of at least 40 cm in the upper 80 cm. Vegetation can be woody or herbaceous. If the wetland occurs within a mosaic of non- peat forming wetland or riparian systems, then the patch must be at least 0.1 hectares (0.25 acres). If the wetland occurs as an isolated patch surrounded by upland, then there is no minimum size criteria………… ……………………………………………………………………………………………**Rocky Mountain Subalpine-Montane Fen**

1b. Wetland does not have at least 40 cm of organic soil (peat) accumulation or occupies an area less than 0.1 hectares (0.25 acres) within a mosaic of other non-peat forming wetland or riparian systems…..**2**

2a. Total woody canopy cover generally 25% or more within the overall wetland/riparian area. Any purely herbaceous patches are less than 0.5 hectares and occur within a matrix of woody vegetation. [Note: Relictual woody vegetation such as standing dead trees and shrubs are included here.] **3**

2b. Total woody canopy cover generally less than 25% within the overall wetland/riparian area. Any woody vegetation patches are less than 0.5 hectares and occur within a matrix of herbaceous wetland vegetation………**5**

3a. Riparian woodlands and shrublands of the foothill and lower montane zones. Woodlands are dominated by *Populus* spp. (*Populus angustifolia*, *P. deltoides,* or the hybrid *P. acuminata*). Common native shrub species include *Salix* spp., *Alnus incana*, *Betula occidentalis, Cornus sericea*, and *Crataegus* spp. Exotic shrub species include *Tamarix spp.* and *Elaeagnus angustifolia.* Sites are most often associated with a stream channel, including ephemeral, intermittent, or perennial streams (Riverine HGM Class). This system can occur on slopes, lakeshores, or around ponds, where the vegetation is associated with groundwater discharge or a subsurface connection to lake or pond water, and may experience overland flow but no channel formation (Slope, Flat, Lacustrine, or Depressional HGM Classes). It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplain swales and irrigation ditches…………………………………… ………………………………..**Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland**

3b. Riparian woodlands and shrublands of the montane or subalpine zone **4**

4a. Montane or subalpine riparian woodlands (canopy dominated by trees). This system occurs as a narrow streamside forest lining small, confined low- to mid-order streams. Common tree species include *Abies lasiocarpa*, *Picea engelmannii*, *Pseudotsuga menziesii*, and *Populus tremuloides*………………………………………**Rocky Mountain Subalpine-Montane Riparian Woodland**

4b. Montane or subalpine shrub wetlands (canopy dominated by shrubs with sparse or no tree cover). This system is most often associated with streams (Riverine HGM Class), occurring as either a narrow band of shrubs lining streambanks of steep V-shaped canyons *or* as a wide, extensive shrub stand on alluvial terraces in low-gradient valley bottoms (sometimes referred to as a *shrub carr*). Beaver activity is common within the wider occurrences. In addition, this system can occur around the edges of fens, lakes, seeps, and springs on slopes away from valley bottoms. This system can also occur within a mosaic of multiple shrub- and herb-dominated communities within snowmelt-fed basins. In all cases,vegetation is dominated by species of *Salix*, *Alnus*, or *Betula.*....................................**Rocky Mountain Subalpine-Montane Riparian Shrubland**

5a. Herbaceous wetlands with a permanent water source throughout all or most of the year. Water is at or above the surface throughout the growing season, except in drought years. This system can occur around ponds, as fringes around lakes and along slow-moving streams and rivers. The vegetation is dominated by common emergent and floating leaved species including species of *Scirpus*, *Schoenoplectus*, *Typha*, *Juncus*, *Carex*, *Potamogeton*, *Polygonum*, and *Nuphar*…………………………………………………………..**Western North American Emergent Marsh**

5b. Herbaceous wetlands that typically lacks extensive standing water. Patches of emergent marsh vegetation and standing water are less than 0.1 ha in size and not the predominant vegetation………**6**

6a. Herbaceous wetlands associated with a high water table or overland flow, but typically lack standing water. Sites with *no channel formation* are typically associated with snowmelt or groundwater and not subjected to high disturbance events such as flooding (Slope HGM Class). Sites *associated with a stream channel* are more tightly connected to overbank flooding from the stream channel than with snowmelt and groundwater discharge and may be subjected to high disturbance events such as flooding (Riverine HGM Class). Vegetation is dominated by herbaceous species; typically graminoids have the highest canopy cover including *Carex* spp., *Calamagrostis* spp., and *Deschampsia caespitosa* .... …………………………………………………………………**Rocky Mountain Alpine-Montane Wet Meadow**

6b. Large herbaceous wetlands associated with a high water table that is controlled by artificial overland flow (irrigation). Sites typically lack prolonged standing water, but may have standing water early in the season if water levels are very high. Vegetation is dominated by native or non-native herbaceous species; graminoids have the highest canopy cover. Species composition may be dominated by non-native hay grasses……………… ………………………………………………….**Irrigated Wet Meadow (not an official Ecological System)**

Key to HGM Classes

When using this classification, keep in mind that a wetland may have characteristics of multiple classes, e.g. an oxbow may function as either a depression or a riverine wetland depending on its connectivity to the riverine system that created it. Wetlands around Great Salt Lake can fall into multiple classes depending on water source and geomorphology. Since the majority of wetlands are supported by surface sources from either natural or manmade conveyance systems, many of the wetlands that are impounded or otherwise supported by channels and ditches should be considered Riverine for the purposes of HGM classification. Wetlands not *directly* supported by surface inflows from channels and ditches should be considered lacustrine fringe, depressional, or mineral soils flats depending on geomorphology. Office evaluation of water source will help in this determination.

1a. Wetland is located in a valley, floodplain, near a stream channel, or on the shore of a waterbody that is greater than 2 ha (20 acres) or with a depth greater than 2 m at the deepest point. The wetland is hydrologically connected to a stream or lake, precipitation or groundwater are not dominant water sources for the wetland…….**2**

2a. Wetland is located in a valley, floodplain, or near a stream channel and its dominant water source is from unidirectional and horizontal water movement from channel overbank flooding and/or subsurface hydrologic connections to the stream channel. **Note:** *Wetlands around Great Salt Lake that are directly supported by diverted stream water should be considered riverine, reference the site water source assessment*…………**Riverine**

2b. Wetland is located on the shore of a waterbody that is greater than 2 ha (20 acres) or with a depth greater than 2 m at the deepest point. Wetland hydrology is influenced by bidirectional flows related to changes in lake levels. Around Great Salt Lake, only consider those fringe wetlands that are influenced or sustained by fluctuations in lake levels. Wetlands located further from the lake are likely either riverine, slope, depressional, or mineral soils flats……….....**Lacustrine Fringe**

1b. Wetland with main water source from either precipitation, overland flow, or groundwater, main source of water not currently from hydrologic connectivity to stream or lake fluctuations………………………………………………….**3**

3a. 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 < 3ft diameter and less than 1 foot deep)*.........**Slope**

3b. Wetland does not meet all of the above criteria……………………………………………………………………………………**4**

4a. Wetland is topographically flat with precipitation as the primary water source. Inputs of groundwater and surface waters may be present, but not significant. Vertical drainage is poor due to low hydrologic gradient. Examples in the arid west include playas (large patch), relic lake beds, mudflats, salt flats.............
....**Mineral Soils Flats**

4b. Wetland is located in a topographic depression and the predominant water source is either precipitation, overland runoff, or intersection with the groundwater table, typically lack direct connection with surface waters. Closed contours in depressional wetlands support the accumulation of surface waters……...**Depressional**

Key to Cowardin Systems, Subsystems, and Classes of Utah[1]

Consider the entire wetland when determining which system to assign to the AA. An AA may include multiple systems and classes, classify the site based on the areal coverage of the system or class that is dominant in the AA and make note of any other systems or classes included in the AA that have considerable area. For example, a lake may include lacustrine as well as edges or islands of palustrine.

Systems

(ESTUARINE and MARINE systems omitted)

1a. Persistent emergents, trees, shrubs, or emergent mosses cover ≥30% of the area................**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[2]

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

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

***Classes*[3]**

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

2a. Water regime subtidal, permanent flooded, intermittently exposed, semipermanently flooded. Substrate usually not soil…………………………………………………………………………………………………….…….**3**

3a. Substrate of bedrock, boulders or stones occurring singly or in combination covers ≥75 of the area……**Rock Bottom**

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

2b. Water regime irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded. 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**

Cowardin Water Regime Modifiers (in order from driest to wettest)*[4]*:

[3] Classes apply to all Systems

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

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[5]). 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.

Saturated (B): The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present. This modifier is often applied to groundwater dependent ecosystems with stable water tables (fens) in this region.

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.

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.

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.

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[5]U.S. Army Corps of Engineers, 2005, Technical Standard for Water-Table Monitoring of Potential Wetland Sites: ERDC TN-WRAP--2.

Cowardin Special Modifiers

Beaver (b): Created or modified by beaver activity.

Partially ditched/drained (d): 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 (f): The soil surface has been mechanically or physically altered for production of crops, but hydrophytes will become reestablished if farming is discontinued.

Diked/impounded (h): Created or modified by a barrier or dam which purposefully or unintentionally obstructs the outflow of water. Both man-made and natural dams included, beaver dams are considered with the beaver modifier.

Artificial (r): Refers to substrates classified as 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 (x): Lies within a basin or channel excavated by humans.

Examples of Palustrine System[5]:
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**

[5] 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 and Surface Roughness

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.

Key to surface roughness adapted from Johnson and Buffler (2008). Evaluate in area approximately 10 m to either side of the buffer transects. Water will be ignored in this evaluation.

1. Developed or managed area (e.g., intensively grazed, mowed, used for agriculture) or exposed mineral soil due to human use .... Low
2. Intact mineral surface and not a managed area
    a. Roughness features, including coarse-woody debris, herbaceous litter, vegetation, biological soil crusts, boulders, rock outcrops and complex undulating microtopography, cover less than 35% of buffer transect .... Low
    b. Roughness features cover more than 35% of buffer transect
        i. <5% of transect has roughness features other than herbaceous vegetation ... Low
        ii. >5% of transect has roughness features other than herbaceous vegetation
            1. 35 to 65% of transect has surface roughness features .... Moderate
            2. >65% of transect has surface roughness features .... High

Wetland Determination- Regions, Hydrophytic Vegetation, Wetland Hydrology

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:

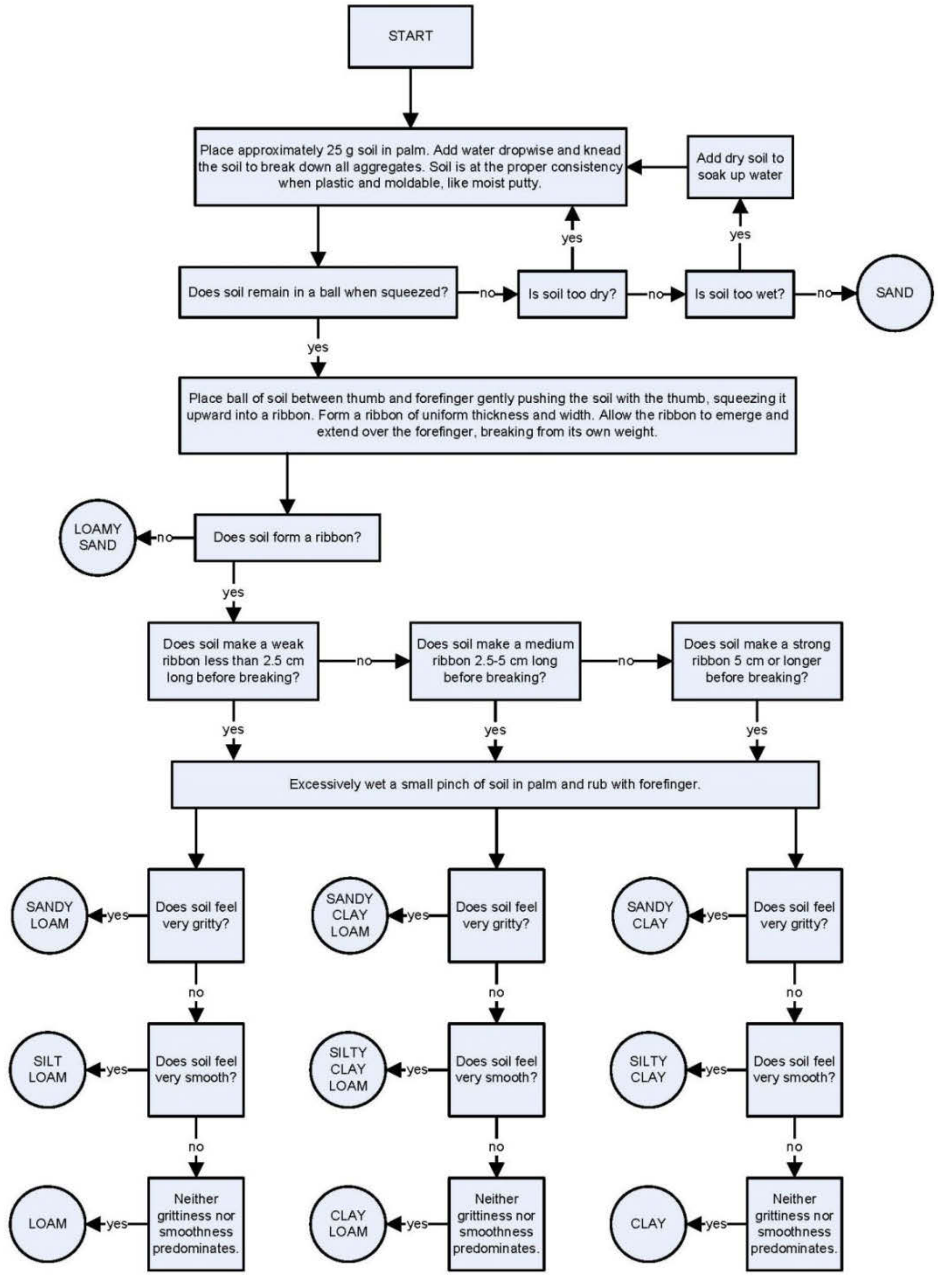
1. Determine strata (vegetation layers) present in the area. Strata include trees (DBH ≥7.6 cm), saplings and shrubs (DBH < 7.6 cm), herbaceous plants, and woody vines.
2. Estimate the percent of the assessment area covered by each strata. For example, all tree species combined (including trunks and 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

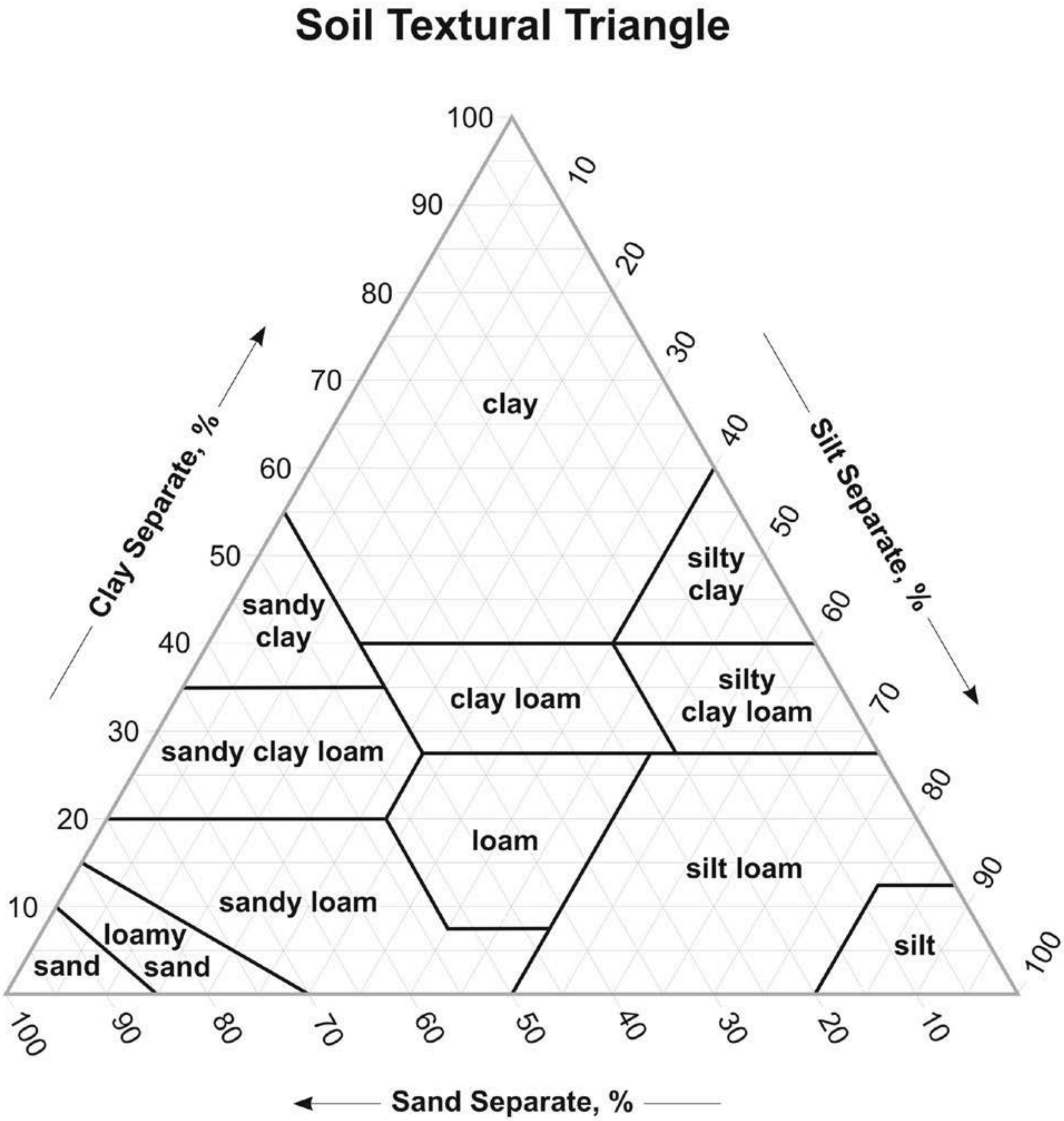
Presence of at least one primary (P) or two secondary (S) features indicates that site has wetland hydrology. Features in italics apply to only one region; indicators that begin with a single * apply to the Western Mountains region and those with ** apply to the Arid West region. *** under type refers 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[6] and Triangle



[6] 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](#).



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

Hydric Soil Indicators

Comparison of indicators with depleted matrices and redox features[7].

	A11	***A12***	***F3***	***S5***
Depleted matrix extent	≥ 60%	≥ 60%	≥ 60%	≥ 60%
Depleted matrix color	chroma ≤ 2	chroma ≤ 2	chroma ≤ 2	chroma ≤ 2
Redox requirements	≥ 2% distinct or prominent redox concentrations ***if matrix color is*** 4/1, 4/2, 5/2	≥ 2% distinct or prominent redox concentrations ***if matrix color is*** 4/1, 4/2, 5/2	≥ 2% distinct or prominent redox concentrations ***if matrix color is*** 4/1, 4/2, 5/2	≥ 2% distinct or prominent redox concentrations
Starting within	< 30 cm	≥ 30 cm	see below	> 15 cm
Min thickness	15 cm or 5 cm if fragmental soil material	15 cm	**5 cm** within 15 cm of soil surface OR **15 cm** within 25 cm of soil surface	10 cm
Color of layers above	***loamy/clayey*** value ≤ 3 chroma ≤ 2 ***sandy material*** value ≤ 3 chroma ≤ 1 70% coated with organic material	***all types to 30cm*** value ≤ 2.5 chroma ≤ 1 ***all types below 30 cm and above depleted matrix*** value ≤ 3 chroma ≤ 1 ***all sandy material*** 70% coated with organic material	no requirements	no requirements

[7] **by** 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.

Hydric Soil Indicators for the Arid West and Western Mountains[8]

*only an indicator for the Arid West Regional Supplement
**Commonly can be combined if the thickness requirement for the individual indicator is not meet. However, the combined depth must meet the more restrictive requirement of thickness between the two.

<u>All Soils – soils with any soil texture</u>

A1. Histosol: Organic soil material**≥40cm** thick within the top **80cm** or any thickness over rock or fragmental soil material that contains ≥90% rocks

A2. Histic Epipedon: Organic soil material **≥20cm** thick above a mineral soil layer with chroma of 2 or less. Aquic conditions or artificial drainage *required,* but can be assumed if hydrophytic vegetation and wetland hydrology are present.

A3.Black Histic (Mucky Histic Epipedon): Very dark organic soil material**≥20cm** thick that starts **within 15 cm** of soil surface. Color:hue = 10YR or yellower; value ≤ 3;chroma≤ 1 and underlain by mineral soil w/ chroma ≤2. Aquic conditions or artificial drainage *not required.*

A4. Hydrogen Sulfide: Rotten egg odor within **30cm** of the soil surface due to the reduction of sulfur. Most commonly found in areas that are permanently saturated or inundated; almost never at the wetland boundary.

***A9. 1cm Muck:** A layer of **MUCK** soil (sapric) ≥**1 cm** with a **value of ≤ 3** and **chroma of ≤1**, starting within **15 cm** of the soil surface.

A11. Depleted Below "*thin*" Dark Surface: Depleted or gleyed matrix layer**≥15 cm** that starts **within 30cm** of the soil surface. Color: chroma ≤ 2. Redox features required if color = 4/1, 4/2, 5/2. Layers above must have a value of ≤ 3 and chroma ≤ 2 (except sandy soils require chroma ≤ 1). See Table 1 for specifics.

A12. Thick Dark Surface (depleted below thick dark surface). Depleted or gleyed matrix layer **≥15**cm that starts **below 30cm** of the soil surface. Color: chroma ≤ 2. Redox features required if color = 4/1, 4/2, 5/2. Layers above must be dark. See Table1 for specifics.

NOTE: For the remaining indicators (EXCEPT S6 & F8), all mineral layers above the indicators must have a dominant chroma of ≤ 2 or the layers with dominant chroma of >2 must be <15 cm thick.

<u>Sandy Soil Types</u> Sandy soil (**loamy fine sand and coarser**) indicators are generally shallower and thinner than loamy/clayey soil indicators.

S1. Sandy Mucky Mineral: A layer of mucky modified sandy soil material**≥5cm** starting **within 15cm** of the soil surface. *Limited in our region ,*but found in swales associated with sand dunes.

S4. Sandy Gleyed Matrix: Gleyed matrix that occupies **≥60%**of a layer starting **within 15 cm** of the soil surface. No minimum thickness required. Gley colors are not synonymous with grey colors. They are found on the Gley page. *Rare in our region;* only found where sandy soils are almost continuously saturated.

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[8] **Adapted from** U.S. Army Corps of Engineers, 2008, Regional supplement to the Corps of Engineers wetland delineation manual—Arid west region, Version 2.0: Vicksburg, Mississippi, ERDC/EL TR-08-28, 133 p. **by** 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.

****S5. Sandy "*with*" Redox *"concentrations"*:** Redox concentration in a depleted layer **≥10cm** that starts **within15cm** of the soil surface. Color: chroma ≤ 2. See Table 1 for specifics. *Most common indicator in our region of the wetland boundary for sandy soils.*

S6. Stripped Matrix: A layer starting **within 15cm** of the surface in which iron/manganese oxides and/or organic matter has been stripped and the base color of the soil material is exposed. Evident by faint, diffuse splotchy patterns of two or more colors. Stripped zones are ≥ 10% and~1–3 cm in diameter.

<u>Loamy/ Clayey Soil Types</u> Loamy/clayey soil indicators are generally deeper and thicker than sandy soil indicators.

****F1.Loamy Mucky Mineral:** A layer of mucky modified loamy or clayey soil material **≥ 10cm** starting within 15 cm of the soil surface. *May be difficult to tell without laboratory testing.*

F2.Loamy Gleyed Matrix: Gleyed matrix that occupies **≥60%** of a layer starting **within 30cm** of the soil surface. No minimum thickness required. Gley colors are not synonymous with grey colors. They are found on the Gley page.

****F3. Depleted Matrix (same as A11):** Depleted matrix **≥5 cm** thick **within 15 cm** *or* **≥15cm** thick w**ithin 30 cm** of the soil surface. Color: chroma ≤ 2. Redox features required if color = 4/1, 4/2, 5/2. See Table 1 for specifics. *Most common indicator at wetland boundaries.*

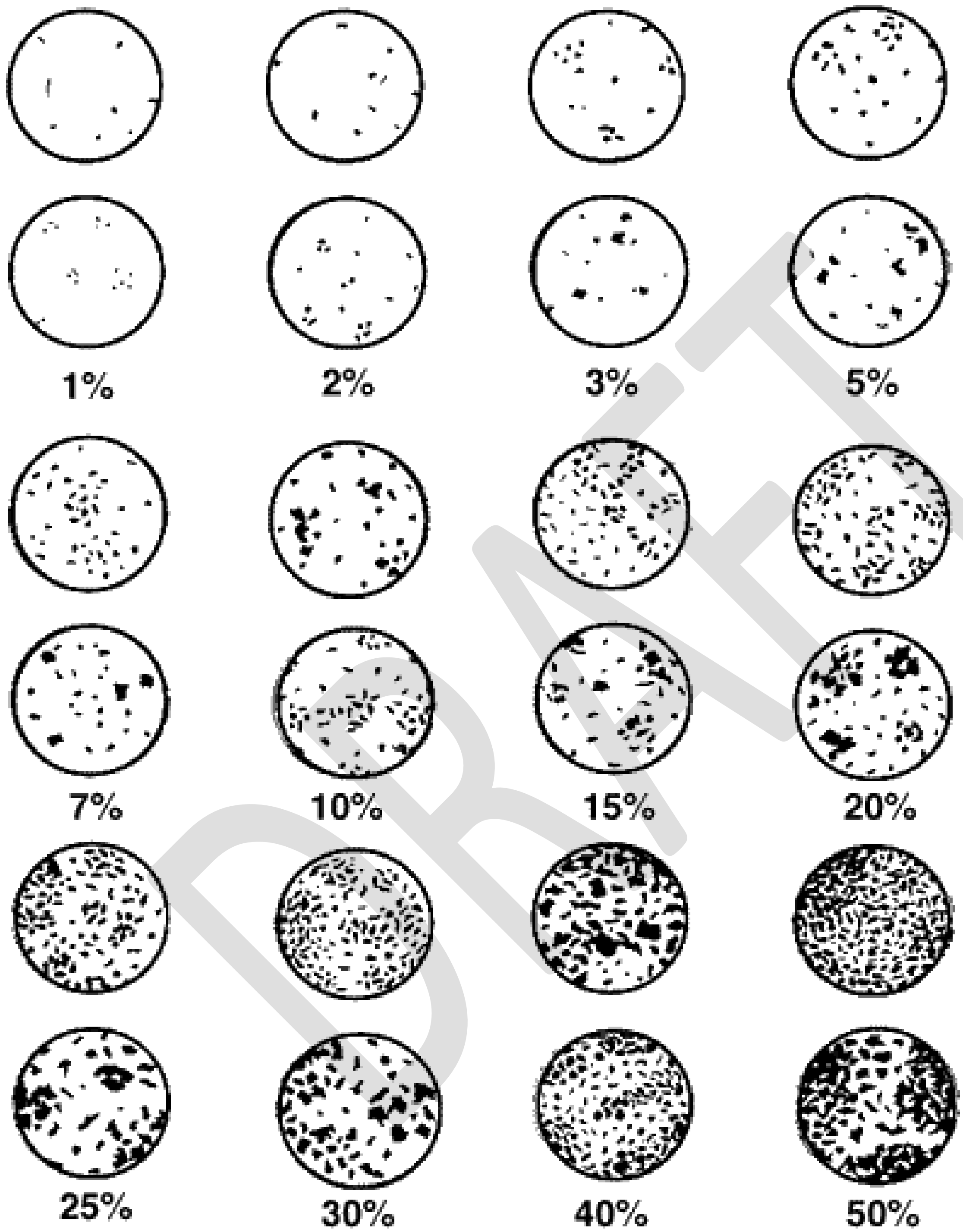
****F6.Redox Dark Surface (dark surface with redox concentration):** A dark surface layer with **redox concentrations.** Depth and location: **≥10cm** thick entirely **within 30cm of** the mineral soil. Matrix color and redox features: matrix value ≤ 3 and chroma≤ 1 with ≥ 2% distinct, prominent redox concentrations OR matrix value ≤ 3 and chroma ≤ 2 with≥ 5% distinct, prominent redox concentrations. The chroma can be higher with more redox features. *Very common indicator to delineate wetlands,* though difficult to see in soils with high organic matter.

****F7. Depleted Dark Surface (dark surface with redox depletions):** A dark surface layer with **redox depletions.** Depth and location: **≥10 cm** thick entirely **within 30 cm of** the mineral soil. Matrix color and redox depletions: matrix value ≤ 3 and chroma≤ 1 with ≥ 10% redox depletions OR matrix value ≤ 3 and chroma ≤ 2 with ≥ 20% redox depletions. The chroma can be higher with more redox depletions. **Redox depletions themselves** should have value ≥ 5and chroma ≤ 2. *Rare in our region.*

F8.Redox Depressions (depressions with redox concentrations): A layer **≥5 cm** thick entirely **within15cm** of soil surface with ≥5% distinct or prominent redox concentrations in closed depressions subject to ponding. *No color requirement for the matrix soil, but only applies to depressions in otherwise flat landscapes.*

***F9. Vernal Pools:** In closed depressions that are subject to ponding, presence of a depleted matrix with ≥60%, chroma of ≤2 in a layer 5 cm thick entirely within the upper 15 cm of the soil.

Plant Cover Reference Cards[9]



Plant Cover Reference Card[10]

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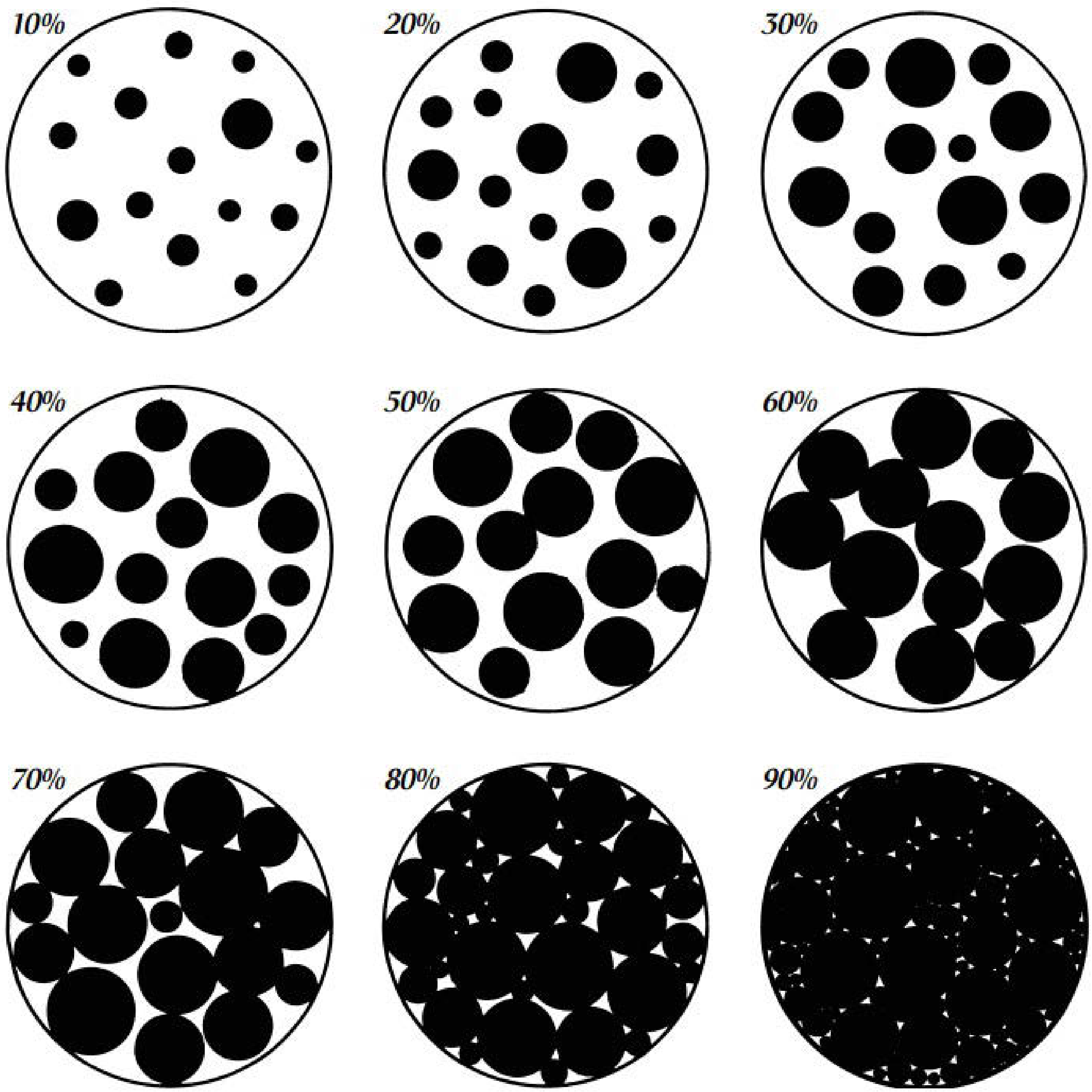
[9] From http://www.for.gov.bc.ca/hts/risc/pubs/teecolo/fmdte/veg.htm



[10] From http://www.birds.cornell.edu/bfl/study_site/describe_habitat/site_char.html#can_cov

Plant Collection Form

Location ID: ________________ GPS ID: _________________ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___
Observer Name: _____________________ Additional Observers:____________________ Survey Date: ________________________

Collection #: ___________ Plant Family: _________________________ Sci. Name: ____
Height: __________ cm m (circle one) Features Present? (circle) Rhizome Stolon Caespitose Basal Rosettes Flowers Fruit
Flower Color: _______________ Other Species Notes: (odor, stickiness, leaf/stem color, habitat , etc.):____________________________________
____

Location ID: ________________ GPS ID: _________________ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___
Observer Name: _____________________ Additional Observers:____________________ Survey Date: ________________________

Collection #: ___________ Plant Family: _________________________ Sci. Name: ____
Height: __________ cm m (circle one) Features Present? (circle) Rhizome Stolon Caespitose Basal Rosettes Flowers Fruit
Flower Color: _______________ Other Species Notes: (odor, stickiness, leaf/stem color, habitat , etc.):____________________________________
____

Location ID: ________________ GPS ID: _________________ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___
Observer Name: _____________________ Additional Observers:____________________ Survey Date: ________________________

Collection #: ___________ Plant Family: _________________________ Sci. Name: ____
Height: __________ cm m (circle one) Features Present? (circle) Rhizome Stolon Caespitose Basal Rosettes Flowers Fruit
Flower Color: _______________ Other Species Notes: (odor, stickiness, leaf/stem color, habitat , etc.):____________________________________
____

Location ID: ________________ GPS ID: _________________ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___
Observer Name: _____________________ Additional Observers:____________________ Survey Date: ________________________

Collection #: ___________ Plant Family: _________________________ Sci. Name: ____
Height: __________ cm m (circle one) Features Present? (circle) Rhizome Stolon Caespitose Basal Rosettes Flowers Fruit
Flower Color: _______________ Other Species Notes: (odor, stickiness, leaf/stem color, habitat , etc.):____________________________________
____

Location ID: ________________ GPS ID: _________________ UTM E: ___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___
Observer Name: _____________________ Additional Observers:____________________ Survey Date: ________________________

Collection #: ___________ Plant Family: _________________________ Sci. Name: ____
Height: __________ cm m (circle one) Features Present? (circle) Rhizome Stolon Caespitose Basal Rosettes Flowers Fruit
Flower Color: _______________ Other Species Notes: (odor, stickiness, leaf/stem color, habitat , etc.):____________________________________
____
____

Appendix B

Field forms used with URAP

2014 UTAH RAPID ASSESSMENT PROTOCOL FIELD SURVEY FORM

LOCATION AND GENERAL SITE INFORMATION

Unique Site ID: ______________________ **Site Name**:____

Surveyor IDs: ____ **Date (mm/dd/yyyy):** _____________________________

AA Dimensions:
__ 40-m radius circle
__ Rectangle, width___, length___
__ Freeform (collect GPS track of edge)

Site is ◯ Level II ◯ Level III

Aspect (deg): ____________ OR Flat OR N/A
Slope (deg): _____________ OR Flat OR N/A

AA Placement and Dimension Comments:

Reason Moved: ◯ not moved ◯ more than one wetland ◯ no wetland present ◯ inclusions too large
◯ multiple Ecological Systems ◯ other:

SPATIAL DATA OF ASSESSMENT AREA (NAD83 UTM Zone 12)

Waypoint categories: Rectangle corner (R), photo (P), soil (S), water quality outside of soil pit (W), level III plots (V), other- describe (O)

Freeform: Track ID:_________________________ Area: _____________ m²

Coordinates include center and four photos for circular, corners and four photo for rectangular, and four photo for freeform AA

Waypoint ID:__________ Category: R P S W V O _________ UTM E:___ ___ ___ ___ ___ ___ UTM N: ___ ___ ___ ___ ___ ___ ___

Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________
Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________
Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________
Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________
Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________
Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________
Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________
Waypoint ID:__________ Category: R P S W V O __________	Waypoint ID:__________ Category: R P S W V O __________

ASSESSMENT AREA PHOTOS

Photo categories: standard AA photo (A), site overview (S), other- include description (O)

Camera ID: _______________________
Photo # Range:_____________________

Photo Category	Waypoint ID	Aspect (deg)	Photo #	Description
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				
A S O				

ENVIRONMENTAL DESCRIPTION AND CLASSIFICATION OF AA

Composition of AA
___ % AA with true wetland
___ % AA with non-wetland riparian area
___ % AA with >1 m standing water
___ % AA with upland inclusions

Wetland origin
___ Natural feature with minimal disturbance
___ Natural feature, but altered or augmented
___ Non-natural feature created by passive or active management
___ Origin unknown

Ecological System

System 1:____ % of AA_____ Fidelity: High Med Low
System 2:____ % of AA_____ Fidelity: High Med Low
System 3:____ % of AA_____ Fidelity: High Med Low

Cowardin classification for dominant type Fidelity: High Med Low

System	Class		Water Regime (wt= water table)		Modifiers
__ Riverine	__ Rock Bottom	__ Unconsolidated Bottom	__ A (brief then low wt)	__ F (all growing season)	__ Beaver
__ Lacustrine	__ Streambed	__ Aquatic Bed	__ B (saturated)	__ G (all year – drought)	__ Partly Drained/Ditched
__ Palustrine	__ Rocky Shore	__ Unconsolidated Shore	__ C (early, wt variable)	__ H (all year, all years)	__ Farmed
	__ Emergent	__ Moss-Lichen	__ E (B + C)	__ J (intermittent)	__ Diked (obstruct inflow)
	__ Scrub-Shrub	__ Forested			__ Impounded (obstruct outflow)
					__ Artificial
					__ Excavated

HGM Class (pick only one) Fidelity: High Med Low

___ Riverine ___ Depressional ___ Mineral Soil Flats ___ Organic Soil Flats ___ Lacustrine Fringe ___ Slope

RIVERINE-SPECIFIC CLASSICATION OF AA

Confined vs. Unconfined Valley Setting
______ Confined Valley Setting (valley width < 2x bankfull width)
______ Unconfined Valley Setting (valley width ≥ 2x bankfull width)

AA Proximity to Channel
AA includes: ___ channel and one bank ___ channel and two banks
___ no channel and one bank ___ no channel and no bank
For sites with no channel, record distance from AA edge to channel center: ______ m

Stream Flow Duration
______ Perennial
______ Intermittent
______ Ephemeral

Stream Depth at Time of Survey (if evaluated):
Channel is : Dry In Pools Only Flowing
Depth: _____ m OR ≥ 1 m

AA REPRESENTATIVENESS

Is AA the entire wetland/riparian area? ___ Yes ___ No
If no, how representative is AA of larger wetland/riparian area ___ Low ___ Moderate ___ High
Provide comments:

ENVIRONMENTAL AND CLASSIFICATION COMMENTS

WILDLIFE OBSERVATIONS

MAJOR VEGETATION PATCHES ZONES WITHIN AA

Patches are distinct vegetation patches that share similar physiognomy and species composition and are the same as those considered by the interspersion metric. Individual patches must be at least 10 m² (~ 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.

Patch 1: Dominant Species:____ Mean Height:_________ cm % AA:_______

Patch 2: Dominant Species:____ Mean Height:_________ cm % AA:_______

Patch 3: Dominant Species:____ Mean Height:_________ cm % AA:_______

Patch 4: Dominant Species:____ Mean Height:_________ cm % AA:_______

Patch 5: Dominant Species:____ Mean Height:_________ cm % AA:_______

Patch 6: Dominant Species:____ Mean Height:_________ cm % AA:_______

BUFFER STRESSORS (Evaluate in 200 m buffer around AA)

Extent: 0= 0%, 1 = trace, 2=1–10%, 3 = >10–25%, 4 = >25–50%, 5 = >50–75%, 6 =>75%.
Severity 0: not affecting 1: Not severe 2: Moderate 3: Severe

Extent is the area the stressor occupies the in the 200-m buffer (whether buffer or non-buffer land cover). The degree of severity should be based on how the stressor affects the AA and not the 200-m buffer. Take into consideration whether stressors are located down-slope from the AA and whether they are hydrologically connected when determining stressor severity.

Stressors	Extent	General Severity	Hydrologically Connected Yes, No, Unknown	Hydroperiod (Severity)	Water Contaminates Nutrients / toxins (Severity)	Sedimentation (Severity)	Vegetation Stress (Severity)
Dikes/dams/levees/berm (excluding roads and railroads)			Y N U				
Water level control structure (Gates, Spring Boxes, Stop Logs, Weirs, etc..)			Y N U				
Ditching (man-made channels)			Y N U				
Modification of natural flow paths (channelization, widening, deepening etc…)			Y N U				
Dredged depression (pond, basin)			Y N U				
Active or visibly evident that it is recent excavation/ dredging **Describe in comments below**			Y N U				
Spoil banks or fill (dumped material)			Y N U				
Stabilizing Shorelines (e.g., riprap)			Y N U				
Plugging of natural channels draining AA (intentional or through unnatural sedimentation)			Y N U				
Discharge from wastewater plants, factories List Types:____________________________			Y N U				
Obvious spills, discharges or odors; unusual water color or foam			Y N U				
Moderate to heavy formation of filamentous algae			Y N U				
Stormwater inputs via discharge pipes, culverts, sewer outfalls)			Y N U				
Pasture / rangeland /Managed grazing (historic or current)			Y N U				
Livestock Barn/ Holding pens/ CAFO			Y N U				
Agricultural crops/ row crops (e.g., corn, wheat, cotton, potatoes, etc....)			Y N U				
Haying crops (e.g., alfalfa, clover and grasses)			Y N U				
Fallow field (severity based on vegetation cover)			Y N U				
Substrate disturbance/rutting, compaction (off-road travel by vehicle, machinery, ATV, etc.)			Y N U				
Nursery			Y N U				
Orchard			Y N U				
Tree plantation present			Y N U				
Timber Harvest/ logging (severity is based on recovery)			Y N U				
Extensive tree herbivory (exclude normal browse from wildlife)			Y N U				

Ext.: 0= 0%, 1 = trace, 2=1–10%, 3 = >10–25%, 4 = >25–50%, 5 = >50–75%, 6 =>75%. Sev. 0: not affecting 1: Not severe 2: Mod. 3: Severe							
	Ext.	**Gen. Sev.**	**Hydro**	**Hy.**	**Nut.**	**Sed.**	**Veg.**
Extensive shrub layer browse (exclude normal browse from wildlife)			Y N U				
Fire lines (fire breaks) (severity based on vegetation cover)			Y N U				
Recently burned forest/ shrub land (severity based on vegetation cover)			Y N U				
Recently burned upland grassland (severity based on veg. cover)			Y N U				
Recently burned wetlands (severity based on veg. cover)			Y N U				
Removal of large woody debris (exclude habitat management))			Y N U				
Removal of large woody debris (for habitat management)			Y N U				
Shrub cutting/ brush hogging (exclude habitat management)			Y N U				
Shrub cutting/ brush hogging (for habitat management)			Y N U				
Mowing of non-ag. vegetation of surrounding buffer (exclude habitat management)			Y N U				
Mowing of non-ag. vegetation of surrounding buffer (for habitat management)			Y N U				
Other mechanical plant removal (exclude habitat management) **Note type below**			Y N U				
Other mechanical plant removal (for habitat management) **Note type below**			Y N U				
Chemical vegetation control (exclude habitat management)			Y N U				
Chemical vegetation control (for habitat management)			Y N U				
Cover of non-native or invasive plant species			Y N U				
Railroad tracks			Y N U				
Residential Homes + associated lawns, driveway, etc. (inc. rural, suburban, urban)			Y N U				
Industrial/commercial buildings including parking lots, landscaping, etc.			Y N U				
Construction/ Development site			Y N U				
Abandoned dwelling			Y N U				
Trails (e.g., hiking paths, bike trails)			Y N U				
High use tractor/ ATV trail and Dirt Road (native material)			Y N U				
Road Gravel (road surface has been imported)			Y N U				
Paved Roads (consider size and use on road and hydrologic connection to site)			Y N U				
Recreational Park			Y N U				
Golf course			Y N U				
Landfill			Y N U				
Trash/ dumping			Y N U				
Presence of power lines or utility corridors (continual maintenance)			Y N U				
Oil/gas wells			Y N U				
Quarry (extraction of stone, sand, soil, etc..)			Y N U				
Mine (including surface/ sub-surface mining of minerals, gases)			Y N U				
Soil subsidence or surface erosion (not from previously listed sources)			Y N U				
Other:			Y N U				
FLAG	Comments:						

LANDSCAPE CONTEXT	
Percent buffer (Evaluate at edge of AA; buffer must extend 10 m along perimeter and 10 m from edge of AA to count)	
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.
FLAG	Comments:

Buffer Width (Evaluate up to 200 m from AA edge

Transect	Length (m)	Position[1]	Open Water[2]	Slope[3]	Roughness	First non-buffer land cover/ subsequent land cover (if first is <10 m wide)
N		U D N	Y N	a b c d	L M H	/
NE		U D N	Y N	a b c d	L M H	/
E		U D N	Y N	a b c d	L M H	/
SE		U D N	Y N	a b c d	L M H	/
S		U D N	Y N	a b c d	L M H	/
SW		U D N	Y N	a b c d	L M H	/
W		U D N	Y N	a b c d	L M H	/
NW		U D N	Y N	a b c d	L M H	/

[1]Position in relation to AA. Select N (neutral) when directionality of transect is unknown. Otherwise select U for transects that are up-gradient from the AA and D for transects down-gradient from the AA.
[2]Circle only when water is ≥30 m in width and directly adjacent to AA edge.
[3]Slope categories include a: 0-2.86° (0-5%); b: 2.86-8.53° (5-15%); c: 8.53-14.04° (15-25%); d: >14.04° (>25%)

FLAG	Comments:

Buffer Condition- Soil and Substrate (Evaluate in *buffer land cover only* within 200-m of AA edge)	
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 inpact.
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.
NA	No buffer land cover present.
Flag	Comments:

Buffer Condition-Vegetation (Evaluate in *buffer land cover only* within 200-m of AA edge)	
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.
NA	No buffer exists.
Flag	Comments:

Percent Intact Landscape (Evaluate in 500 m buffer)	
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.
Flag	Comments:

ASSESSMENT AREA STRESSORS (Evaluate directly in AA)

Extent: 0= 0%, 1 = trace, 2=1–10%, 3 = >10–25%, 4 = >25–50%, 5 = >50–75%, 6 =>75%. Severity 1: Low 2: Moderate 3: Severe

Stressors to Vegetation

Stressor	Extent	Severity
Timber Harvest/ logging (severity is based on recovery)		
Moderate to heavy formation of filamentous algae		
Evidence of planting of non-native vegetation		
Mowing of native vegetation w/in the AA margin (exclude management of invasive species)		
Mowing of native vegetation w/in the AA margin (for management of invasive species)		
Chemical vegetation control, e.g.,herbicide application, defoliant use (exclude invasive management)		
Chemical vegetation control, e.g.,herbicide application, defoliant use (for invasive management)		
Other mechanical plant removal (exclude invasive management) Describe in comments		
Other mechanical plant removal (for invasive management) Describe in comments		
Off-road travel by vehicle, machinery, ATV, ORV, etc..		
Recreation/human visitation (trampling of Vegetation)		
Upland plant species encroaching into AA (due to drying of wetland)		
Die-off of trees within AA due to increased ponding (exempting beaver impounded sites)		
Excessive shading from large artificial structure, e.g., bridge, boardwalk, dock		
Grazing and browsing by domestic or feral animals (cows, sheep, pigs, etc)		
Excessive wildlife herbivory (deer, muskrat, geese, carp, beaver, etc.)		
Excessive insect herbivory of tree canopy, shrub stratum		
Recently burned wetlands (if regeneration is healthy- check low severity)		
Fire lines (fire breaks)		
Other:		

Stressors to Physical Substrate

Anthropogenic caused surface erosion (not from natural flooding)		
Soil subsidence		
Soil compaction by off-road vehicles, dirt roads, mountain biking, trails cut, etc.		
Recent dredging or other prominent excavation in AA		
Trampling, digging, wallowing by domesticated/ feral animals		
Current filling, grading, or other prominent deposition of sediment		
Dumping of garbage or other debris		
Mechanical plant removal disturbing substrate (rutting, grubbing by heavy machinery, etc.)		
Fire lines (fire breaks) dug in AA		
Other:		

Stressors to Hydrology

Dredged inlets and outlets (channelization/ ditching)		
Livestock pugging and entrenchment from paths		
Rutting and soil compaction from vehicles or other types of machinery		
Siphons, pumps moving water out of AA		
Siphons, pumps moving water into AA		
Stormwater inputs directly into the AA from impervious surfaces		
Water level control structure controlling flow WITHIN AA		
Dikes/dams/levees/ berm		
Other:		

Flag	Comments

HYDROLOGIC CONDITION

Major Water Sources (only check those that are substantial contributors to sites, put a star by dominant water source)

Natural Sources	*Unnatural Sources*
___ overbank flooding from channel ___ overbank flooding from lake ___ groundwater discharge ___ alluvial aquifer (subsurface floodplain flow) ___ 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 ___ discharge from impoundment release ___ urban run-off/culverts ___ pipes directly feeding wetlands ___ other (list)_______________________________

Hydroperiod (Evaluate state in relation to natural hydroperiod- i.e. a week change in duration is much longer for a playa than for a marsh)

Rank	State
A	The hydroperiod, including frequency and duration of inundation and drawdown, within the AA is natural. There are no major hydrologic stressors that impact the hydroperiod. 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	Hydroperiod is predominantly controlled by natural hydrologic processes, but deviates slightly from natural conditions. The duration may be slightly longer or shorter due to decreases or increases in the amount of water reaching the AA or due to minor modifications affecting the inflow and outflow of water. The frequency of major inundation periods within a year is natural, though there might be one or two fewer or additional minor peaks of inundation. The site may be somewhat more susceptible to a change in inter-annual inundation frequency, but only in response to more severe drought or flood years. Potential deviations include: • Small decrease in inundation duration (e.g., small diversions that remove water during peak inundation, small enlargement of channel exiting AA, small noticeable effects of nearby water withdrawals, slightly flashier floods due to cover of impervious surfaces in the contributing area) • Small increase in inundation duration (e.g., minor inputs of tailwater irrigation, outflow slowed by small amount of sedimentation blocking channels, small increase in natural berm height, slightly more controlled water input due to dams on tributaries feeding the AA) • Change in intra-annual frequency by one or two minor periods of inundation (e.g., secondary flooding in fall with duration and depth much less than primary flooding) • Rare (only in extreme years) change in inter-annual flood frequency (e.g., due to impact of groundwater pumping or water withdrawals or management priorities)
C	The hydroperiod of the AA deviates moderately from natural conditions. The pattern of inundation and drawdown is still predominantly natural, but may be more noticeably shifted in duration or may occur in conjunction with more noticeable changes in frequency. Some potential deviations include more moderate examples of stressors to duration listed above as well as occasional (2 or 3 years out of 10) change in inter-annual flooding frequency
C-	The hydroperiod of the AA deviates substantially from natural conditions. A natural pattern of inundation and drawdown is still evident, but may be more dramatically shifted in duration and frequency, or may be secondary to anthropogenically created hydropatterns. The hydropattern may be predominantly or entirely created, 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. Some potential deviations include more severe examples of stressors to duration listed above as well as frequent (every 3 or 4 years) change in inter-annual flooding frequency
D	The hydroperiod is dramatically different from any natural wetland analogue. The duration and frequency of inundation may be completely artificially controlled. Natural hydrologic inputs to the wetland may be severely limited or eliminated. The wetland may be in steady decline and may not be a wetland in the near future. Sites are more likely to rate in this category when they experience drying conditions rather than simply because they receive artificial water inputs because the latter sites will often be at least tangentially analogous to a natural wetland. Sites in this category will often experiences extreme changes in the frequency of flooding. Examples of conditions that may lead to sites being rated in this category include: • extreme(relative to natural period) alteration of inundation duration (e.g., groundwater pumping causing spring to run dry except briefly in the spring) • extreme (almost every year or several times per year for sites that are flooded annually) change in flooding frequency (e.g., dikes blocking all flow to site except during years of extreme floods, groundwater pumping or water withdrawal that leave sites dry most years, detention basins that undergo short fill and release cycles following heavy precipitation events)
Flag	Comments:

Timing of Inundation	
Rank	**State**
A	Site inundation has no to very little deviation from natural timing. Sites that fall into this category generally have no or only very distant stressors to the water sources in their contributing area and no on-site stressors that affect water input, including artificial water sources.
B	Sites have a small shift in inundation timing of hours up to several days or inundation timing is natural for the majority of inflow to sites, but there are either small additional inputs of water during the growing season at times when the site would not normally receive water input or moderate additional inputs of water near the end of the growing season. Examples of potential deviations include: • accelerated timing of water input due to straightening of input channels • accelerated timing of water input due to small or distant areas of impervious surface in the contributing area • delayed timing of water input due to flow regulation on tributaries • small inputs of irrigation water via seepage or tailwater runoff in addition to naturally timed influxes of water • moderate levels of artificial fall inundation due to increased flow in channels at the end of irrigation season or moderate amount of water released from impoundments
C	Sites have a moderate shift in inundation timing of several days up to three weeks or inundation timing is mostly natural (shifted up to hours or days) for the majority of inflow to sites, but there are either moderate additional inputs of water in the middle of the growing season at times when the site would not normally receive water input or large additional inputs of water near the end of the growing season. Examples of potential deviations include: • accelerated timing of water input due to moderate to large areas of impervious surface in the contributing area • delayed timing of water input due to water control structures that more directly control input to sites • water added to impoundments according to management schedule only somewhat in tune with seasonal patterns • moderate inputs of irrigation water via seepage or tailwater runoff in addition to naturally timed influxes of water • pumping of water into site at times when site would normally not receive input • large levels of artificial inundation in the fall for management purposes
C-	Sites have a large shift in inundation timing of three weeks up to two months or inundation timing is somewhat natural (shifted up to days or weeks) for the majority of inflow to sites, but there are large additional inputs of water during the growing season at times when the site would not normally receive water input. Examples of potential deviations include: • naturally timed water input almost entirely absent (or naturally small) and majority of water influx is now from irrigation return-flows, irrigation seepage, or wastewater effluent pipes during times that site would normally be dry • site managed with very little regard to natural timing of water inputs (e.g., multiple large additional inundations throughout the dry season with only a little inundation during normal flood periods)
D	Sites have an extreme shift in inundation timing of over two months or there is a large shift of weeks to months in inundation timing as well as large additional inputs of water in the middle of the growing season during times when the site would not normally receive water. Sites that no longer receive natural water inputs due to anthropogenic stressors most years will also score in this category. Examples of potential deviations include: • site completely dry except when it rains because pumping has eliminated natural groundwater supply • site only flooded late in the growing season when water from up-gradient impoundments are released
Flag	Comments:

Algae Growth (Evaluate for wet sites whenever possible, can do both if site hydrology is very variable)			
Rank	**State- Wet Sites**	**Rank**	**State- Dry Sites**
A	Water is clear with minimal algal growth and there is no visual evidence of degraded water quality.	AB	Site has little to no evidence of dried algal mats.
B	Algal growth is limited to small and localized areas of the wetland. Water may have a greenish tint or cloudiness	C	Site has moderate to large patches of dried algal mats.
C	Algal growth occurs in moderate to large patches throughout the AA. Water may have a moderate greenish tint or sheen. Sources of water quality degradation are apparent (identify in comments below).	D	Site has extensive dried algal mats. Mats may be relatively thick, cover much of the AA, and/or are matted around vegetation
D	Algal mats are extensive, blocking light to the bottom. Water may have a strong greenish tint and the bottom is difficult to see. There are obvious sources of water quality degradation (identify in comments below).		
Flag	Comments:		

Turbidity and Pollutants	
Rank	**State**
NA	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
Flag	Comments, including possible sources of contamination.

Connectivity **(Evaluate both for the area immediately adjacent to the AA edge and the whole-wetland. For very large wetlands, assessment can be made at the edge of the area approximately 500 m from the AA instead of the whole wetland, but make a note in the comments)**

AA edge	Whole-wetland	State
A	A	Rising water has unrestricted access to adjacent areas 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 (see entrenchment ratio in optional riverine metrics).
B	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 <50% 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. If playa, surrounding vegetation does not interrupt surface flow.
C	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 50–90% 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. If playa, surrounding vegetation may interrupt surface flow.
D	D	The amount of adjacent transition zone or the lateral movement of flood waters is limited, relative to what is expected for the setting, by unnatural features for >90% of the boundary of the AA. Channel, if present, is severely entrenched and entirely disconnected from the floodplain. If playa, surrounding vegetation may dramatically restrict surface flow.
Flag	Comments:	

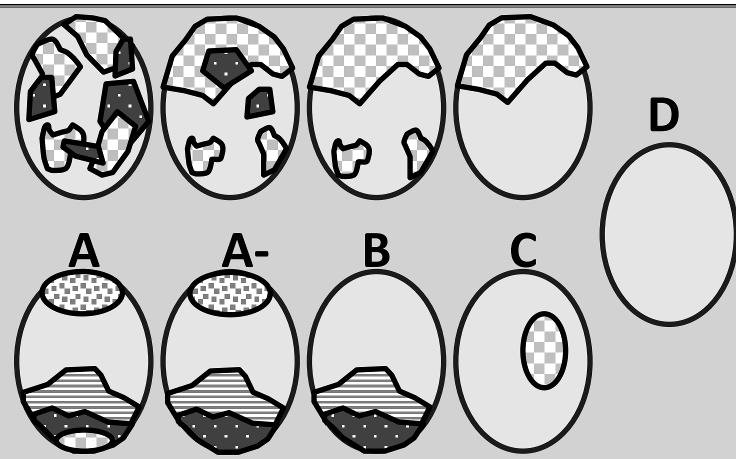
Water Quality	
A	There are no water quality stressors within 200 m up-gradient of the site or potentially a few that are minor (e.g., small areas with bare ground or lightly grazed pasture, a few fertilized lawns, etc.) and unlikely to impact the site (e.g. at least 100 m from site or further with steep slopes or poorer quality buffer). The land cover of the contributing area to the site is predominantly natural with no oil and gas extraction, Superfund sites, or 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. Stressors may include: • up-gradient stressors within 200 m of site that are minor or somewhat buffered from site or well-buffered if more severe (e.g., run-off from dirt road with narrow buffer or expansive area of exposed sediment with 100 m vegetated buffer) • development or cropland in <20% of contributing area and inputs from these stressors are minor or diluted by tributaries • extensive rangeland or pasture with mostly intact soils • streams that feed site have unimpaired water and dischargers are distant from site and likely to be highly diluted by tributaries or attenuated by reservoirs before reaching the site • oil and gas extraction and Superfund sites are unlikely to influence site.
C	Site likely to receive moderate input of water quality stressors. Stressors may include: • up-gradient stressors that occur within 200 m of the site that are more moderate in extent or severity and less well-buffered from site (e.g., run-off from low-density development directly reaching site or nutrient input from a farm; consider both the buffer between the stressor and slope; very low slope may be B and very steep slope may be C-) • light to moderate livestock grazing may occur within site, though unnatural bare patches in sites are absent or uncommon. • development or cropland in ~20-60% of the contributing area • moderately grazed rangeland/pasture across much of the contributing area • oil and gas extraction and point source dischargers may have some influence on site, but are generally distance, not considered major, and heavily diluted before reaching site. • major water supply to the site is not listed as impaired under the state's most current 303(d) list unless the water quality is likely to improve before reaching the wetland (e.g., site is distant from impaired section, water flows through reservoirs or emergent vegetation that may help attenuate water quality stressors, etc.).
C-	Site likely to receive substantial water quality stressors, though the most severe stressors are at least somewhat buffered from sites. 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). Stressors may include: • high intensity livestock grazing, irrigation water return flow, fertilizer and pesticide application, and erosion from fires, construction, off-road vehicles, and dirt roads *directly discharging into sites.* These stressors may be considered C run-off from the features is likely to only occur infrequently or if slope is shallow. • Heavy grazing within AA with large patches of bare earth and/or extensive additional of manure • Site has reasonable likelihood of groundwater contamination from nearby Superfund site or other activities. • Over 60% of the contributing area contains agriculture or development that is likely to impact the site's water supply • Large concentration of CAFOs or point source dischargers that contribute to the AA's water supply that are somewhat attenuated before reaching site
D	Site receives severe inputs of water quality stressors with little to no buffer from the influence of these stressors. • Overland run-off from nearby stressors is severe enough to be visibly evident within the AA (e.g., sedimentation runoff from a nearby burned area clearly covering vegetation and/or making water very turbid or manure run-off from animal feeding operation is large and shows clear unfiltered pathway between operation and AA). • evidence of recent severe spill at site, such as a large oil spill or release of contaminated water. • Hydrology of site may be highly impacted by groundwater contaminants from Superfund or other sites. • Major point source dischargers and dischargers in violation of permit standards may discharge directly into the water source near the site. • Site's main water source may be listed as impaired under the state's most current 303(d) list and the site receives direct input of this water with very little potential attenuation of water quality.
Flag	Comments

PHYSICAL STRUCTURE	
Substrate and Soil Disturbance (Evaluate in terms of the combination of severity and extent)	
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. Damage is obvious, but not excessive. 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.
Flag	Comments

VEGETATION STRUCTURE

Horizontal Interspersion

Evaluate number and arrangement of patches of water and distinct vegetation patches. 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. Distinct vegetation patches are patches that share similar physiognomy and species composition.



Rank	State
A	High degree of horizontal interspersion: AA characterized by a very complex array of nested or interspersed zones with no single dominant zone.
A-	Moderate to high degree of horizontal interspersion: AA is characterized by a complex array of nested or interspersed zones with no single dominant zone
B	Moderate degree of horizontal interspersion: AA characterized by a moderate array of nested or interspersed zones with no single dominant zone.
C	Low degree of horizontal interspersion: AA characterized by a simple array of nested or interspersed zones. One zone may dominate others.
D	No horizontal interspersion: AA characterized by one dominant zone.
Flag	Comments

Woody Debris	
Rank	**State**
NA	There are no obvious inputs of woody debris.
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. 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.
Flag	Comments:

Woody Species Regeneration	
Rank	**State**
NA	Woody species are naturally uncommon or absent.
A	All age classes of desirable (native) woody species present.
B	Age classes restricted to mature individuals and young sprouts. Middle age groups absent.
C1	Stand comprised of mainly mature species, with seedlings and sapling absent
C2	Stand mainly evenly aged young sprouts that choke out other vegetation.
D1	Woody species predominantly consist of decadent or dying individuals
D2	AA has >5% canopy cover of *Elaeagnus angustifolia* (Russian olive) and/or *Tamarix* (tamarisk) or other invasive woody species (list species below). If you select this state, select an additional statement that describes native regeneration in AA.
Flag	Comments

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.
Flag	Comments (If site scores below AB, briefly describe litter and note potential causes):

AUXILIARY METRICS

Topographic Complexity (Sketch profile and indicate if sketch corresponds to axes other than those indicated. Then circle both the rank and specific combination of elevation gradients and micro-topography present at the site) Gradients must be at least 15 cm in height difference.

North	South
East	West

Circle *both* the rank as well as the specific combination of attributes present at site.

Rank	1 Elevation Gradients	2 Elevation Gradients	≥3 Elevation Gradients
A	≥50% micro-topography	≥30% micro-topography	≥15% micro-topography
B	30-49% micro-topography	10-29% micro-topography	<15% micro-topography
C	10-29% micro-topography	<10% micro-topography	
D	<10% micro-topography		
Flag	Comments		

Structural Patch Richness (only list patch size for features with cover class 1 or 2, i.e. features that occupy less than 50 m^2 in standard AA)					
Structural Patch		**Description**	**Cover Class**	**Patch Size (m^2)**	**Wet or Dry?**
Cover Class: 1: trace **2**: <1% **3**: 1–<2% **4**: 2–<5% **5**: 5–<10% **6**: 10–<25% **7**: 25–<50% **8**: 50–<75% **9**: 75–<95% **10**:>95%					
Bare Ground	Mudflats, sandflats	A flat is a non-vegetated area of silt, clay, sand, or a mix of abiotic substrates (mud) that adjoins the wetland foreshore and can be intermittently flooded or exposed.			**W D**
	Salt flat/alkali flat	Dry open area of fine-grained sediment and accumulated salts. Often wet in the winter months or with heavy precipitation.			
	Soil cracks	Cracks formed by repeated wetting and drying of fine grain soil. Cracks must be a minimum of 2.5 cm deep to qualify.			
	Wallows or similar animal excavations	Any depression in the land surface that is caused by animals sitting, lying, or rolling on the ground surface or digging into it.			
	Animal tracks	Native (e.g. elk) or introduced (e.g. cattle) tracks that are deep enough to hold water.			
Litter	Wrack or organic debris in channel or on floodplain	Wrack is an accumulation of natural or unnatural floating debris along the high water line of a wetland. The organic debris must be free of its original growth position. Senesced plant material that is still attached to the parent plant does not count (for example, last year's cattail or bulrush growth)			
	Large woody debris	Large woody debris is any woody fragment greater than 10 cm diameter and 1 m long.			
	Standing snags	Any standing, dead woody vegetation that is at least 3 m tall with at least a 10 cm diameter is considered a snag.			
Mounds and Rocks	Animal mounds or burrows	Mounds or holes associated with animal foraging, denning, predation, or other behaviors.			
	Plant hummocks (naturally formed)	A mound composed of plant material resulting in a raised pedestal of persistent roots or rhizomes.			
	Sediment mounds	Depositional features formed from repeated flood flows depositing sediment on the floodplain, similar to hummocks but lacking plant cover.			
	Cobbles and boulders	The middle axis of a cobble ranges from 6.4 cm to <25.6 cm and for a boulder is ≥ 25.6 cm. The middle axis is the longest axis that is perpendicular to the true longest axis of the rock			
Channel and Channel-Like	Swales on floodplain or along shoreline	Swales are broad, elongated, vegetated, shallow depressions that can sometimes help to convey flood flow to and from vegetated floodplains. They lack obvious banks, regularly spaced deeps and shallows, or other characteristics of channels.			**W D**
	River/stream	Areas of flowing water associated with a sizeable channel			**W D**
	Tributary/secondary channel	Secondary channels of varying size that convey flood flows, including the diverging and converging secondary channels found in braided and anastomosing fluvial systems. Tributary channels that originate in the wetland and that only convey flow between the wetland and the primary channel are also regarded as secondary channels.			**W D**
	Rivulets/streamlet	Areas of flowing water associated with a small, diffuse channel. Often occurring near the outlet of a wet meadow or fen or at the very headwaters of a stream.			**W D**
	Oxbow/backwater channel	Areas holding stagnant or slow moving water that have been partially or completely disassociated from the primary river channel.			**W D**
	Pools or depressions in channels	Pools are areas along fluvial channels that are much deeper than the average depths of their channels and that tend to retain water longer than other areas of the channel during periods of low or no surface flow			**W D**
	Riffles or rapids	Riffles and rapids are areas of relatively rapid flow, standing waves and surface turbulence in fluvial channels. A steeper reach with coarse material (gravel or cobble) in a dry channel indicates presence.			**W D**
	Interfluves on floodplain	The area between two adjacent streams or stream channels flowing in the same general direction			
	Point bars	Patches of transient bedload sediment that can form along the inside of meander bends or in the middle of straight channel reaches, sometimes supporting vegetation. They are convex in profile and their surface material varies in size from finer on top to larger along their lower margins.			
	Active beaver dam	Debris damming a stream clearly constructed by beaver (note gnawed ends of branches)			
	Debris jams/woody debris in channel	Aggregated woody debris in a stream channel deposited by high flows.			

Cover Class: 1: trace **2**: <1% **3**: 1–<2% **4**: 2–<5% **5**: 5–<10% **6**: 10–<25% **7**: 25–<50% **8**: 50–<75% **9**: 75–<95% **10**:>95%

	Structural Patch	**Description**	**Cover Class**	**Patch Size (m^2)**	**Wet or Dry?**
Pool or Pond-Like	Pond or lake	Natural water body with areas of open water deeper than 2 m in depth that do not support emergent vegetation			**W D**
	Beaver pond	Areas that hold stagnant or slow moving water behind a beaver dam.			**W D**
	Pools- filled by groundwater	Areas that hold stagnant or slow moving water from groundwater discharge but are not associated with a defined channel (more active areas of groundwater discharge may be evaluated under seeps/springs)			**W D**
	Pools- filled by overland flow	A shallow topographic basin lacking vegetation but existing on a well-vegetated wetland plain that fills with water at least seasonally due to overland flow.			**W D**
Shore or Bank	Bank slumps in channel or along shoreline	A bank slump is the portion of a stream or other wetland bank that has broken free from the rest of the bank but has not eroded away.			
	Undercut banks in channel or along shoreline	Undercut banks are areas along the bank or shoreline of a wetland that have been excavated by waves or flowing water.			
	Variegated or crenulated foreshore	As viewed from above, the foreshore of a wetland can be mostly straight, broadly curving (i.e., arcuate), or variegated (e.g., meandering). In plan view, a variegated shoreline resembles a meandering pathway.			
Miscellaneous Water-Associated Features	Adjacent or onsite springs/seeps	Localized point of emerging groundwater, often on or at the base of a sloping hillside.			
	Floating mat	Mats of peat held together by roots and rhizomes of sedges. Floating mats are underlain by water and /or very loose peat and are found on the edges of ponds and lakes and are slowing encroaching into open water.			
	Marl/limonite beds	Marl is a calcium carbonate precipitate often found in calcareous fens. Limonite forms in iron-rich fens when iron precipitates from the groundwater incorporating organic matter.			
	Beaver canals	Canals cut through emergent vegetation by beaver.			
	Water tracks/hollows	Depressions between hummocks or mounds that remain permanently saturated or inundated with slow moving surface water.			
	Islands (exposed at high-water stage)	An island is an area of land above the usual high water level and, at least at times, surrounded by water. Islands differ from hummocks and other mounds by being large enough to support trees or large shrubs			
	Woody vegetation in water	Live trees or woody vegetation in water. This does not including riparian woody vegetation at the edge of the wetland but rather trees or large shrubs that are within the wetland.			
	Concentric or parallel high water marks	Evidence of repeated variation in water level in the wetland, such as water marks etched in substrate or concentric bands of vegetation that result from water level-driven differences in soil moisture, chemistry, etc. The variation in water level might be natural (e.g., seasonal) or anthropogenic.			

Flag	Comments

Site ID:	Surveyors:				Date:
Ground Cover and Vertical Strata (all estimates in % unless otherwise stated)					
Ground Cover Type **AA/Plot**	**AA**	**1**	**2**	**3**	**4**
Cover of exposed bare ground[1]– soil / sand / sediment (including mudflats and salt encrustations)					
Cover of exposed bare ground[1]– gravel / cobble (~2–250 mm)					
Cover of exposed bare ground[1]– bedrock / rock / boulder (>250 mm)					
Area of AA with dense canopy of litter mostly >10-20 cm ***above*** wetland surface (dense enough to obscure boots)					
Area of AA with dense canopy of litter mostly reaching down to wetland surface (dense enough to obscure boots)					
Cover of remaining litter (too low to hide a boot in- i.e. all litter not as above)					
Predominant litter type (C = coniferous, E = broadleaf evergreen, D = deciduous, S = sod/thatch, F = forb)					
Actual *cover of water (any depth, vegetated or not, standing or flowing)*					
Actual cover of shallow water <20 cm					
Actual cover of deep water >20 cm					
Actual cover of open water with no vegetation					
Actual cover of water with submergent or floating aquatic vegetation[2]					
Actual cover of water with emergent vegetation					
Potential cover of water at ordinary high water					
Potential average depth at ordinary high water	cm	cm	cm	cm	cm
Cover of standing dead trees (>5 cm diameter at breast height (DBH)- 1.4 m)					
Cover of standing dead shrubs/small trees (<5 cm DBH- 1.4 m)					
Cover of downed coarse woody debris (fallen trees, rotting logs, >5 cm diameter)					
Cover of downed fine woody debris (<5 cm diameter)					
Cover bryophytes (all cover, including under water, vegetation or litter cover)					
Cover lichens (all cover, including under water, vegetation or litter cover)					
Cover algae(all cover, including under water, vegetation or litter cover)					
Cover of desiccated/dried algae					
Cover of wet filamentous algae					
Cover of macroalgae (chara, etc.)					
Epiphytic algae (covering submerged vegetation)[3]	N L M H	N L M H	N L M H	N L M H	N L M H
Substrate algae (algae covering rocks, litter, etc.)[3]	N L M H	N L M H	N L M H	N L M H	N L M H
For the measures below, do not look at the exact cover (i.e. the shadow produced when the sun is directly overhead). Instead, look at the general area where the layers are found.					
Circle all layers present (in at least 5% of suitable area), including Submerged (Su), Floating (Fl), Short <0.5 m (Sh), Medium 0.5-1.5 m (Me), Tall 1.5-3.0 m (Ta), and Very Tall > 3.0 m (VT)	Su Fl Sh Me Ta VT	Su Fl Sh Me Ta VT	Su Fl Sh Me Ta VT	Su Fl Sh Me Ta VT	Su Fl Sh Me Ta VT
Area of AA with overlap of three or more plant layers (layers listed above)					
Area of AA with overlap of two plant layers (layers listed above)					

[1]Bare ground has no vegetation/litter/water cover, but may have algae cover. The three categories are mutually exclusive and should total ≤100%.
[2]Can overlap with other water cover, such as emergent vegetation
[3]Select Not present/trace (N), low (L), medium (M), or high (H)

FLAG	Comments:

Site ID:	Surveyors:	Date:

Site Sketch: Define scale for grid, add north arrow. Mark inlets and outlet if present in or adjacent to AA.

Site ID:	Surveyors:	Date:

Plant Species Table: List all plant species found in AA and estimate height, cover class and dominant phenology

Height class (H): A: <0.5 m **B**: 0.5–1 m **C**: 1-2 m **D**: 2–5 m **E**: 5- 10 m **F:** >10 m **50 m² = 1% of standard circular AA**

Phenology (P): V: Vegetative , **Fl:** Flowering **Fr:** Fruiting **SD:** standing dead (from current year, not previous years)

Scientific Name/Pseudonym	Coll #	Photos	H	P	% AA	% 1	% 2	% 3	% 4

Measure litter depth and water depth at four representative locations in the AA or, for Level III, in four locations within each plot. If there is no litter or water of the specified depth, enter a dash, NOT a zero.

All measurements in cm	AA		Plot 1		Plot 2		Plot 3		Plot 4	
Litter depth										
Water depth < 20 cm										
Water depth ≥ 20 cm										

Site ID:	Surveyors:	Date:

Plant Species Table: List all plant species found in AA and estimate height, cover class and dominant phenology

Height class (H): A: <0.5 m **B**: 0.5–1 m **C**: 1-2 m **D**: 2–5 m **E**: 5- 10 m **F:** >10 m **50 m² = 1% of standard circular AA**

Phenology (P): V: Vegetative , **Fl:** Flowering **Fr:** Fruiting **SD:** standing dead (from current year, not previous years)

Scientific Name/Pseudonym	Coll #	Photos	H	P	% AA	% 1	% 2	% 3	% 4

Site ID:____________________ Patch Number:________ LIST ANY PHOTOS ON THE MAIN SURVEY FIELD FORM

PIT # In Patch:______ Waypoint ID:_____________________ Pit Depth (cm): ______ Settling Time Begin (Time):_________________ Settling Time End (Time):__________________

Settling Time (mins): ___________ Depth to saturated soil* (cm): ___________Depth to free water* (cm): _____________ ☐ Not observed, if so: ☐Pit is filling slowly OR ☐Pit appears dry

*depths below the soil surface are recorded as positive values and depths above the soil surface are recorded as negative

Horizon (optional)	Depth (cm)	Matrix Color (moist)	Dominant Redox Features Feature Type[1]	Dominant Redox Features Color (moist)	Dominant Redox Features %	Secondary Redox Features Feature Type[1]	Secondary Redox Features Color (moist)	Secondary Redox Features %	Texture	% Coarse)
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains **Hydric Soil Present? Yes_____ No_____ Hydric Indicators? Yes_____ No_____**

Hydric Soil Indicators: See field manual for descriptions and check all that apply to pit.

____Histosol (A1)
____Histic Epipedon (A2/A3)
____1 cm Muck (A9)
____Mucky Mineral (S1/F1)
___Hydrogen Sulfide Odor (A4)
____ Gleyed Matrix (S4/F2)
____ Depleted Matrix (A11/A12/F3)
____ Redox Concentrations (S5/F6/F8)
____ Redox Depletions (S6/F7)
____Vernal Pools(F9)

Indicators of Site Hydrology: See field manual for descriptions and check and circle all that apply

_____ Observation of Surface Water or Saturated Soils (A1, A2, A3)
_____ Evidence of Recent Inundation (B1*, B2*, B3*, B4, B5, B6, B8, B9, **B10**, B11, B12, B13)
_____ Evidence of Current or Recent Soil Saturation (C1, **C2**, C3, C4, C6, C7, C8)
_____ Evidence from Other Site Conditions or Data (**D2, D3, D5, D7**)

Bold- Secondary Indicators *- Secondary Indicator for Riverines **All Secondary Indicators Require 2**

Water Chemistry

Colors include Cl (clear), Br (brownish), Gr (greenish), Re (reddish), Bl (blue), or Or (orange)

GPS WP#	Location (circle)	Water Depth (cm)	Surface OR Ground	Standing OR Flowing (circle)	Color	Trans. Tube Depth (cm)	Visibility = or > than depth?	Meter	pH	EC/TDS Out of Range	EC (mS or uS)	TDS (ppm or ppb)	Temp (C°)
	Soil Pit OR Well	NA	Ground	NA	NA	NA	NA	Low		☐			
								High		☐			
	Channel OR Pool OR Discharge OR Base Wetland		Surface	Standing OR Flowing	Cl Br Gr Re Bl Or		= OR >	Low		☐			
								High		☐			
	Channel OR Pool OR Discharge OR Base wetland		Surface	Standing OR Flowing	Cl Br Gr Re Bl Or		= OR >	Low		☐			
								High		☐			

Soil and Water Quality Comments (include potential problem soils if no hydric indicators present):

Site ID:____________________ Patch Number:________ LIST ANY PHOTOS ON THE MAIN SURVEY FIELD FORM

PIT # In Patch:______ Waypoint ID:_____________________ Pit Depth (cm): ______ Settling Time Begin (Time):_________________ Settling Time End (Time):__________________

Settling Time (mins): ___________ Depth to saturated soil* (cm): ____________Depth to free water* (cm): _____________ ☐ Not observed, if so: ☐Pit is filling slowly OR ☐Pit appears dry

*depths below the soil surface are recorded as positive values and depths above the soil surface are recorded as negative

Horizon (optional)	Depth (cm)	Matrix Color (moist)	Dominant Redox Features: Feature Type[1]	Dominant Redox Features: Color (moist)	%	Secondary Redox Features: Feature Type[1]	Secondary Redox Features: Color (moist)	%	Texture	% Coarse)
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______
________	_______	_______________	____________	_______________	_______	____________	_______________	_______	_____________	______

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains **Hydric Soil Present? Yes_____ No_____ Hydric Indicators? Yes_____ No_____**

Hydric Soil Indicators: See field manual for descriptions and check all that apply to pit.

____Histosol (A1)
____Histic Epipedon (A2/A3)
____1 cm Muck (A9)
____Mucky Mineral (S1/F1)
___Hydrogen Sulfide Odor (A4)
_____ Gleyed Matrix (S4/F2)
_____ Depleted Matrix (A11/A12/F3)
_____ Redox Concentrations (S5/F6/F8)
_____ Redox Depletions (S6/F7)
_____Vernal Pools(F9)

Indicators of Site Hydrology: See field manual for descriptions and check and circle all that apply

_____ Observation of Surface Water or Saturated Soils (A1, A2, A3)
_____ Evidence of Recent Inundation (B1*, B2*, B3*, B4, B5, B6, B8, B9, **B10**, B11, B12, B13)
_____ Evidence of Current or Recent Soil Saturation (C1, **C2**, C3, C4, C6, C7, C8)
_____ Evidence from Other Site Conditions or Data (**D2, D3, D5, D7**)

Bold- Secondary Indicators *- Secondary Indicator for Riverines **All Secondary Indicators Require 2**

Water Chemistry

Colors include Cl (clear), Br (brownish), Gr (greenish), Re (reddish), Bl (blue), or Or (orange)

GPS WP#	Location (circle)	Water Depth (cm)	Surface OR Ground	Standing OR Flowing (circle)	Color	Trans. Tube Depth (cm)	Visibility = or > than depth?	Meter	pH	EC/TDS Out of Range	EC (mS or uS)	TDS (ppm or ppb)	Temp (C°)
	Soil Pit OR Well	NA	Ground	NA	NA	NA	NA	Low		☐			
								High		☐			
	Channel OR Pool OR Discharge OR Base Wetland		Surface	Standing OR Flowing	Cl Br Gr Re Bl Or		= OR >	Low		☐			
								High		☐			
	Channel OR Pool OR Discharge OR Base wetland		Surface	Standing OR Flowing	Cl Br Gr Re Bl Or		= OR >	Low		☐			
								High		☐			

Soil and Water Quality Comments (include potential problem soils if no hydric indicators present):

Appendix B.

Individual Maps of Study Sites.

The following descriptions explain the legend items used on the following maps in more detail. The maps depict differences between wetland boundary data collected in the field by the Utah Geological Survey (UGS) and wetlands mapped using aerial imagery by the UGS, the U.S. Forest Service Uinta-Wasatch-Cache National Forest (Forest Service), and the National Wetland Inventory Program (NWI).

Point features include:

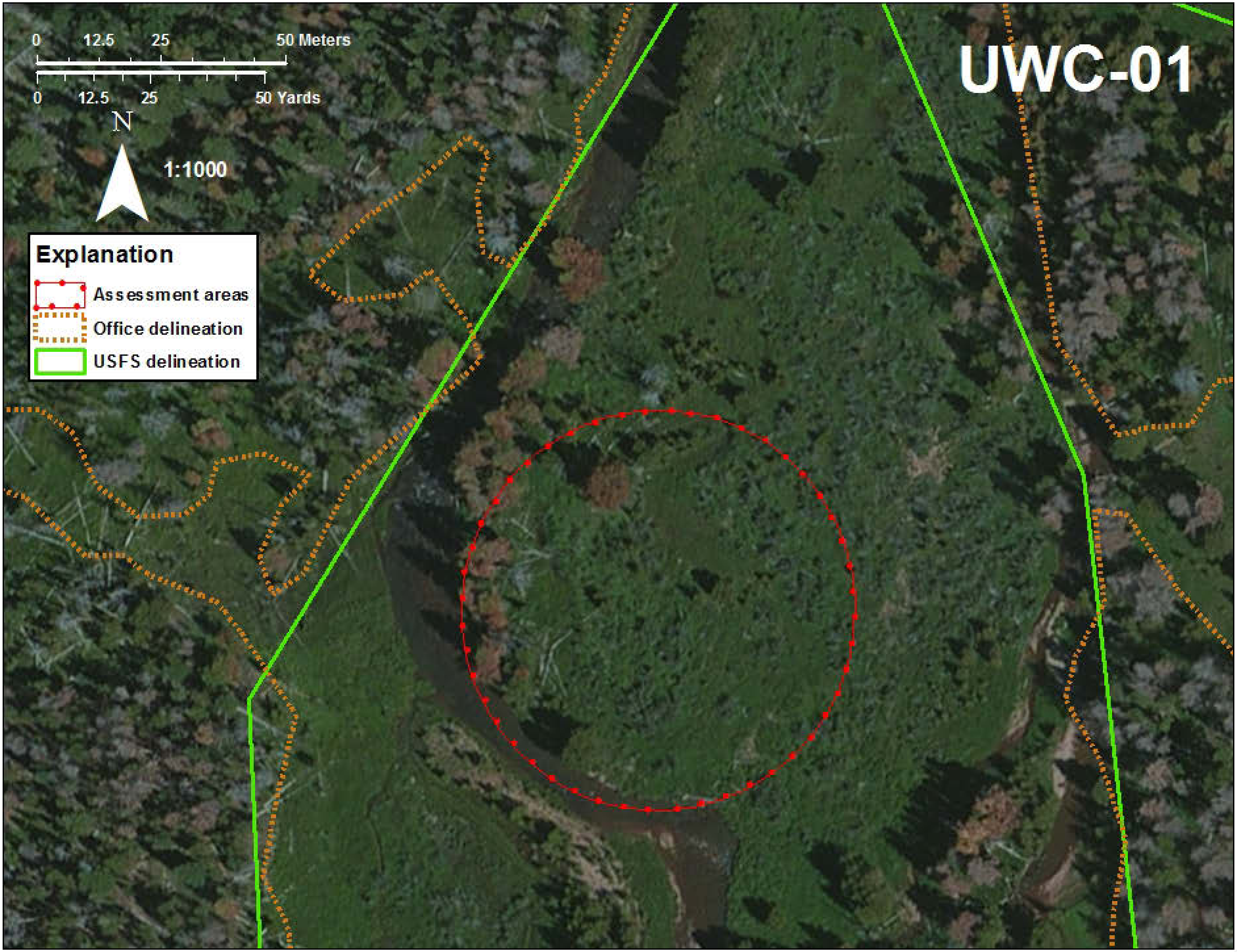
1. **Jurisdictional wetland:** GPS point locations collected by the UGS that met the U.S. Army Corps of Engineers (USACE) wetland definition as detailed in the USACE western mountains regional supplement. Jurisdictional wetlands must have a predominance of hydrophytic plants, indicators of wetland hydrology, and indicators of hydric soils.
2. **Non-Jurisdictional wetlands:** GPS point locations collected by the UGS that did not meet the USACE jurisdictional definition, but had at least one of the three wetland indicators present (hydrophytes, hydric soils, and hydrology).
3. **Upland:** Terrestrial lands without any of the three indicators present.

Line features include:

4. **Delineation tracks:** These tracks represent the boundary between jurisdictional and non-jurisdictional wetlands. The tracks were field delineated by the UGS.

Polygon features include:

5. **Assessment areas:** These polygons show the location where the UGS conducted a rapid assessment to assess wetland condition using the Utah Rapid Assessment Procedure. Assessment area locations were randomly selected and altered to include primarily jurisdictional wetland.
6. **Office delineation:** Wetland boundaries that were mapped in the office by the UGS according to the NWI standards using aerial photo interpretation and field reconnaissance data collected during site visits.
7. **USFS delineation:** Wetlands that were mapped by the Forest Service hydrologist in 2006 and 2007 using 2004 imagery and loosely using NWI mapping guidelines with more focus on wetland vegetation and landform than hydrology and soil indicators.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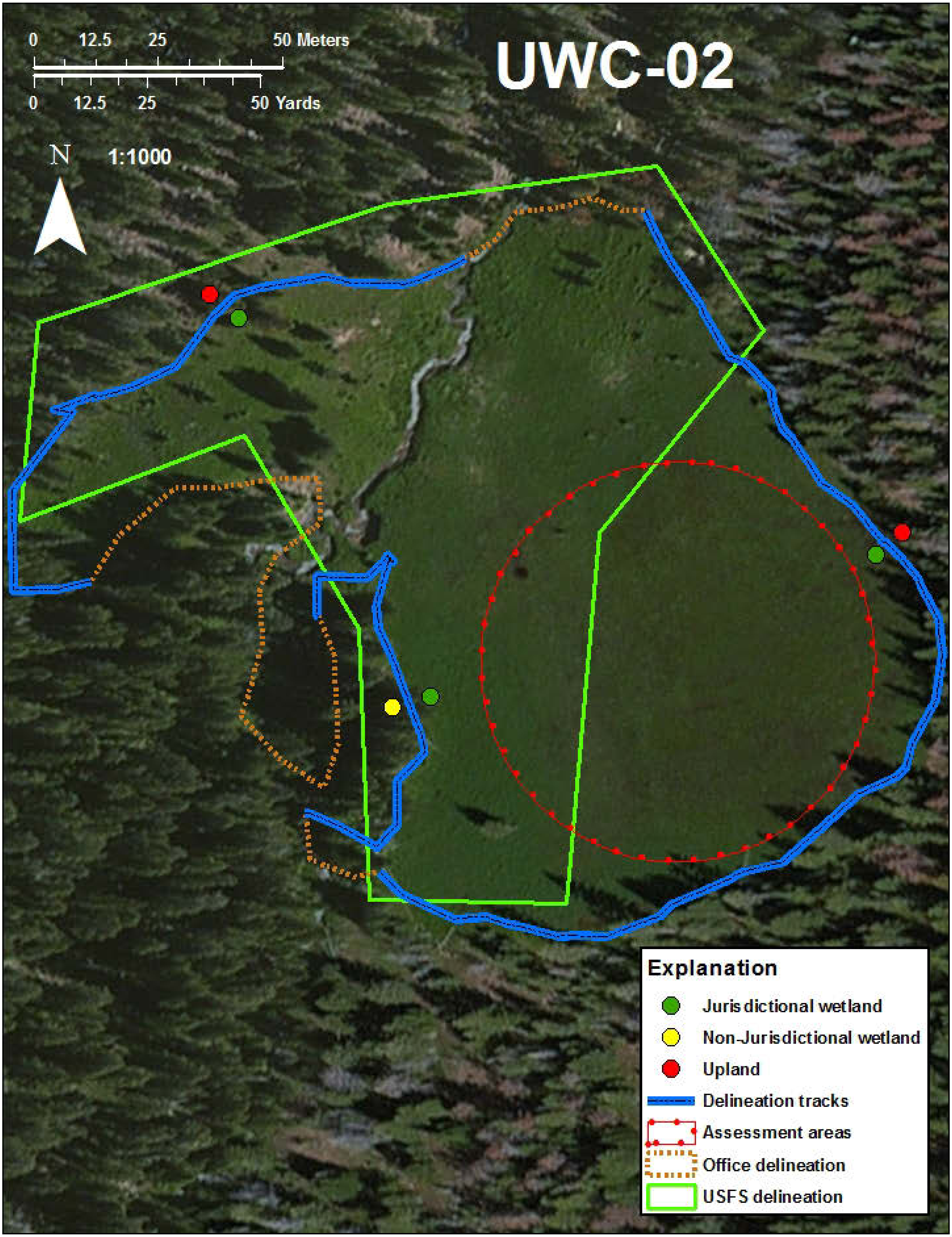
Explanation
Assessment areas
Office delineation
USFS delineation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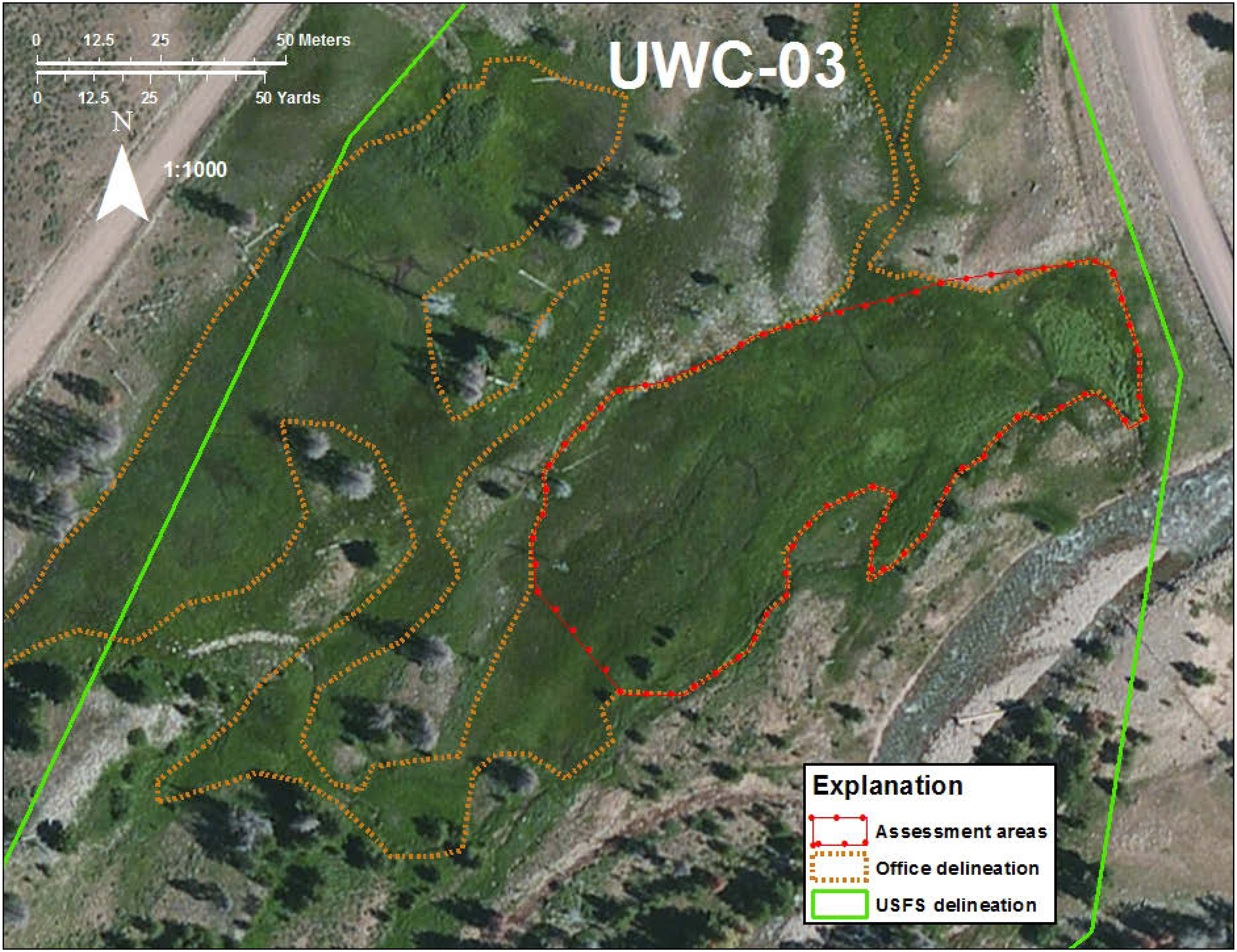
Non-Jurisdictional wetland
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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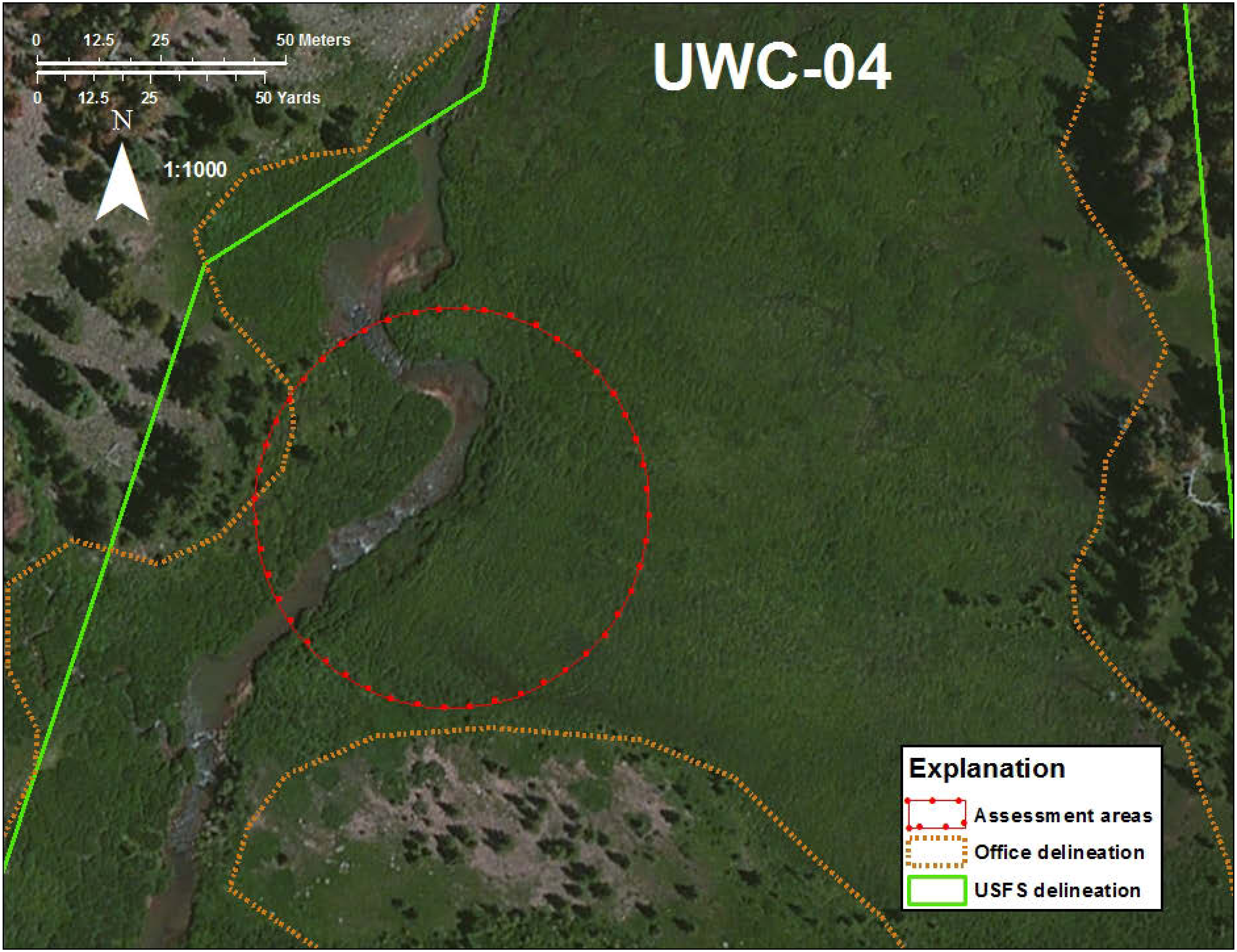
Assessment areas
Office delineation
USFS delineation



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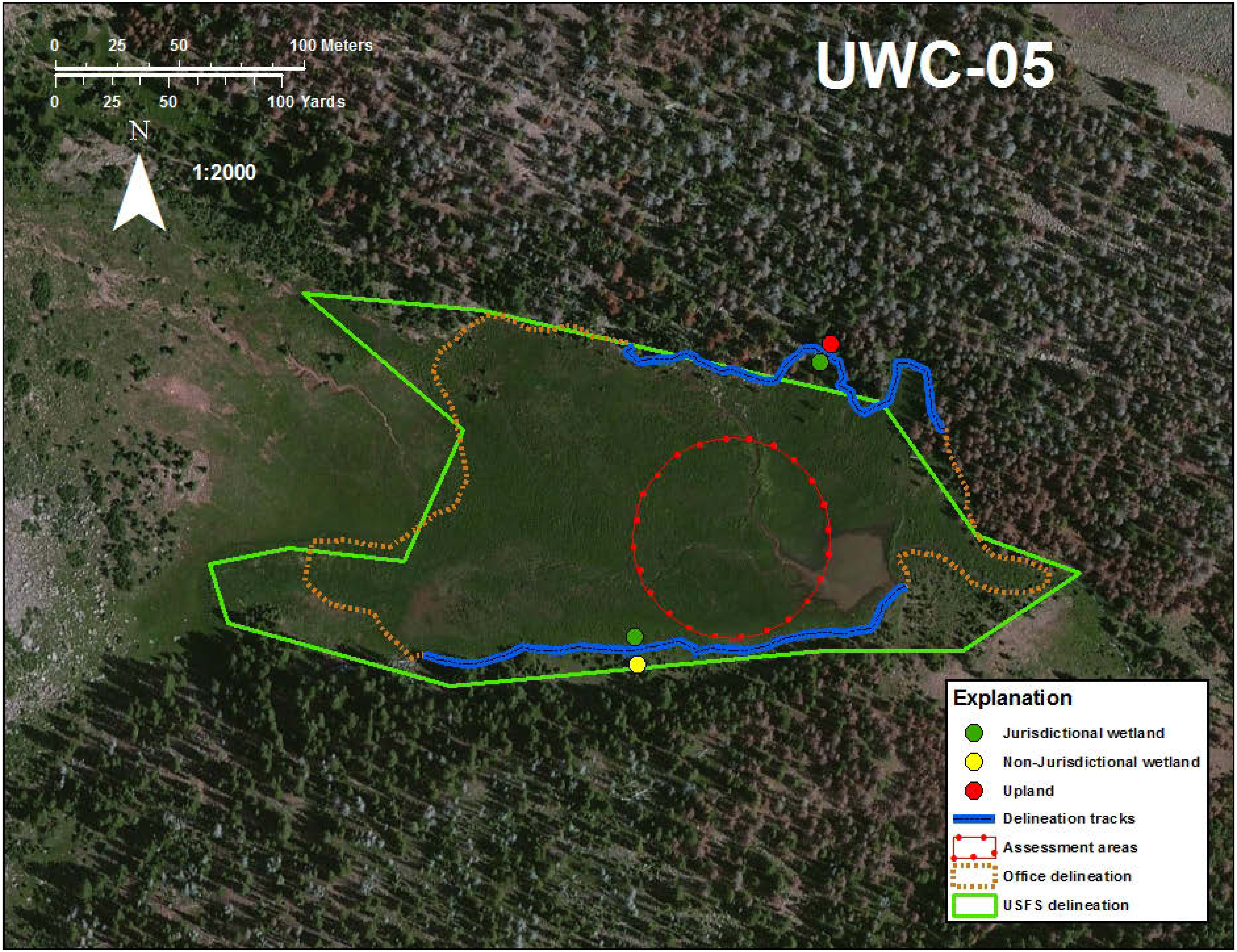
Office delineation
USFS delineation



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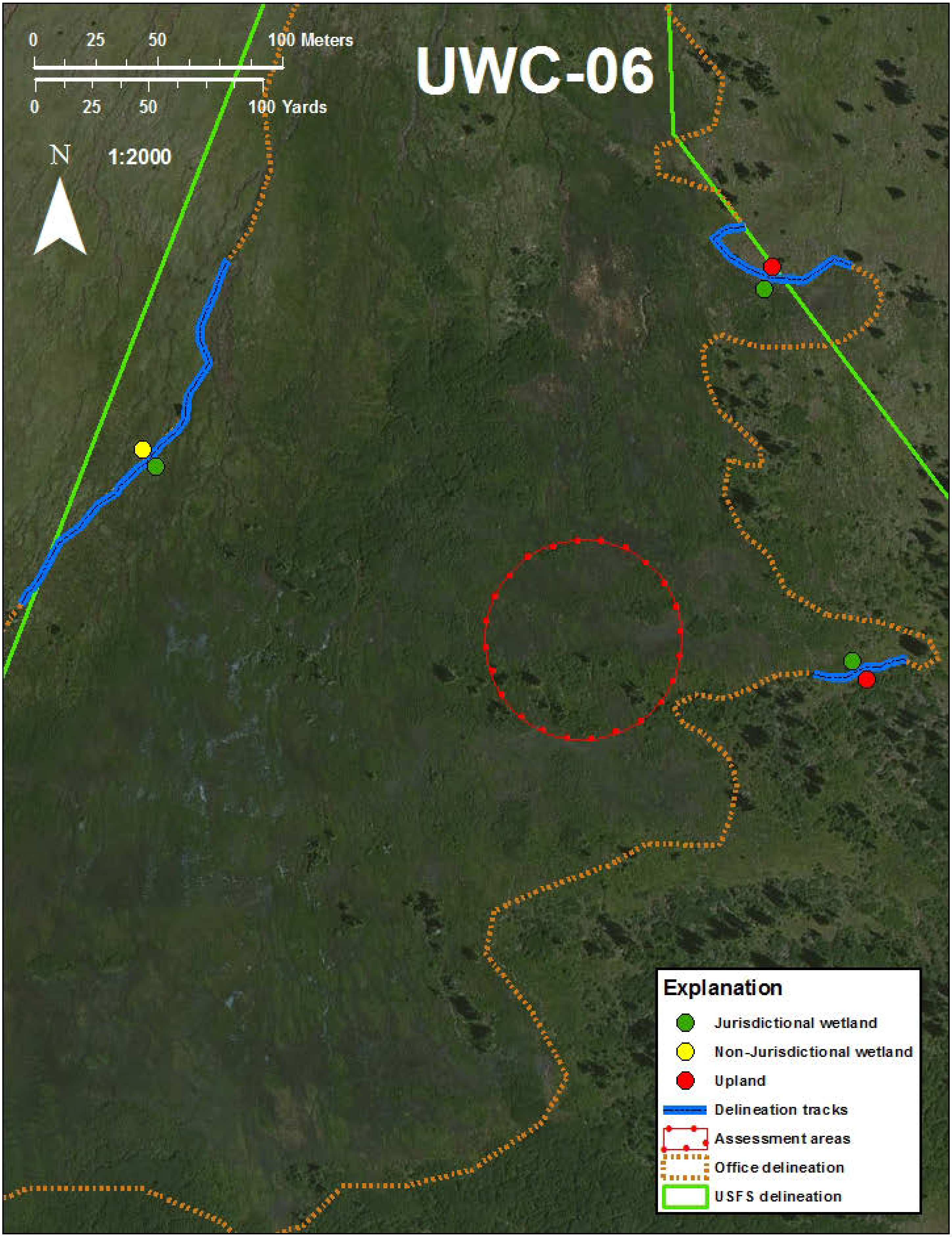
Non-Jurisdictional wetland
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation



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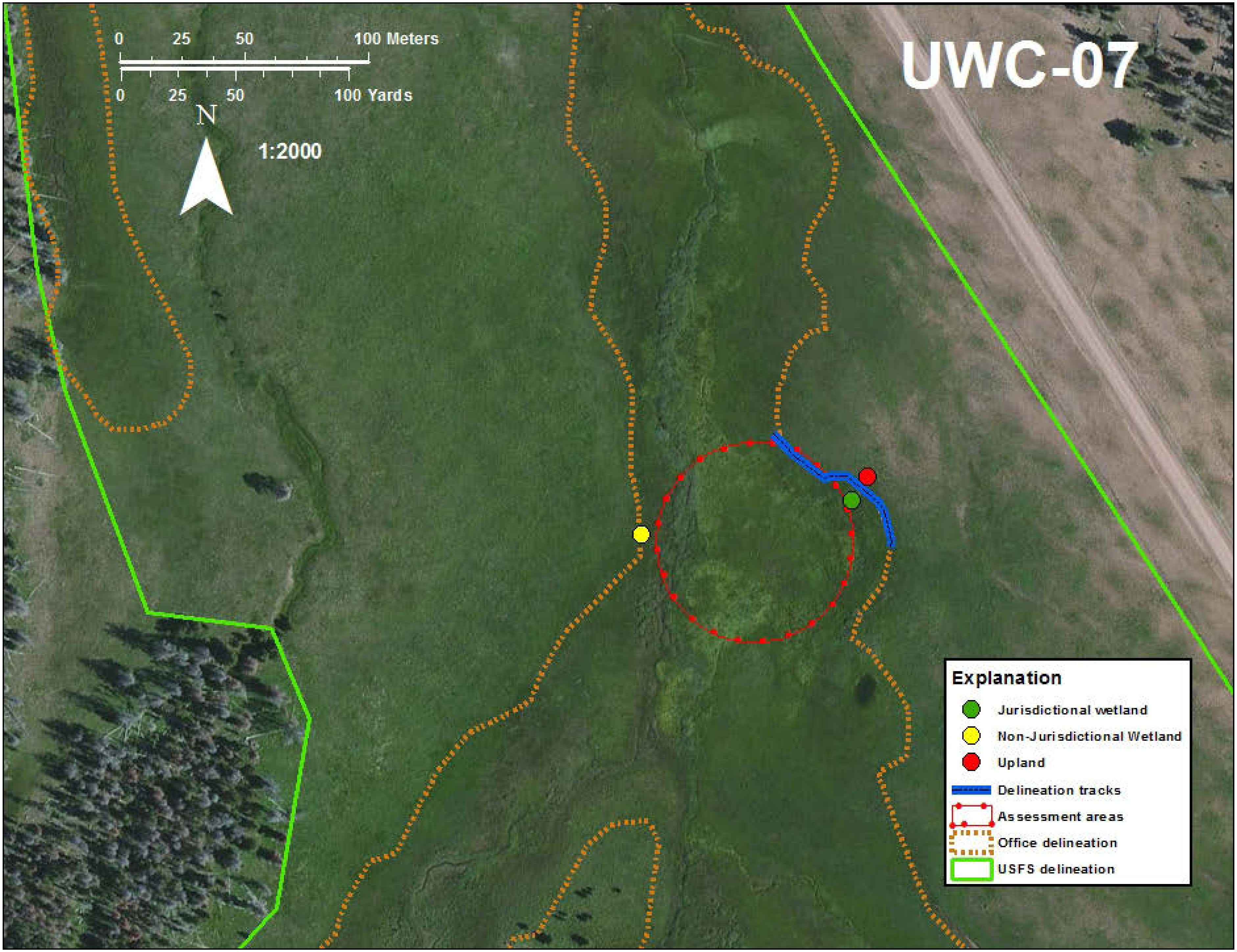
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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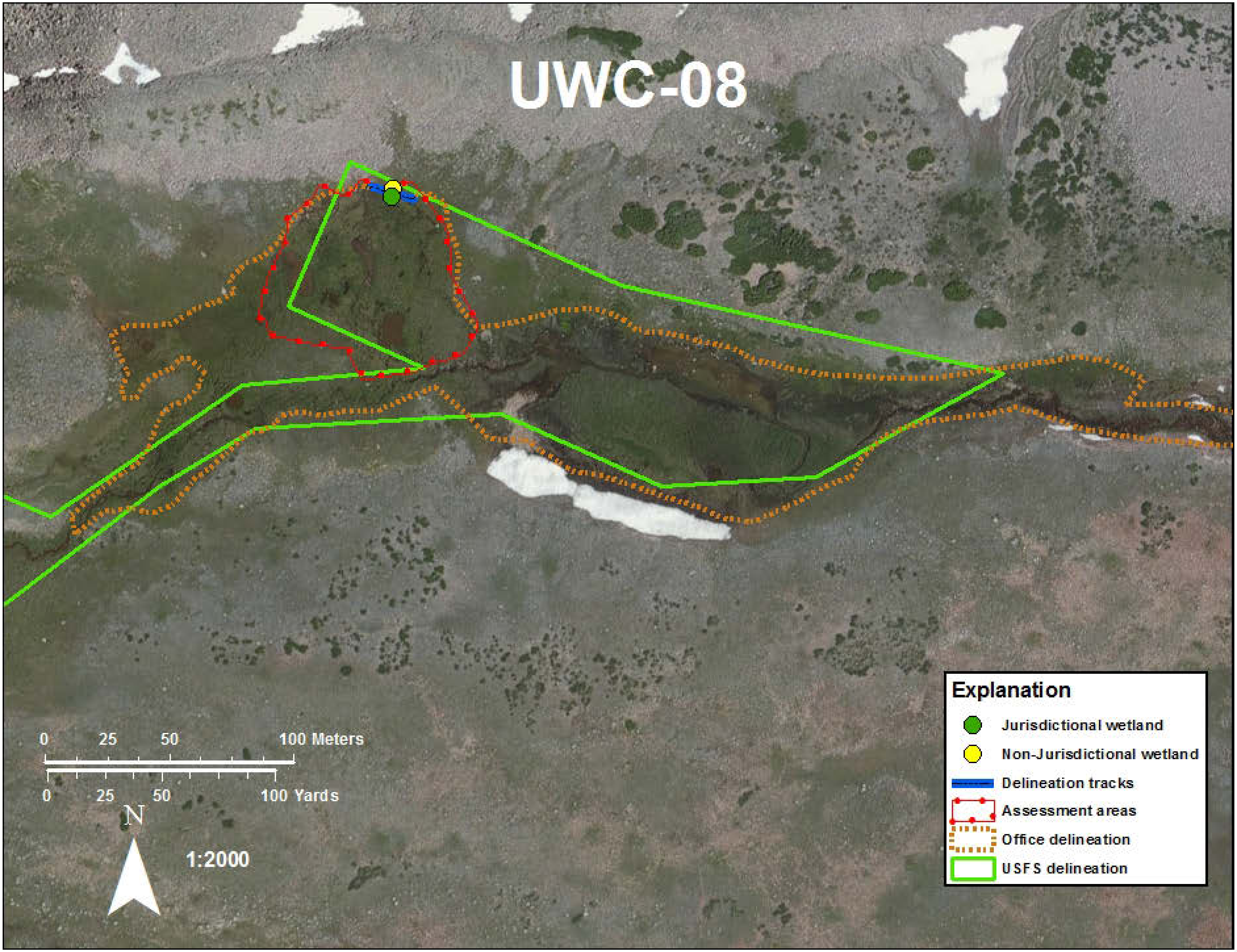
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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Delineation tracks
Assessment areas
Office delineation
USFS delineation
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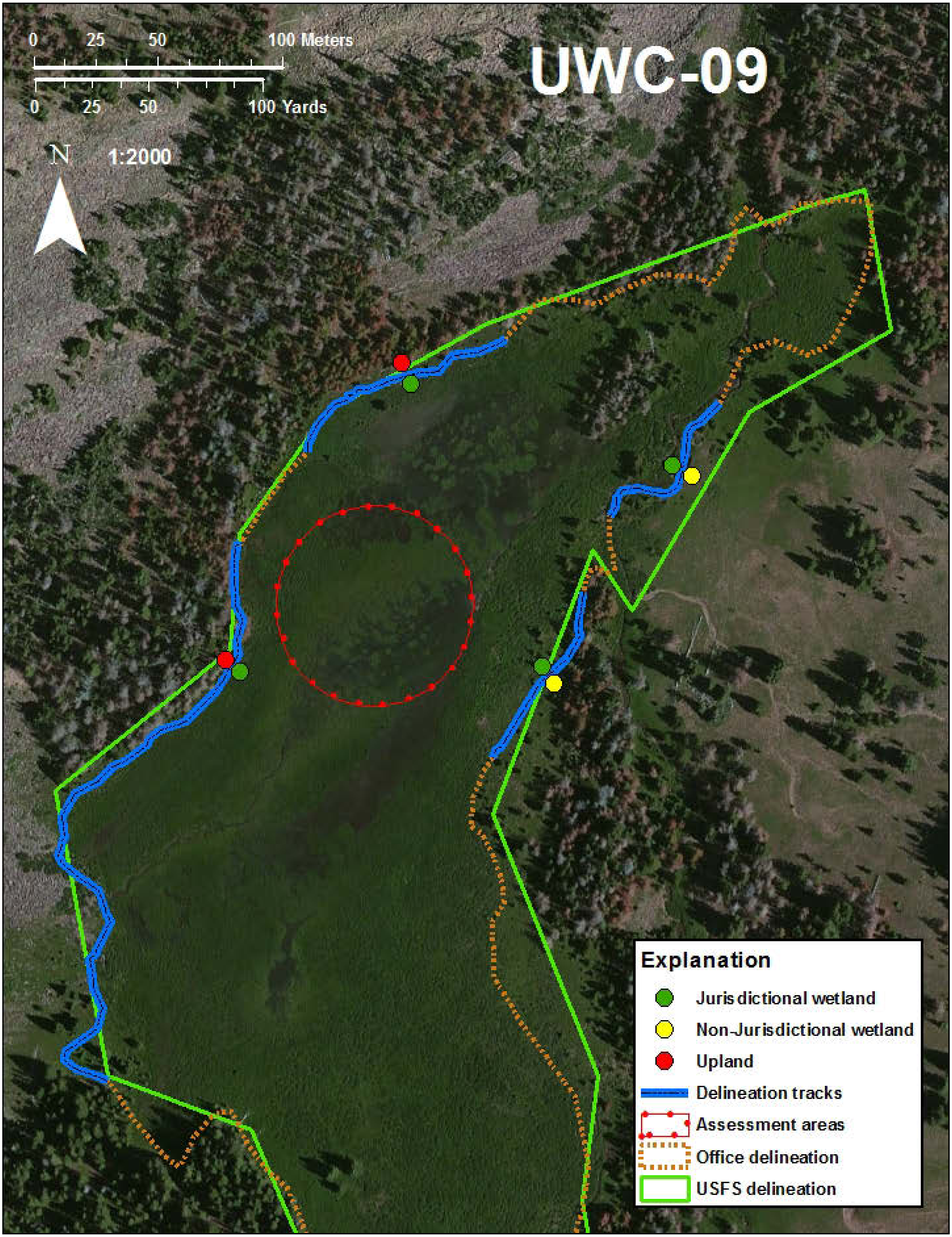

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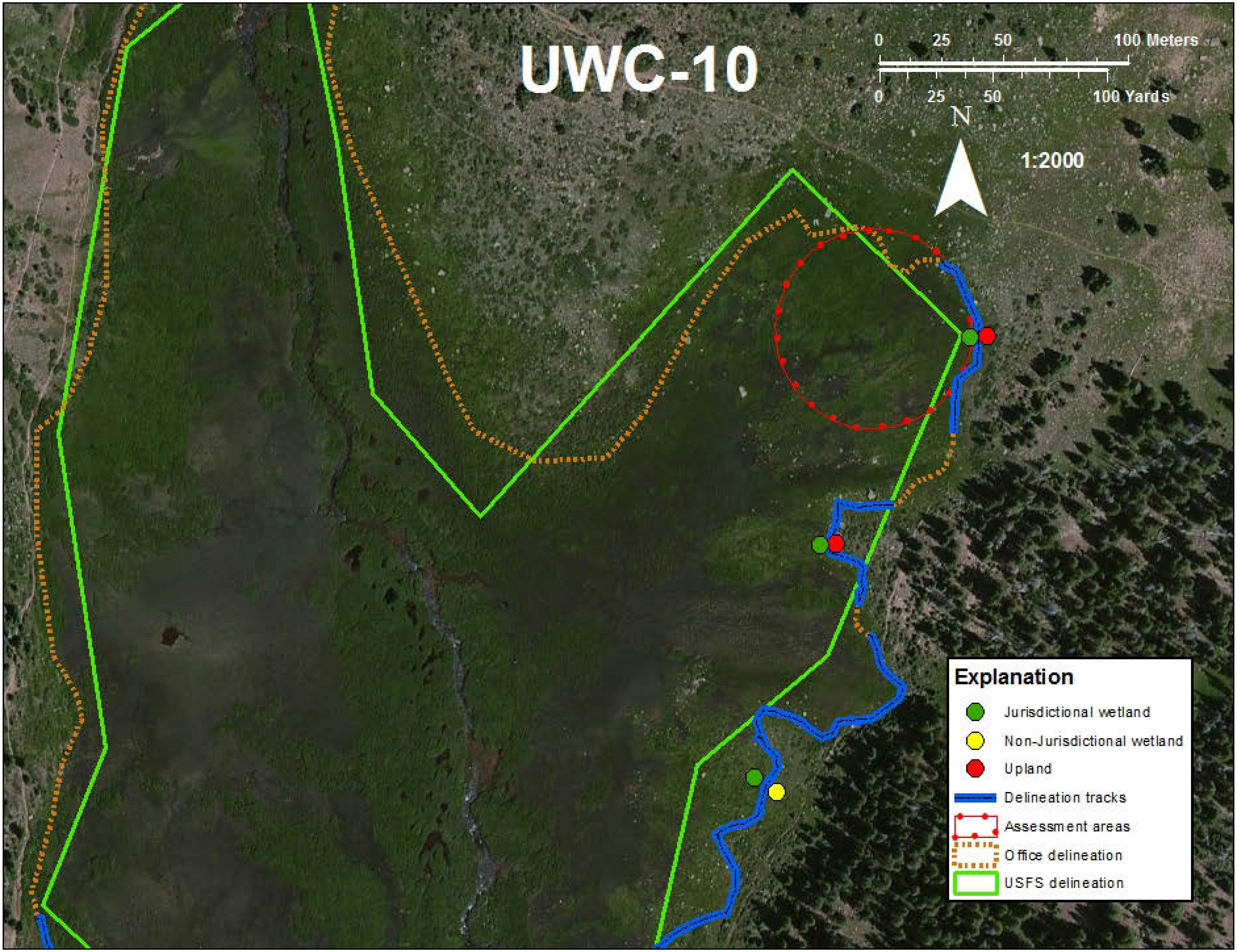
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation



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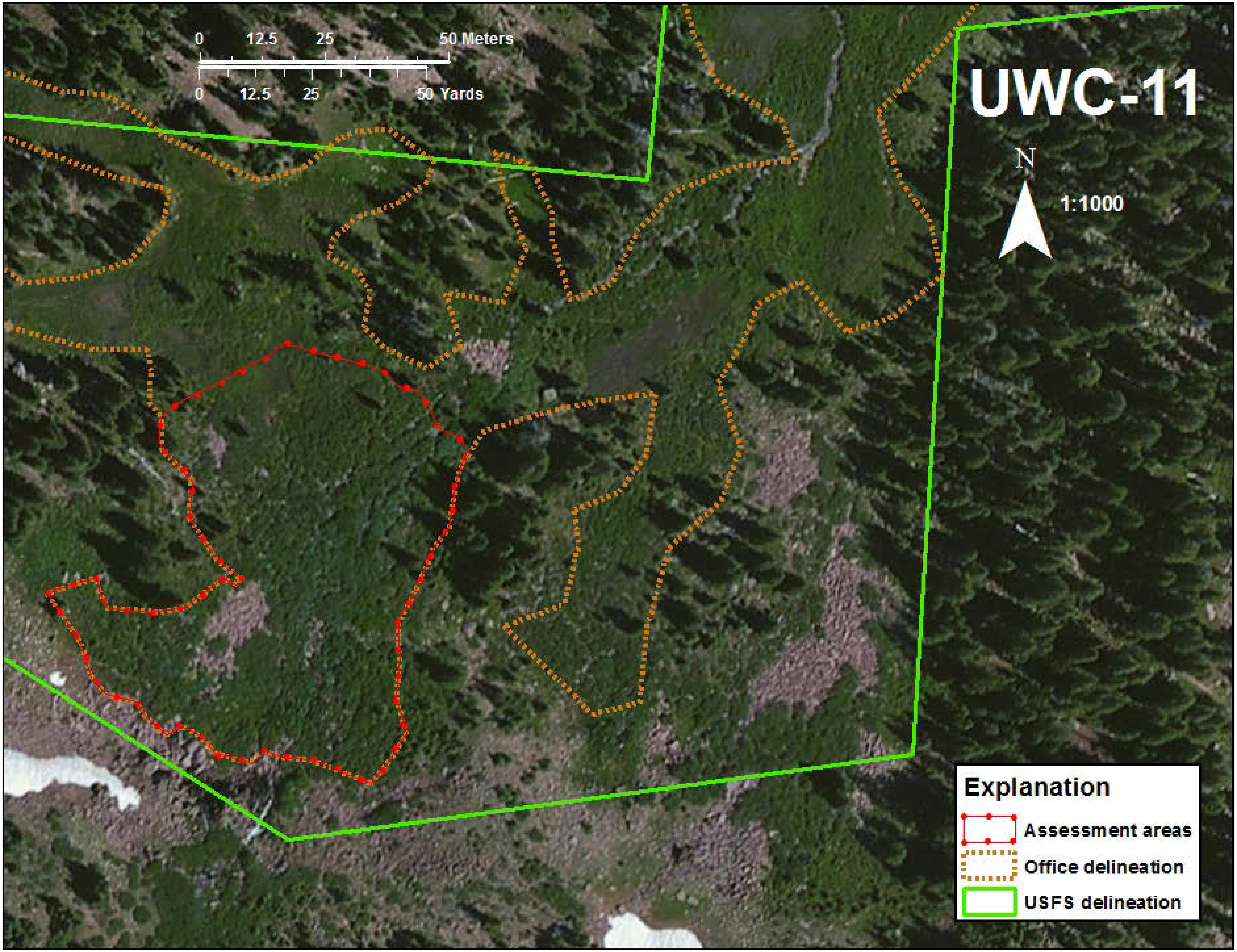
Delineation tracks
Assessment areas
Office delineation
USFS delineation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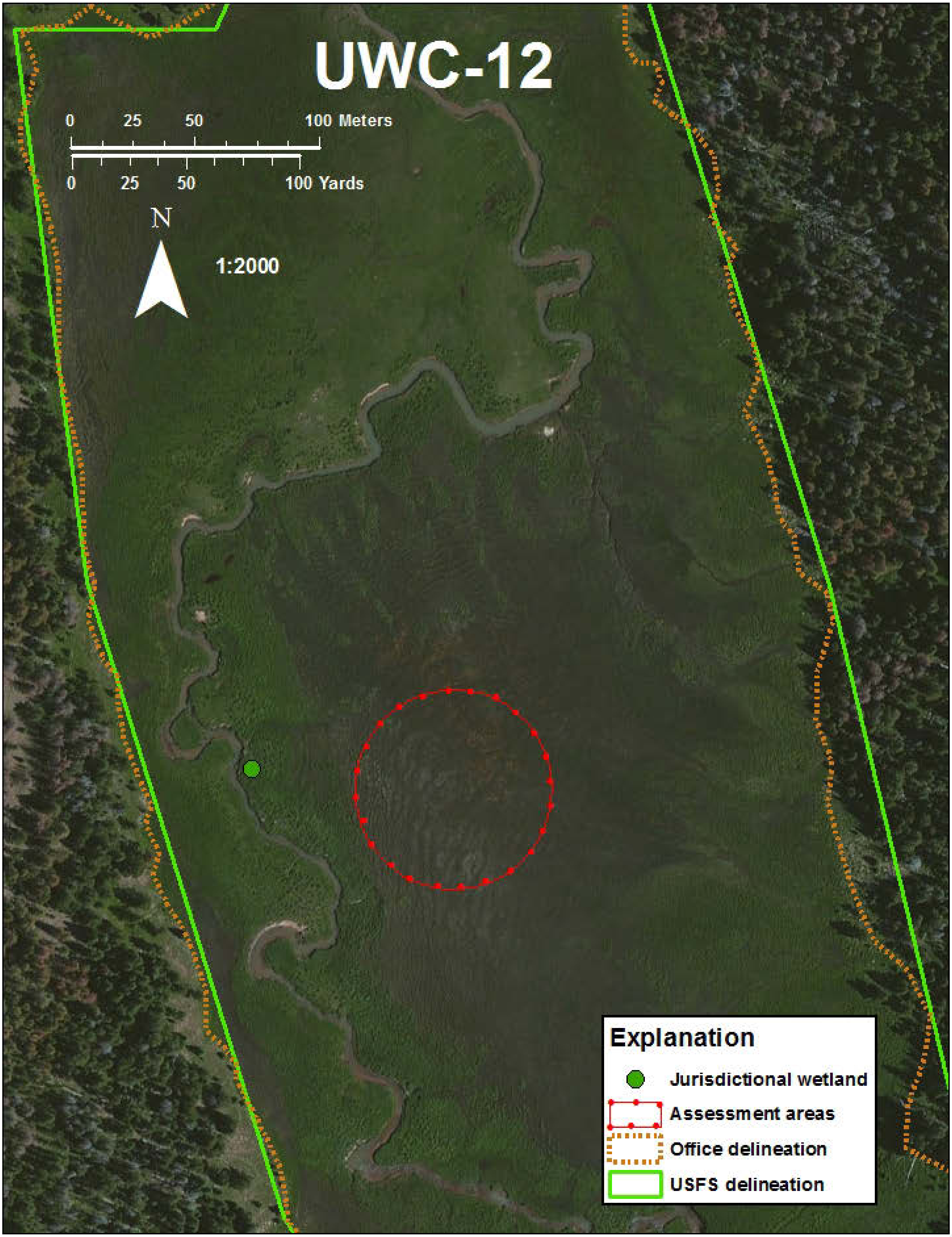
Explanation
Assessment areas
Office delineation
USFS delineation



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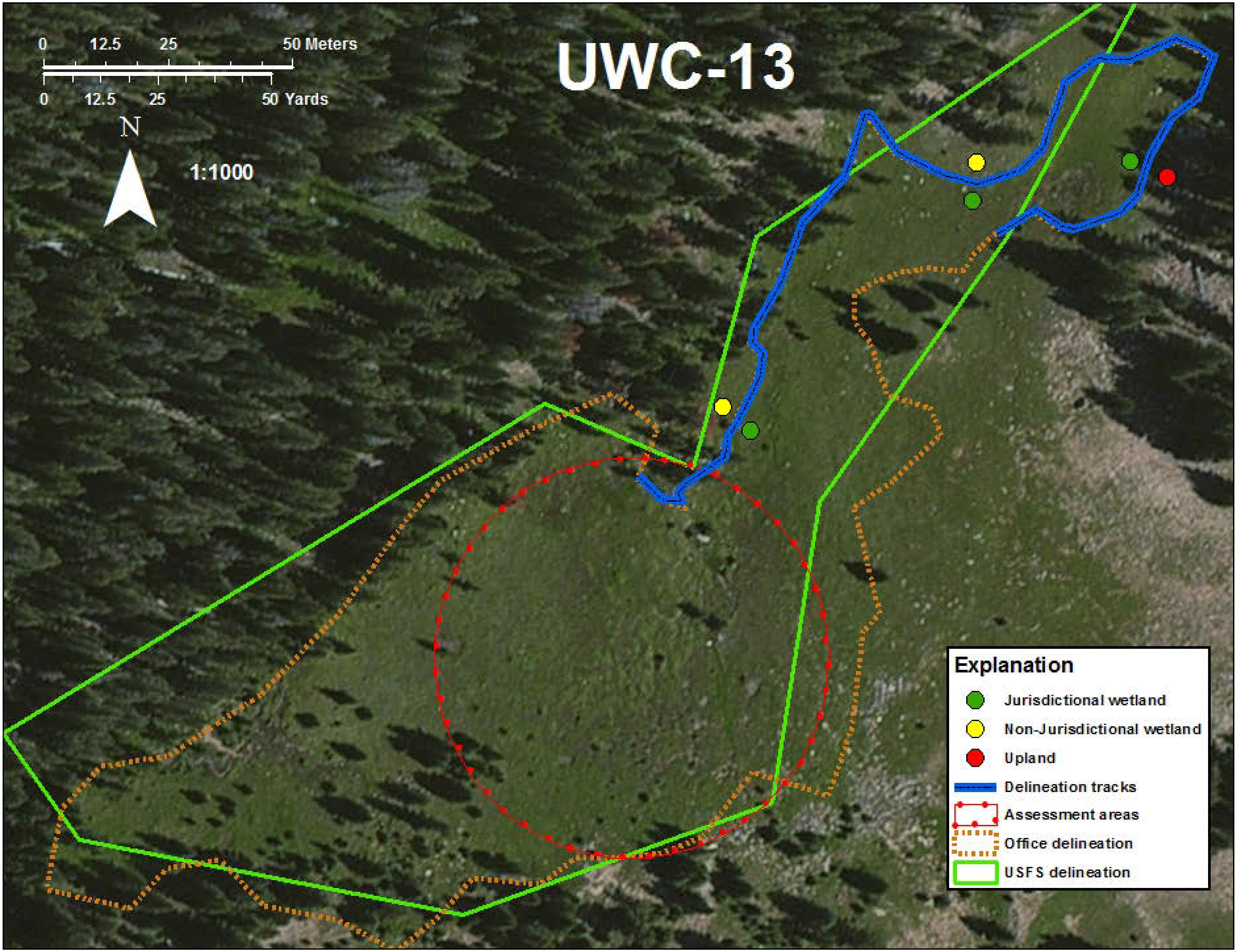
Assessment areas
Office delineation
USFS delineation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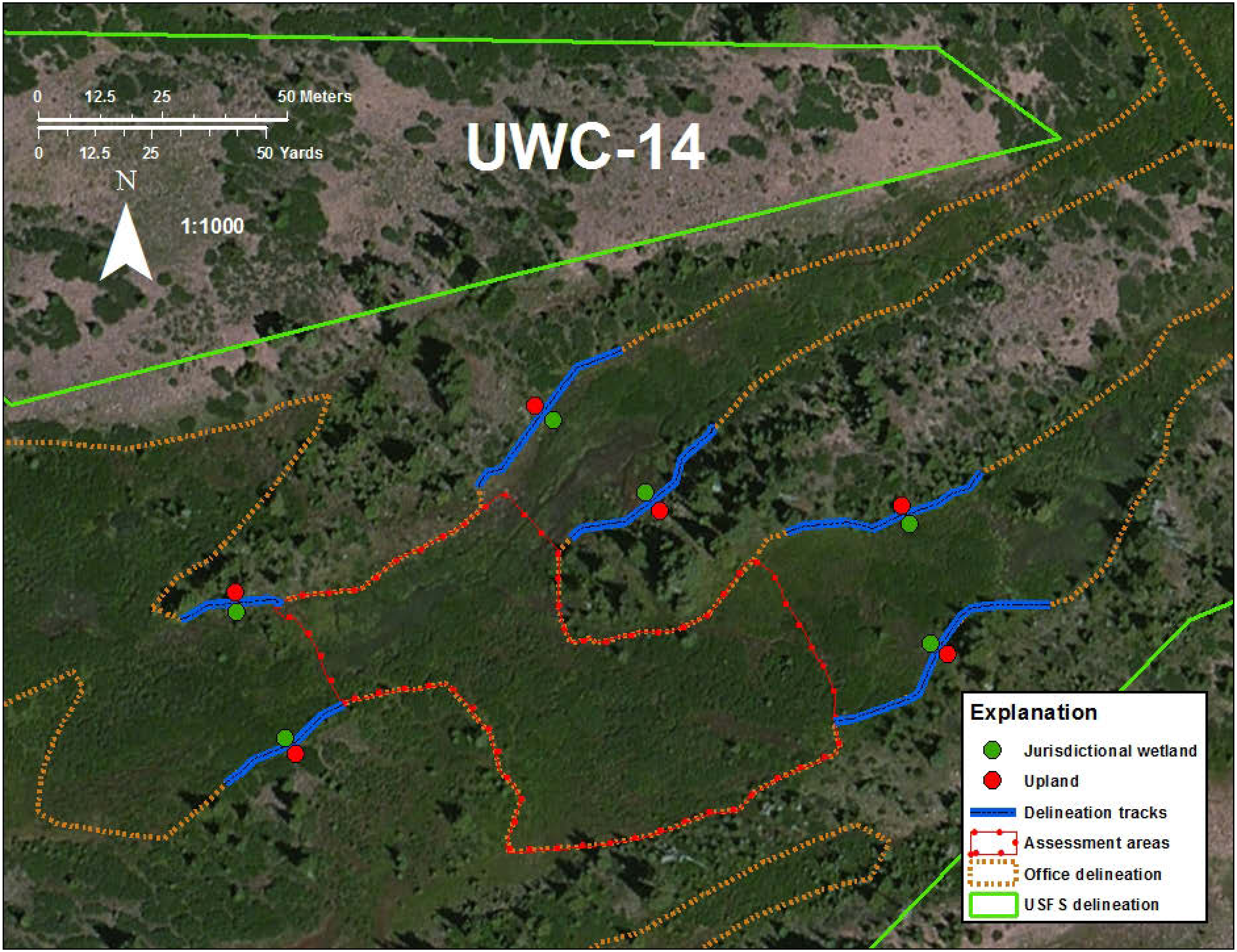
Non-Jurisdictional wetland
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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50 Yards
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Explanation
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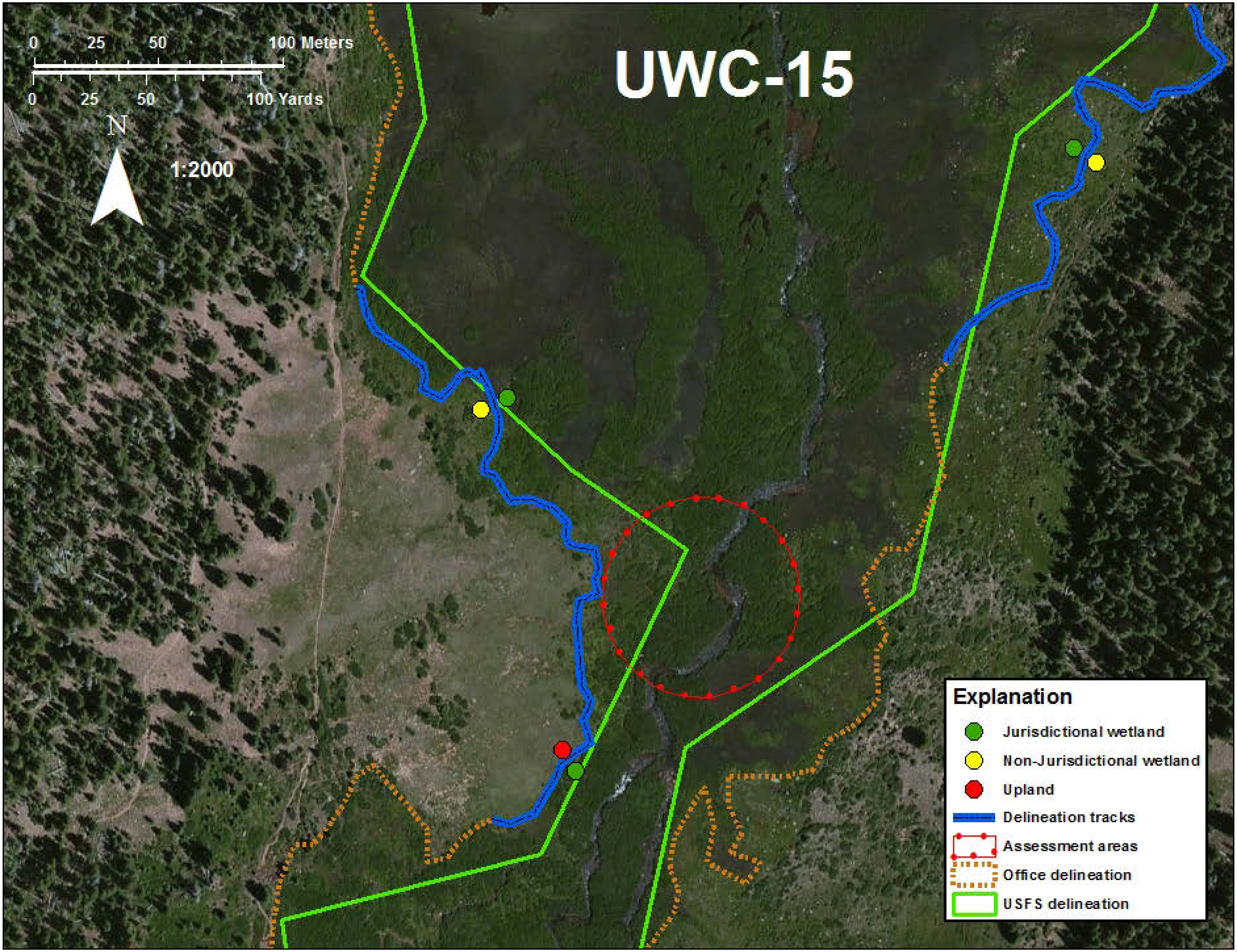
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation



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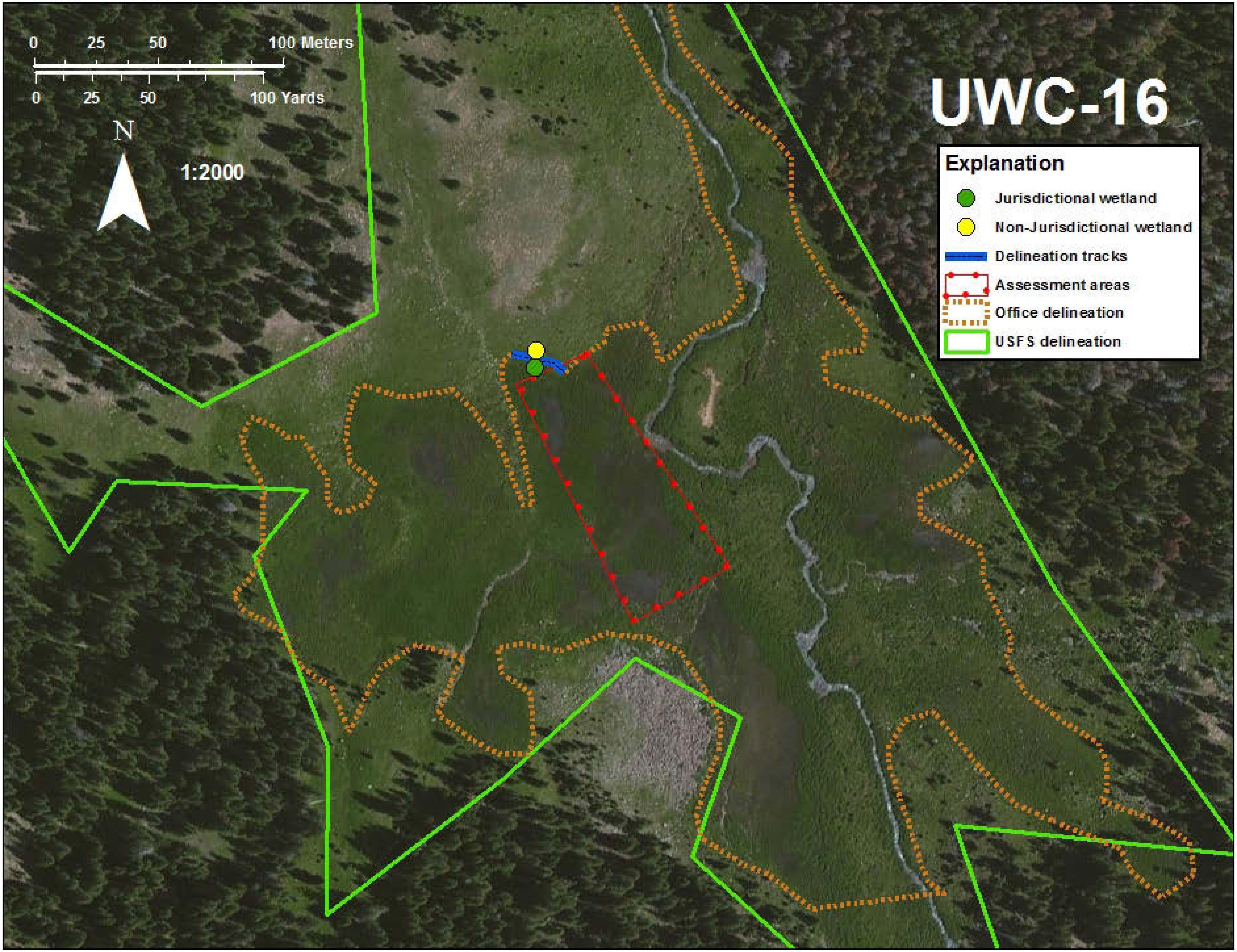
Non-Jurisdictional wetland
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation



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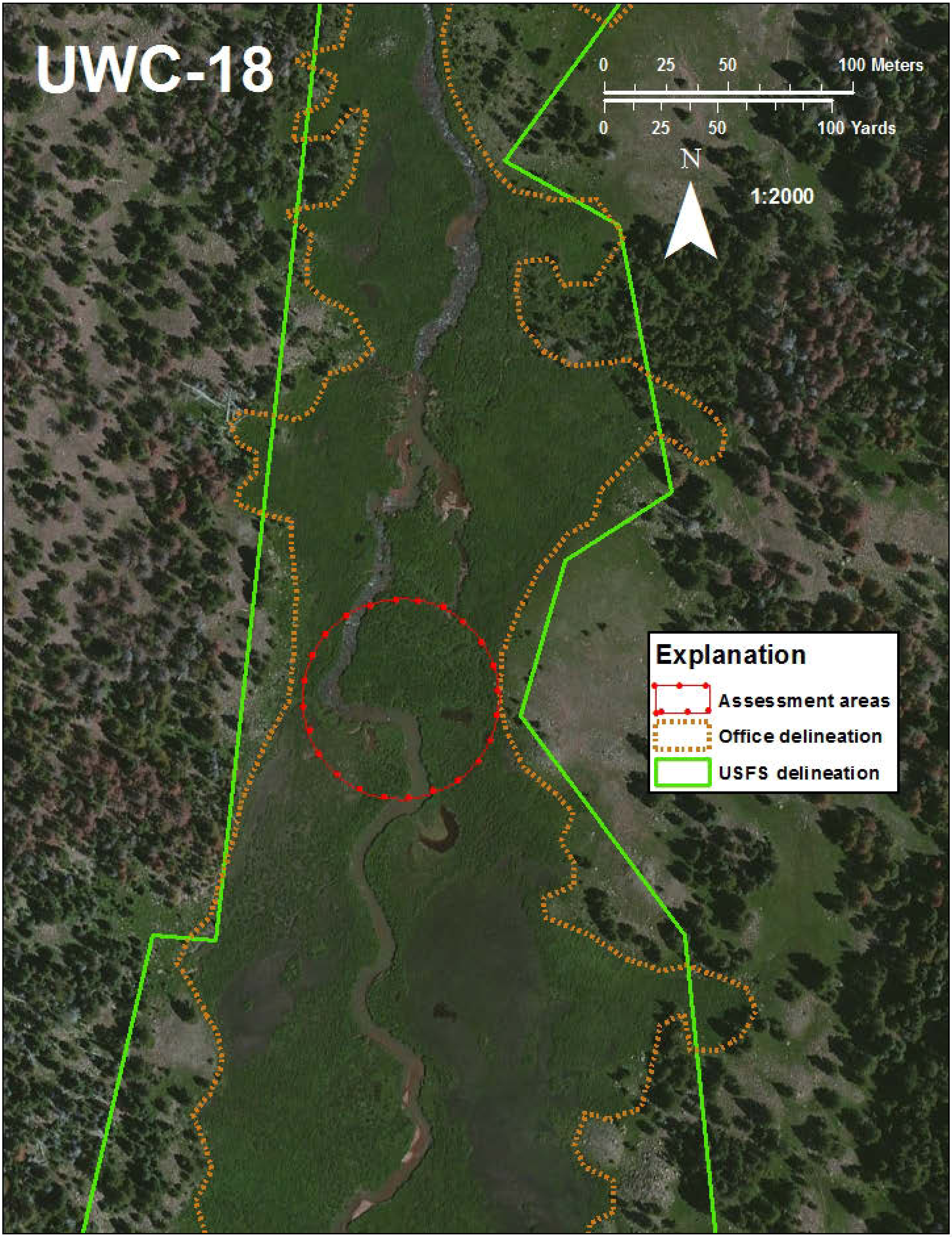
Delineation tracks
Assessment areas
Office delineation
USFS delineation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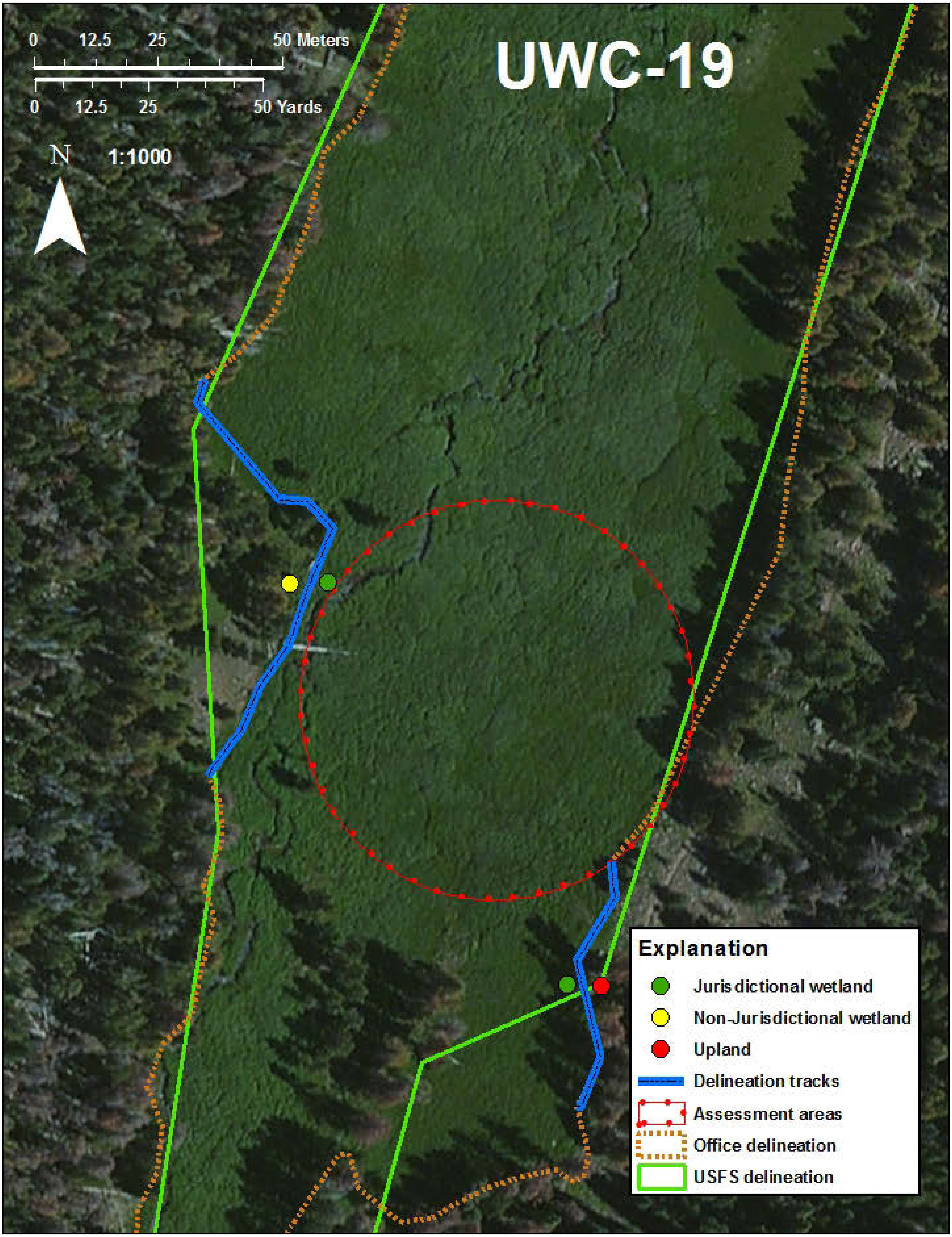
Office delineation
USFS delineation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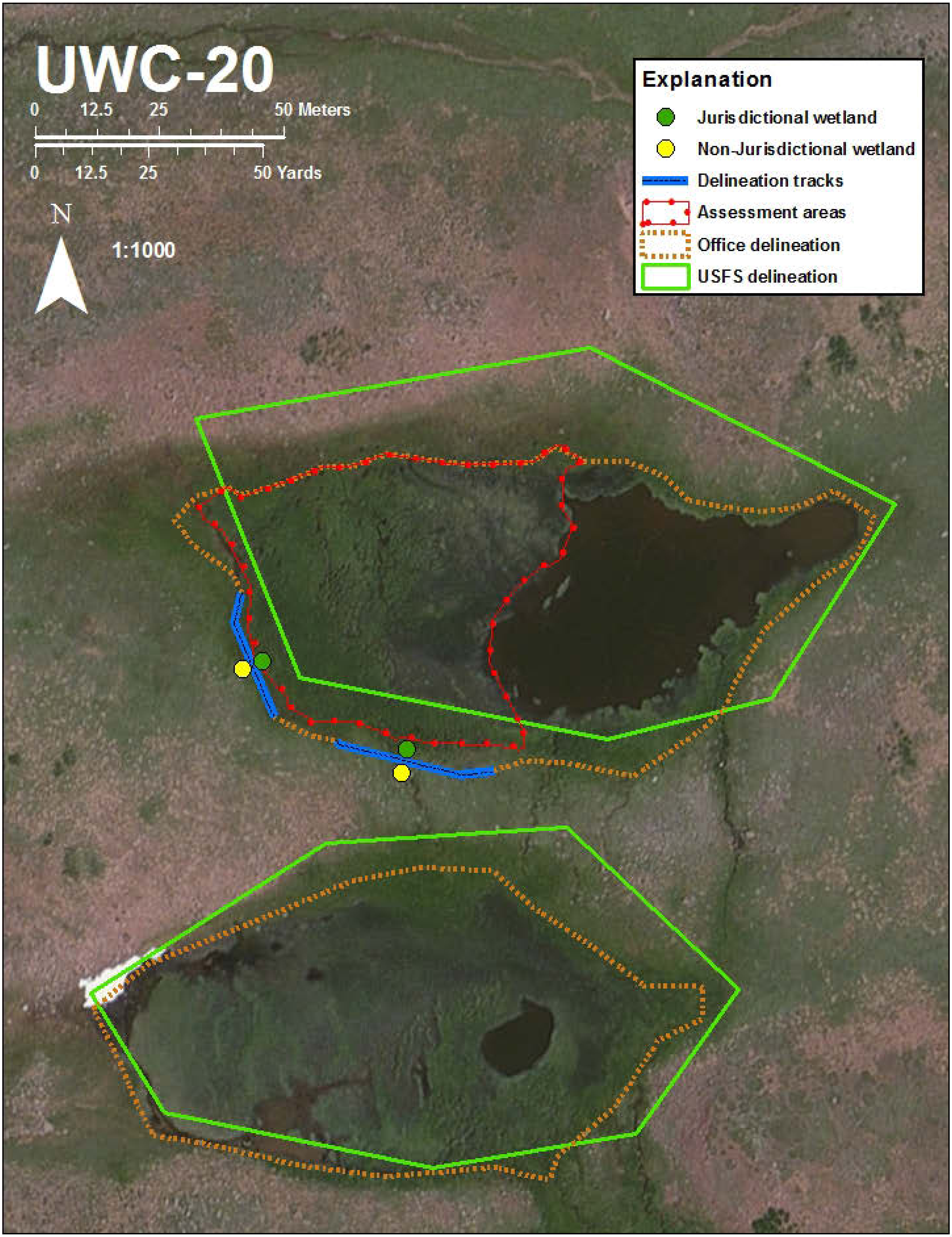
Non-Jurisdictional wetland
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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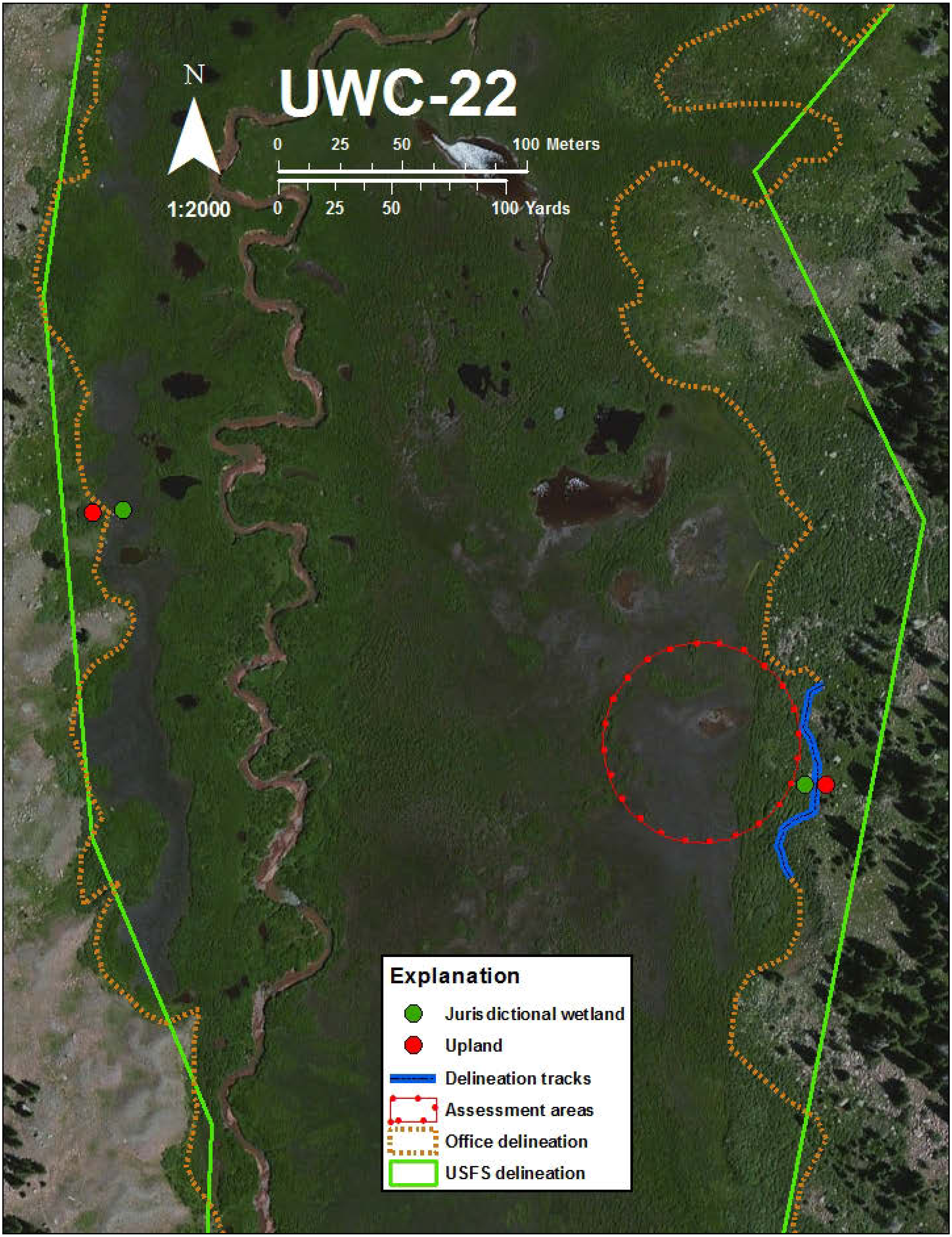
Delineation tracks
Assessment areas
Office delineation
USFS delineation



N
UWC-22
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Explanation
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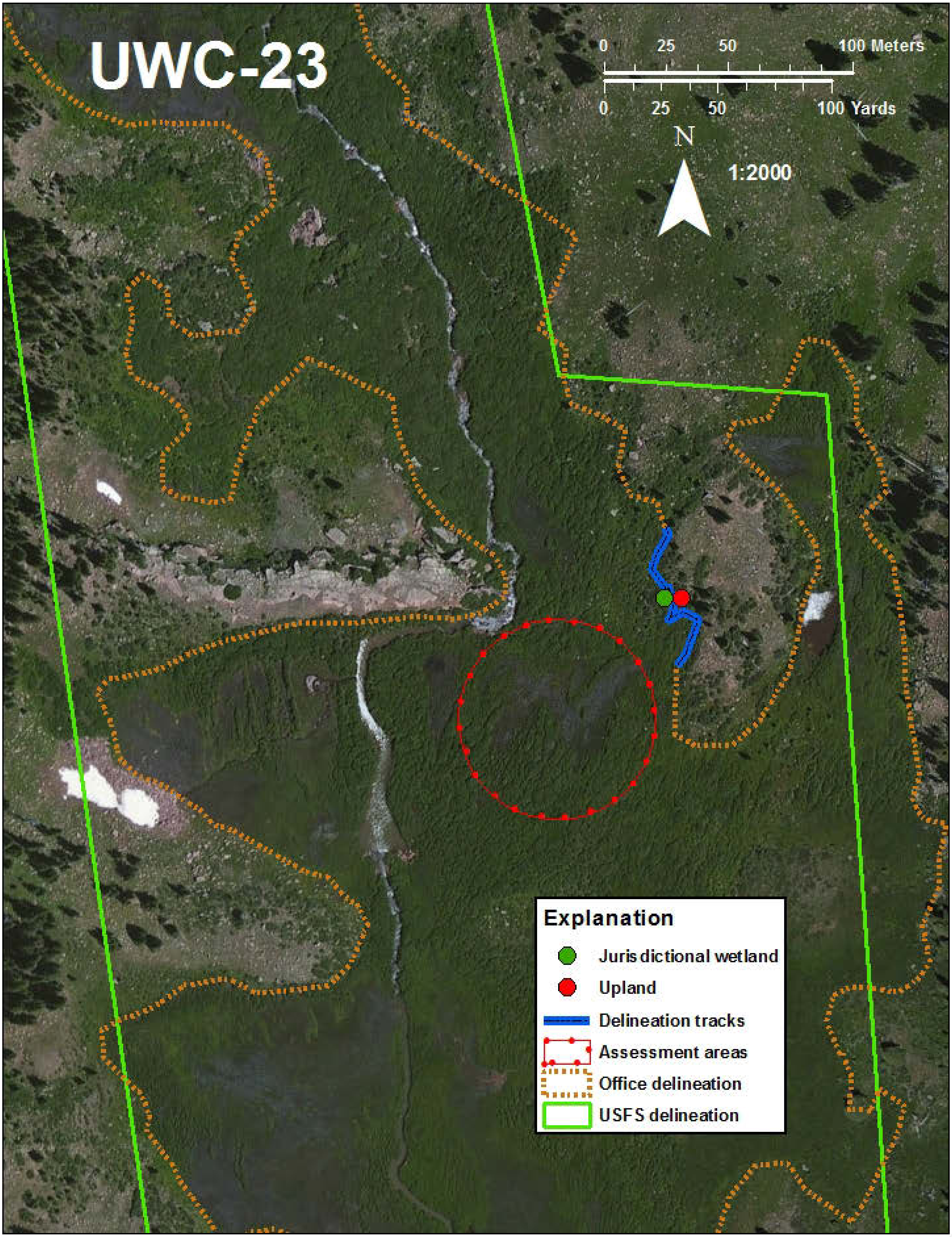
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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Upland
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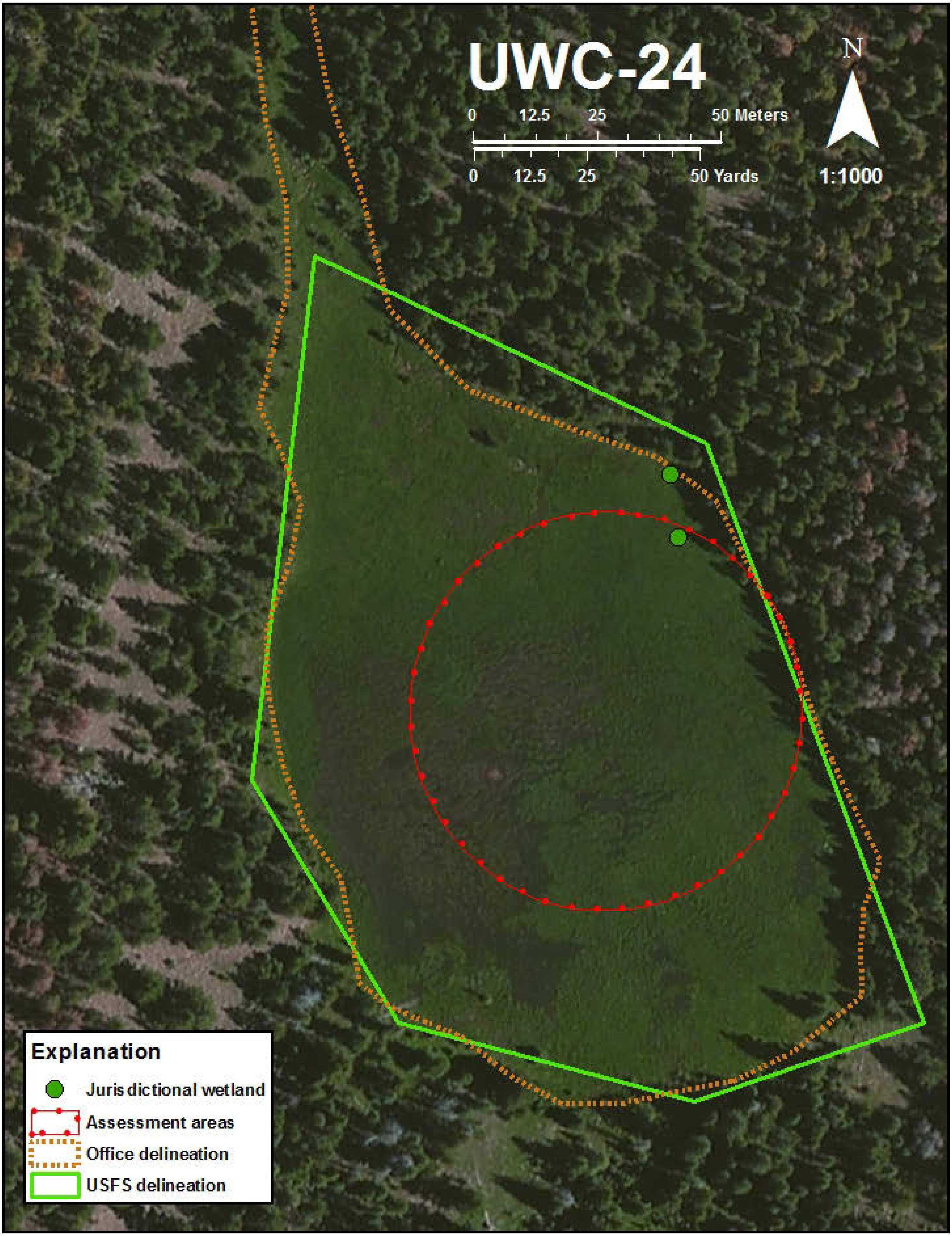
Assessment areas
Office delineation
USFS delineation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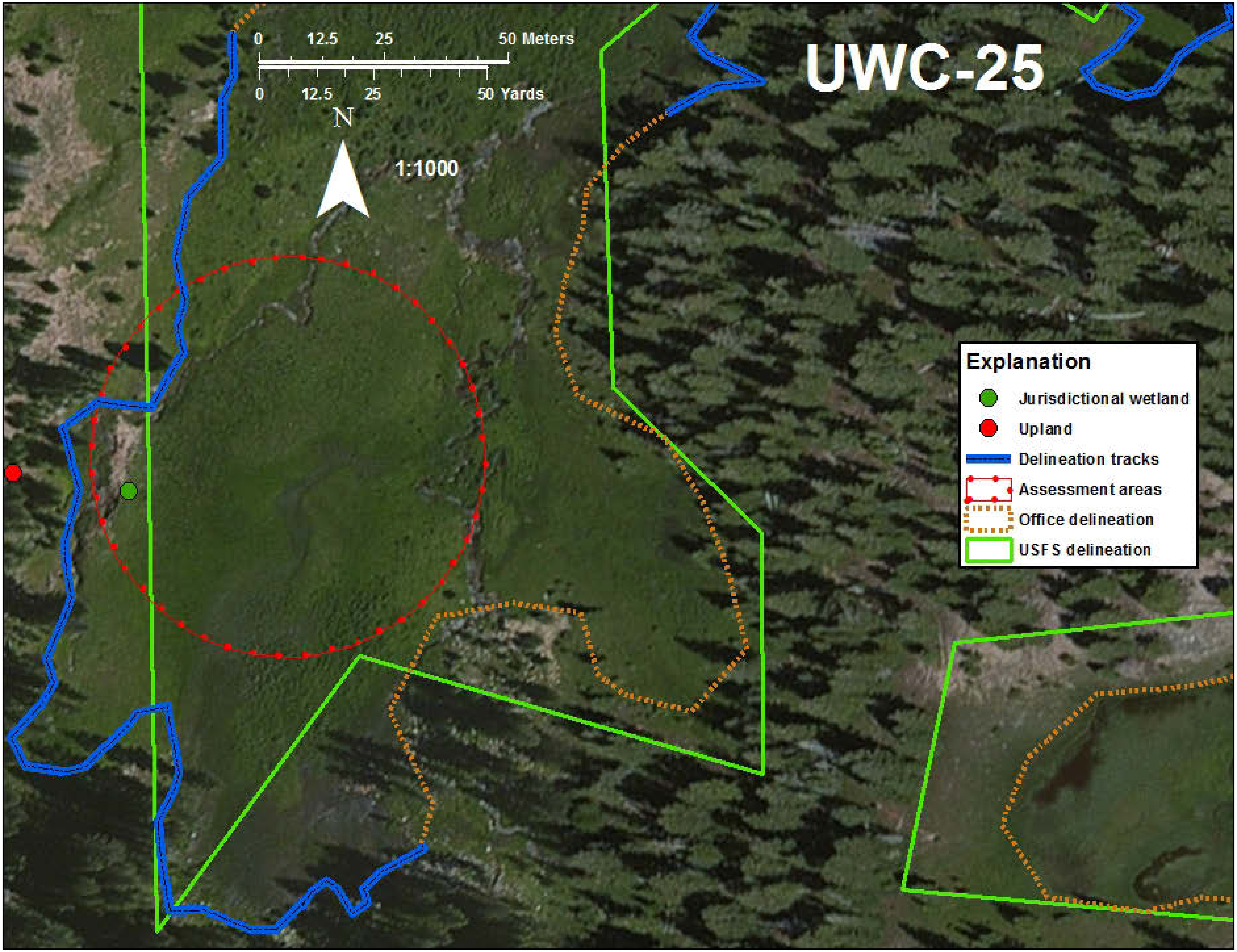
Explanation
Juris dictional wetland
Assessment areas
Office delineation
USFS delineation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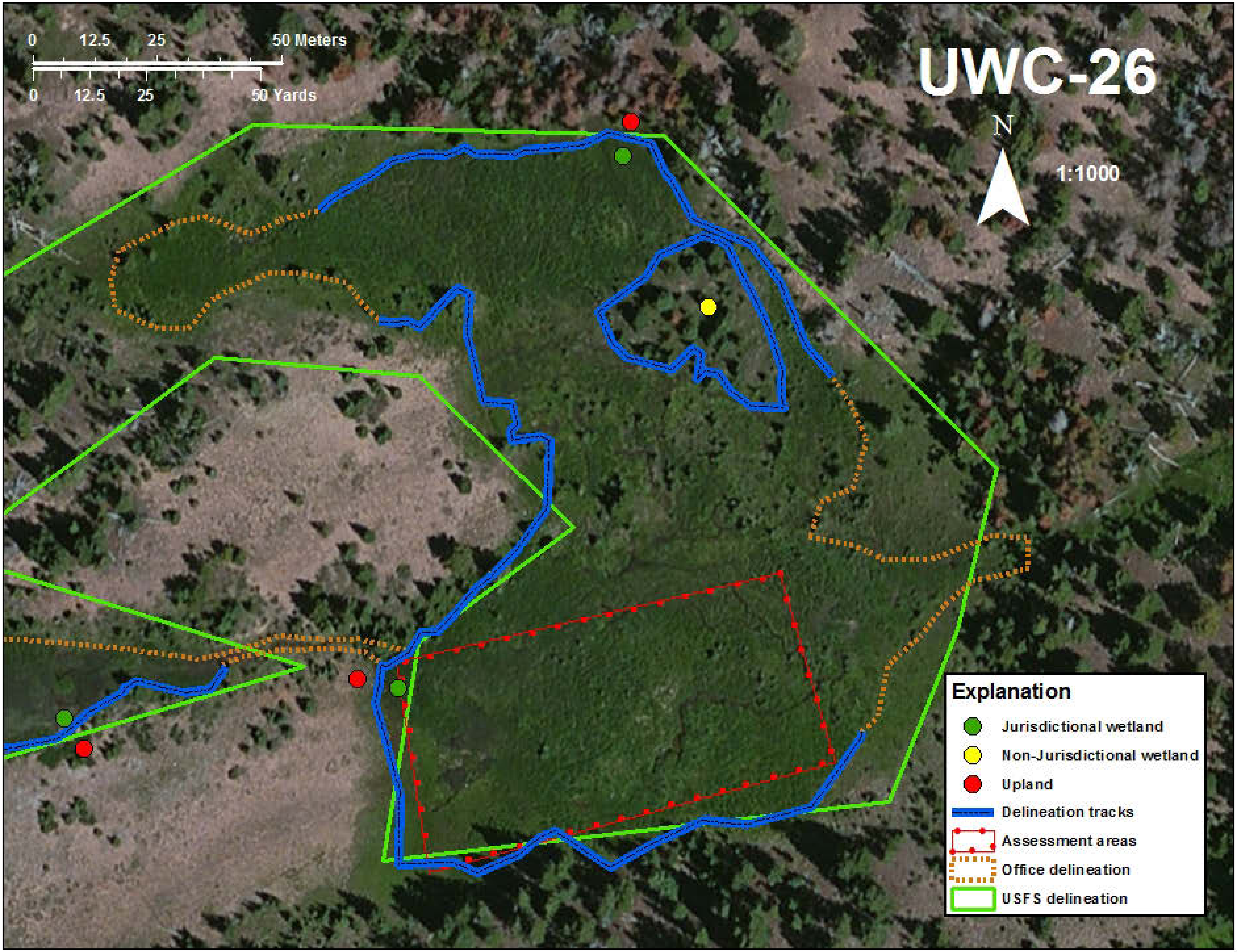
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation



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Explanation
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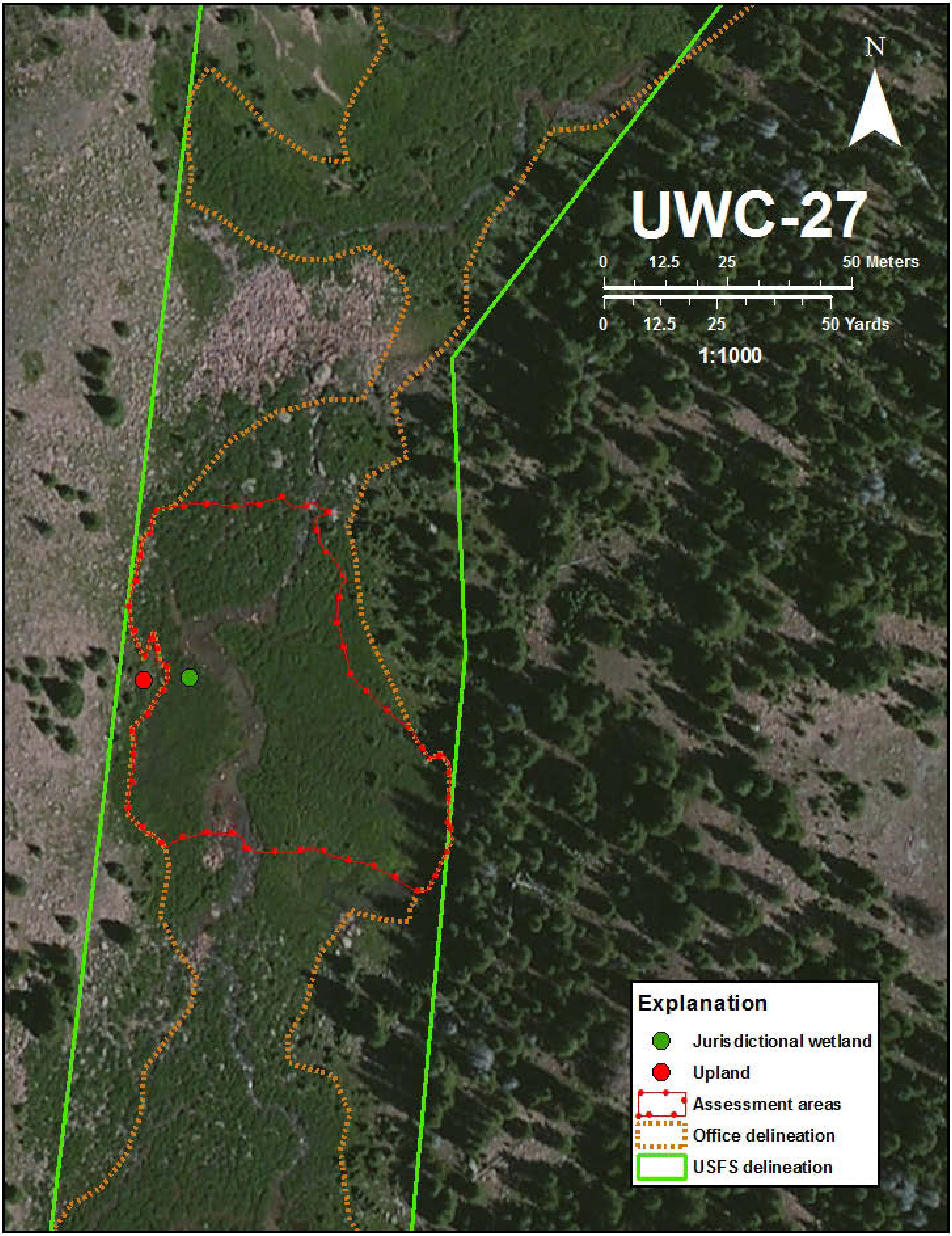
Non-Jurisdictional wetland
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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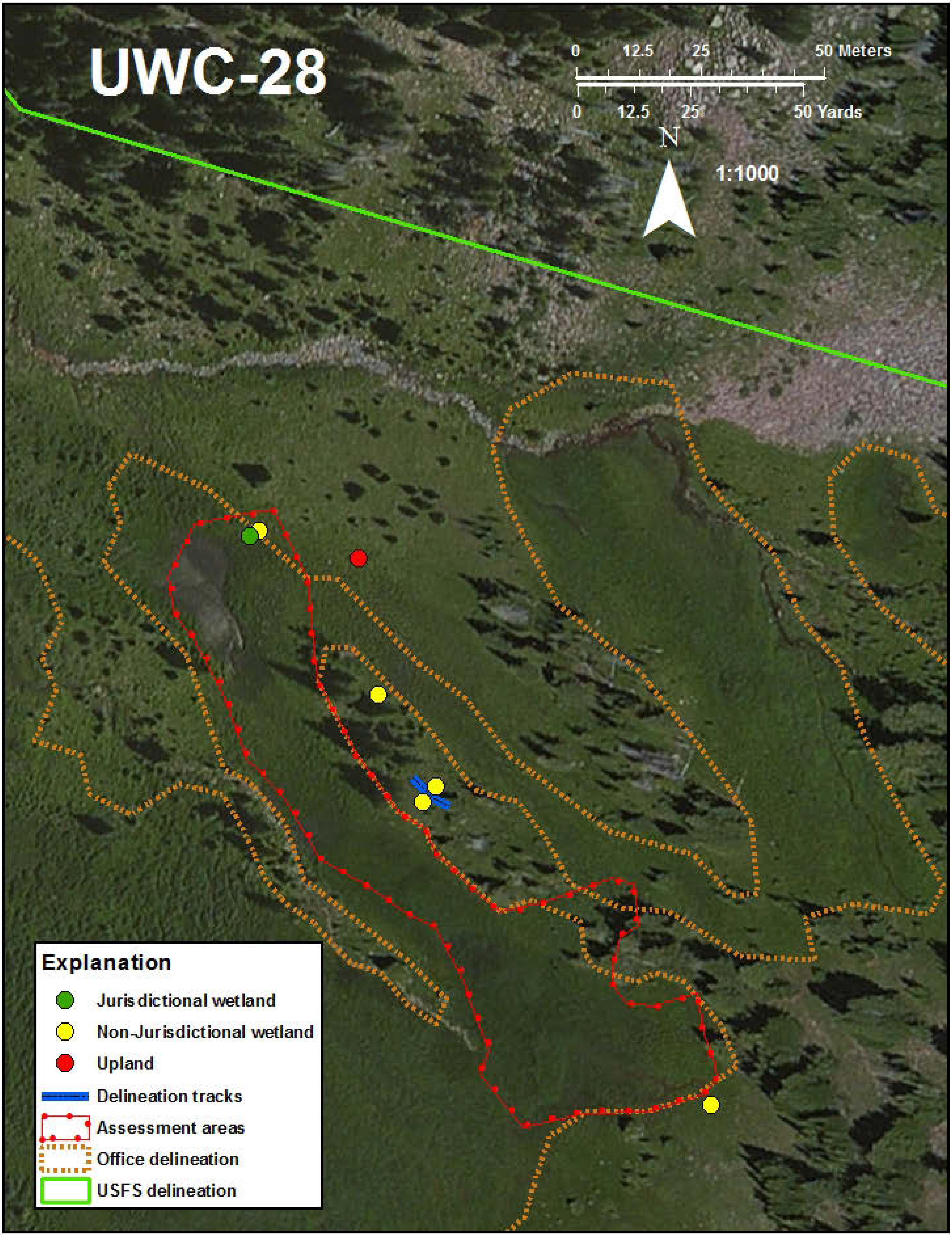
Upland
Assessment areas
Office delineation
USFS delineation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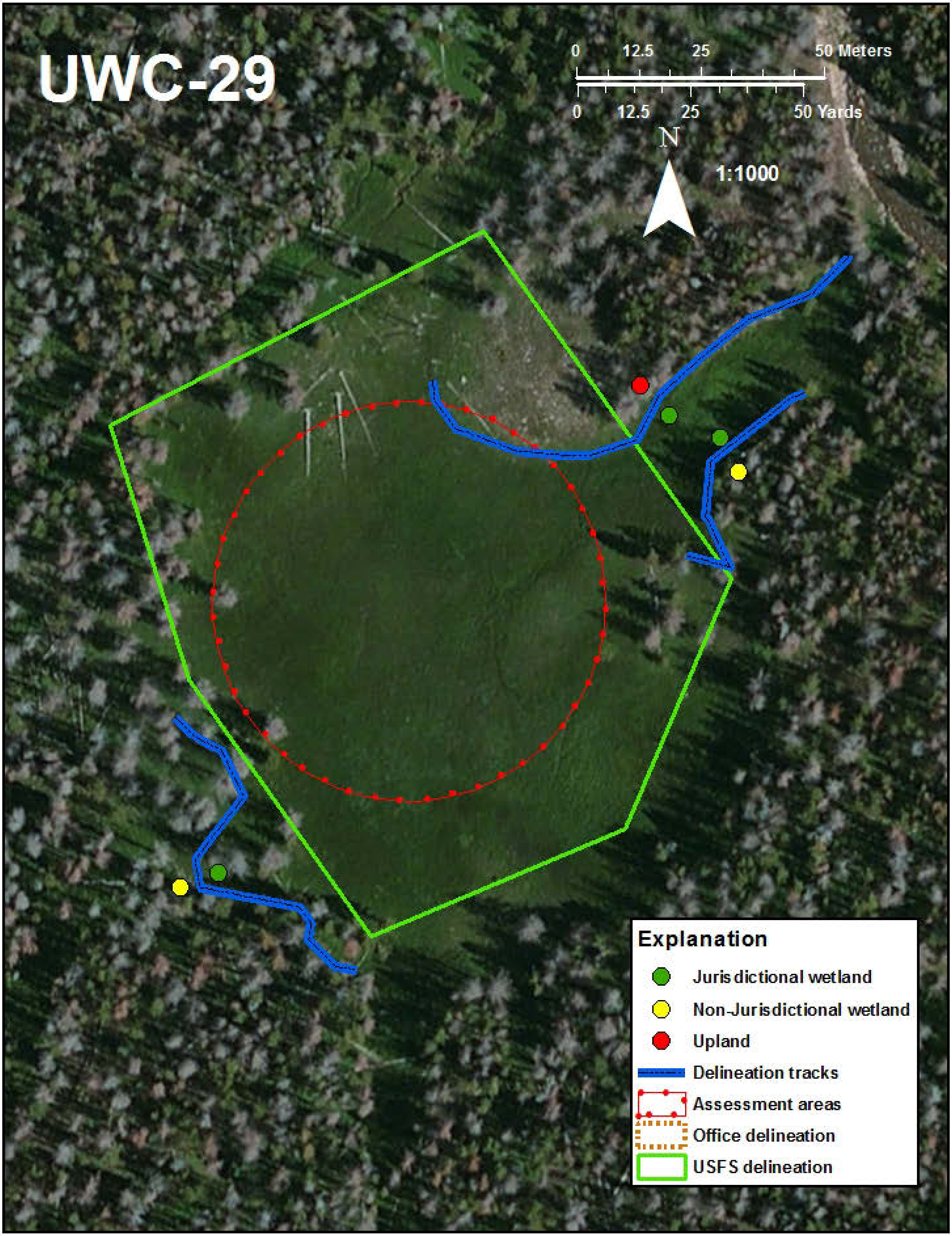
Upland
Delineation tracks
Assessment areas
Office delineation
USFS delineation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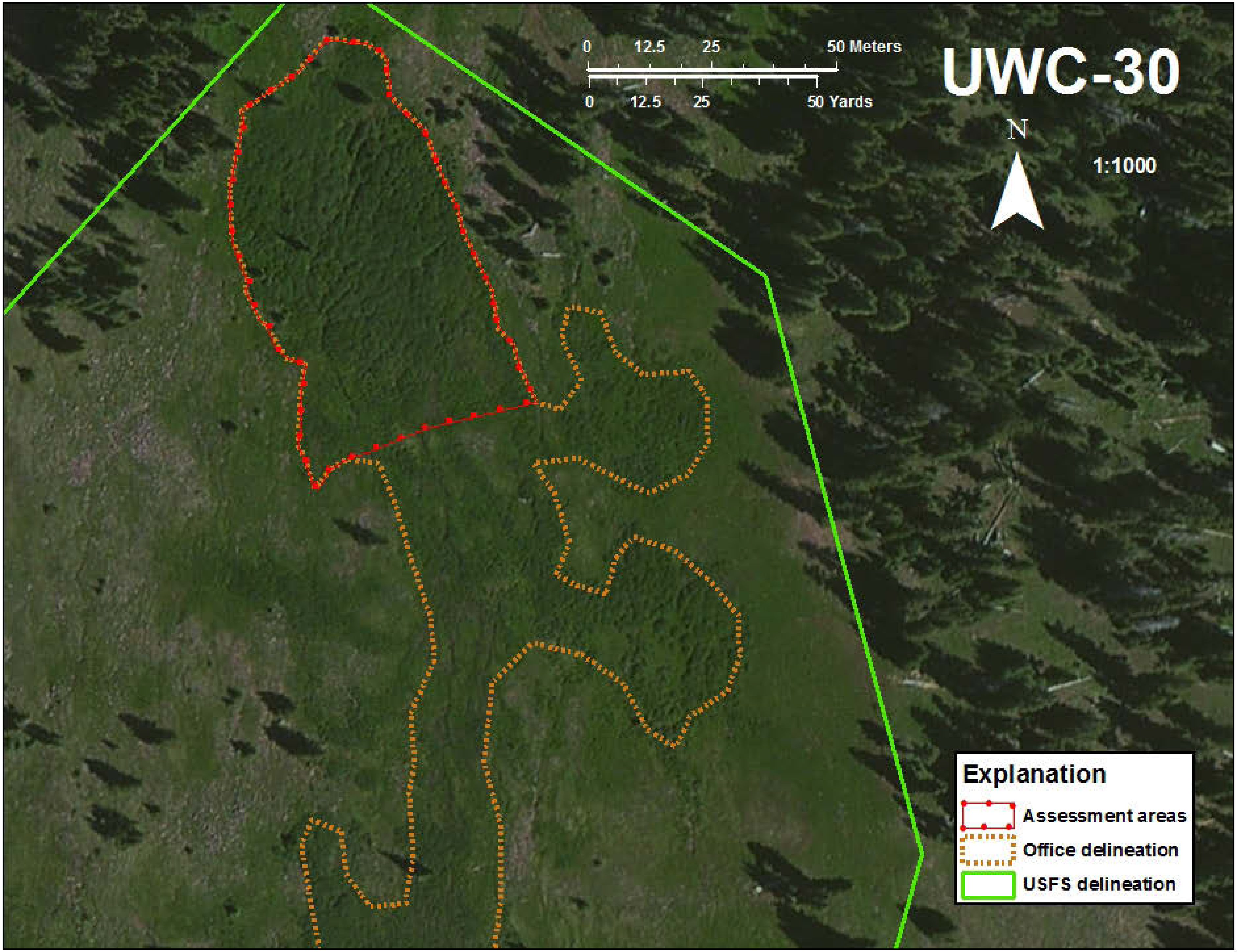
Office delineation
USFS delineation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1:1000
Explanation
Assessment areas
Office delineation
USFS delineation