Appendix A.
Method Verification and Calibration

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1.0 Introduction

1.1 Overview of Verification and Calibration

Utah Rapid Assessment Procedure (URAP) was used for the first time in 2014 for a watershed-wide survey in the Weber watershed and for a study on the north slope of the Uinta Mountains (Menuz and others, draft). The collected data were used for method verification and calibration. Verification is a general assessment of whether metrics are measuring wetland condition as intended, and calibration is the determination of the scientific validity of metrics through correlation with more intensive measures of condition (Sutula and others, 2006). Aspects of verification that must be conducted on a regional basis include determining whether metrics and statements within metrics comprehensively capture all wetland states found in the region, determining if metrics are sensitive to the disturbance gradient particular to the region, and adjusting the scaling of individual metrics based on data obtained in regional high and low quality wetlands. Calibration further refines metrics and scoring through the use of independent and more intensive measures of wetland condition.

We explored the relationship between metric ratings and other data collected in the field to look for outliers or inconsistencies in ratings. For example, we compared water quality metric ratings with recorded water quality stressors. For metrics values that could be calculated in the office, we frequently explored several calculation methods before deciding on a final method of calculation. For example, we compared algae metric ratings scored in the field with ratings developed from algae cover estimates. We discussed discrepancies in scoring with field personnel to determine whether metric ratings should be altered. We also discussed metric strengths and shortcomings with personnel to determine whether metrics adequately captured conditions observed in the field and whether metrics needed to be amended to provide greater clarity to field personnel. We also verified plant community composition data collection by comparing floristic results with and without low-cover plant species and data collected at different spatial scales within sites.

In addition to verifying individual metrics, we also needed to determine a final scoring method for the protocol. We calibrated URAP scoring using stressor data and plant community composition data. Wetland condition should be affected by nearby stressors or landscape modifications. 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. We assumed that sites with more stressors should receive lower URAP scores and sites with more intact plant communities should receive higher scores. We tested many different methods of combining individual metric data to create a final score and used the method that provided the strongest correlations within Ecological Systems for stressor and plant community composition measures.

1.2 Data Used for Calibration

We used Floristic Quality Assessment (FQA) metrics and stressor indices calculated using the methods presented in the *Weber River Watershed Wetland Condition Assessment* report to verify and calibrate the URAP method. However, we tested three different methods of calculating overall severity values for buffer stressors before settling on the method presented in the report. In each case, we converted low, medium, and high severity stressors to the values of 1, 2, and 4, respectively and converted extent classes to extent weights using the following conversion factors: <1%- 0.001; 1-10%- 0.06, 10 to 25%- 0.20; 25 to 50%- 0.43, 50 to 75%- 0.72; 75 to 100%- 1.0. We then either multiplied severity values by extent weights, multiplied severity values by the extent class (1 through 6), or did not change the severity value. Stressors were then added together within categories and for the overall buffer. We conducted an exploratory analysis examining correlations between stressors and other measures before settling on the final method of stressor indices calculation discussed in the *Weber River Watershed Wetland Condition Assessment* report.

We used two summarized measures of stress to calibrate and validate the overall scoring method and used individual aspects of stress data to calibrate individual methods (e.g., hydroperiod stress for the hydroperiod metric). We added total buffer and total AA stress together. This measure, the overall field stress index, did not include any office evaluation data and did not include any category-specific buffer summary information. The second measure was created by adding the water quality, vegetation, and hydroperiod categorical stress indices together, creating the total stress index.

2.0 Metric Exploration and Calibration

2.1 Buffer Metrics

Several URAP metrics evaluate land surrounding the assessment area to determine whether it qualifies as natural or semi-natural buffer land cover. Buffering land has the potential to mitigate against external stressors, provide natural habitat for wildlife, and provide natural litter inputs to a site. We estimated the length of continuous transect that ran from the assessment area edge to the first place without buffer land cover for eight transects extending 200 m from the assessment area edge. We also recorded the transect slope, whether each transects was upslope or downslope from the wetland, and the degree to which each transect had surface roughness features likely to entrain runoff.

We tested several methods of calculating a final buffer width score. First, we compared results with 200 meters or 95 meters as the maximum mean transect width needed for a site to be scored as A. We originally adopted the length of 200 m from the Colorado Natural Heritage Program (Lemly and Gilligan, 2013); however, in 2014, they adopted a new version of their protocol where they only evaluated transect length up to 100 m (L. Gilligan, Colorado Natural Heritage Program, written communication, June 2014). Wetland buffers between 30 and 50 m are reported to be effective at removing most sediment, nitrogen, phosphorus, and pesticides before they reach wetlands (McElfish and others, 2008; Zhang and others, 2010), though results depend on slope and vegetative cover of buffer. Buffers in the arid west 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). Regardless, a 100 m buffer likely would be adequate for pollutant filtration; broader landscape disturbance is considered in a separate metric that evaluates a 500 m area surrounding sites. We tested two sets of thresholds for converting the mean transect distance into rankings (table 1).

Second, we tested three methods of using the slope, surface roughness, and direction information in the buffer width evaluation through the designation of some buffer transects as "problematic transects." To begin, we considered problematic transects as those transects that were upslope from the site and were shorter than the recommended buffer distances for the given slope and

Table 1. Thresholds used to evaluate mean buffer transect length. Sites with the indicated number of problematic transects received the lower of the two scores. For example, a site with a mean buffer width of 80 m would receive a score of A- if it had zero problematic transects but a score of B if it had one problematic transect.

Rank	200 m thresholds	100 m threshold	Problematic transects
A	200	≥ 95	0
A-	100 - <200	75 - <95	0
B	50- <100	50 - <75	1 or 2
C	25 - <50	25 - <50	3 or 4
D	<25	<25	5

surface roughness shown in Johnson and Buffler (2008), using the highest slope value across all soil hydrologic groups listed in the report. Then, we considered problematic transects as all upslope buffer transects less than 30 m in length. Last, we considered problematic transects as all transects less than 30 m in length. Sites were evaluated using both the 100 m thresholds for mean length and thresholds based on the number of problematic transects, always receiving the lowest of the two ranks (table 1).

We had a total of five different transect width ratings per site, one each for the basic 100 m and 200 m scores and three for 100 m scores adjusted based on the number of problematic transects. We then calculated the overall buffer scores using the following equation taken from Colorado Natural Heritage Program (Lemly and Gilligan, 2013), after converting percent buffer, buffer width, and buffer soil and vegetation condition ranks to scores between 1 and 5:

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

We evaluated the five buffer widths by determining the degree to which using different buffer widths produced different results for the overall buffer score, looking at correlations between buffer width and overall buffer scores with FQA metrics, and looking more closely at the sites with changed results to determine the degree to which the changes were important for the site overall.

Different methods for calculating the buffer width had a small effect on the buffer width score and a much smaller effect on the overall buffer score. Not surprisingly, more sites were scored as A for buffer width when 100 m was used instead of 200 m as the maximum buffer distance (50 versus 33). However, this difference in buffer width ratings only translated to a maximum of five sites changing rank in the overall buffer score. Among the four methods that used a 100 m threshold, there was a maximum difference of only two sites in the A rank and one site in the remaining ranks. Correlations between buffer width and both Mean C and CW Adj. FQI were strongest with the 200 m buffer score and very similar between all of the other scores. However, the 200 m buffer score also had the strongest correlation with the percent intact landscape metric.

We selected the 100 m buffer with no adjustment for problematic transects for the final method for scoring the buffer width metric. Literature review showed no justification for requiring a very wide buffer to filter out water quality stressors, and other landscape considerations, such as introduction of non-native species and wildlife disturbance, were already being considered in the percent intact landscape metric. It was unclear whether the adjustments we made based on problematic transects improved site scores since differences were very minimal. The additional transect data seemed overly intensive for a rapid assessment method without providing a clear benefit. The effect of small buffers on runoff will be captured in part by the water quality metric.

2.2 Algae Metric

The presence of excessive algae growth was evaluated using two metrics, one evaluating algae in areas with standing water and the second evaluating dried algal mats. Surveyors also separately recorded the percent of each assessment area with filamentous algae and dried algal mats. All but one site received a score of AB for the dried algae metric; the low scoring site had 7% dried algae cover. The remaining sites all had less than 0.5% dried algae cover, except one site with 4% cover.

We calculated the percent filamentous algae for the portion of each assessment area with standing water. There was not a perfect correspondence between percent algae versus wet algae metric scores, but the best match to the data had sites with <5% wet algae scored as A, <20%, B, and the remaining C (table 2, figure 1). No sites received a score of D for the wet algae metric, though one site appeared to be an outlier, with 75% algae cover. We combined the dry and wet algae metrics into a single final algae metric, using the wet algae score when available, the dry algae score only for the site that was scored as B, and NA for the remaining sites. We did not want to assume that AB scores for the dry algae metric were indicative of condition because we could not be sure how recently sites had been inundated with water.

We evaluated the relationship between the final algae metric value and the percent filamentous algae cover (for the wet portion of the assessment area) against water quality nutrient data, available at 29 sites. Nitrate plus nitrite was correlated with percent of surface water area covered in filamentous algae (Pearson correlation coefficient 0.42, $p=0.03$), though the relationship appears driven by a single outlier (figure 1). Ammonia, total phosphate, and total Kjeldahl nitrogen were highly correlated with one another (>0.70) and not correlated with algae cover. Metric ratings, converted to values between 1 and 5, were not correlated with any nutrient measures.

2.3 Turbidity and Pollutants

We compared results of the field-recorded turbidity and pollutants metric and transparency tube measurement with laboratory total dissolved suspended solids (TSS) values, though an important note is that the metric was evaluated for the site overall, and transparency tube measurements and laboratory samples were usually taken at a single location within a site. Sites with TSS values between 36 and 463 always had turbidity metrics ratings of B or C and transparency tube readings of 50 cm or less (table 3). Most sites with TSS values ≤10 were rated as A and had transparency tube readings greater than 60 cm (the maximum possible reading). Sites with TSS values between 10 and 36 had

Table 2. Number of sites with the minimum, maximum, and mean percent area with filamentous algae, for the portion of the site with standing water, by the wet algae metric score for each site. Only those Weber sites with at least 1% water cover are included.

Rank	N	Minimum	Maximum	Mean
A	22	0%	16.7%	2.5%
B	15	0.3%	75%	16%
C	2	20%	33%	27%

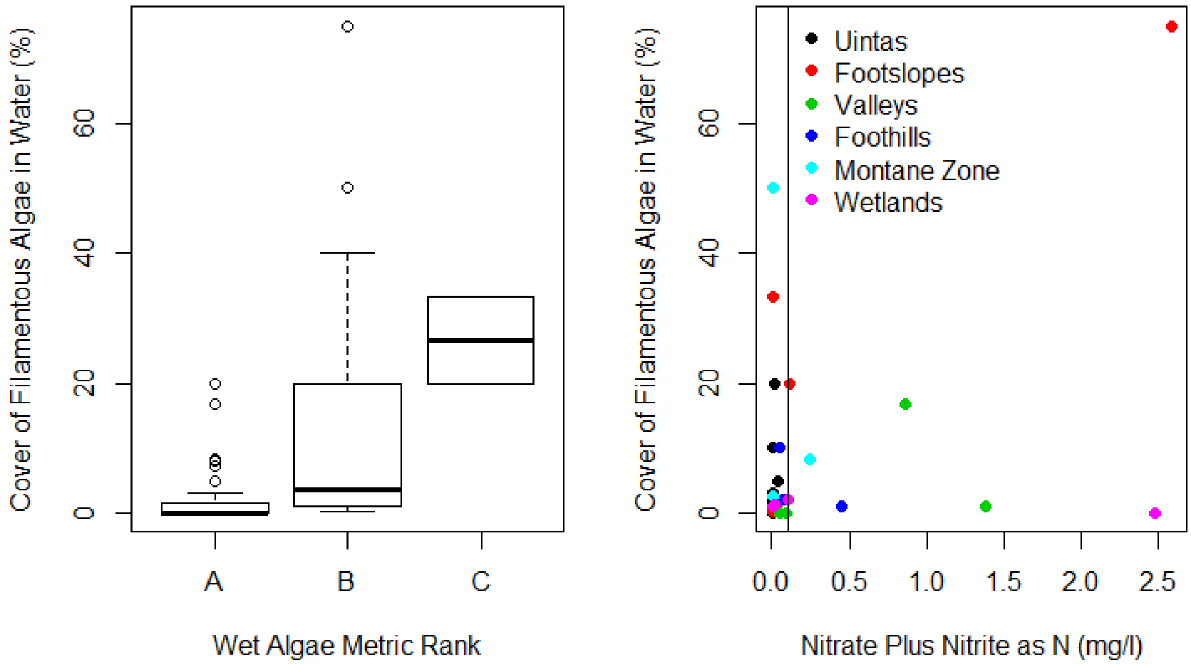

Figure 1. Boxplot of wet algae metric ratings versus percent of surface water with filamentous algae (left) for sites rated for the wet algae metric (n=71), and scatterplot of nitrate plus nitrite in water quality samples versus percent of surface water with filamentous algae (right), for sites with water quality samples (n=29). The vertical line on the plot on the right indicates the minimum reporting limit, the value at which signal is strong enough to accurately quantify versus merely detect the parameter.

Table 3. Number of sites with corresponding total dissolved solids, transparency tube reading and turbidity metric rating values. Cells with values in bold are expected to contain the majority of sites, cells with values in grey are expected to contain few or no sites, and cells with values in italics are uncertain.

		Total dissolved solids (mg/l)			**Transparency tube value**	
		<=10	**>10 and <=36**	**> 36**	**<50 cm**	**>60 cm[1]**
Metric Rating	**A**	**12**	*6*	0	3	**15**
	B	2	*2*	**3**	**4**	2
	C	0	*1*	**2**	**2**	0
Transparency tube value	**<50 cm**	1	*2*	**4**		
	>60 cm[1]	**10**	*3*	0		

[1]Maximum reading of transparency tube was 60 cm, so these sites had transparency values greater than the measurement capacity of the tubes.

mixtures of metric ratings and transparency tube values. Turbidity metric ratings were corroborated by either TSS values or tube readings at all sites that had both values. Analysis of variance (ANOVA) showed only marginally significant differences between TSS and turbidity metric ranks (p=0.05); only A and B ratings differed in values based on post-hoc Tukey comparison (p=0.07, figure 2). We also used ANOVA to test the difference between metric ratings and, first, the sum of the buffer sediment and AA physical stress indices and, second, the total water quality stress index. The first index could only reliably separate A and B sites from C sites whereas the latter index separated all three ranks from one another (figure 2).

2.4 Hydrologic Condition Metrics and Stressors

We evaluated the consistency of ratings for hydrologic condition metrics versus stressors recorded in the office and field. We used boxplots to compare the hydroperiod, timing of inundation, and water quality metric ranks with hydropattern or water quality stressor indices calculated for assessment area, buffer, and office evaluation stressors, and the total of the three. We examined outliers in the boxplots and made corrections in the data if warranted after discussion with field surveyors. In many cases, stressors recorded during the office evaluation did not affect sites or were not as severe as anticipated because actual source of wetland hydrology differed from that determined in the office. After final adjustments, we compared stressor indices values with ranks for the three metrics using analysis of variance (ANOVA) and used post-hoc Tukey comparisons to determine which rankings

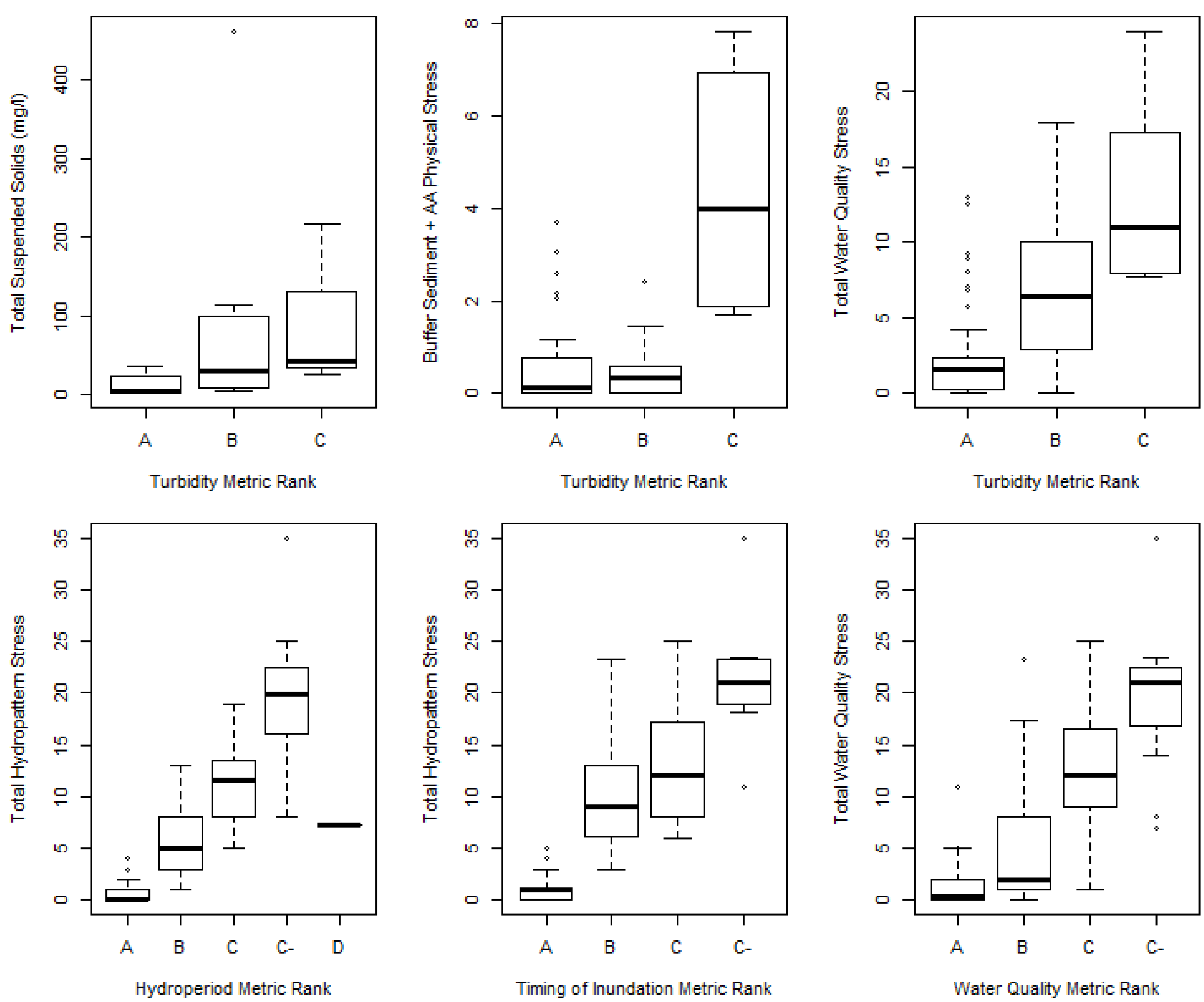

Figure 2. Hydrologic metric ratings versus stressor indices and other measures of wetland condition.

were different from one another. Though all stressor indices had a least a marginal ability to separate rankings from one another for all three stressors ($p \leq 0.10$), the total stress indices showed the strongest differentiation between ranks and could separate out the most ranks from one another (figure 2). Total hydropattern stress differed between all ranks for the hydroperiod metric ($p<0.001$ for all comparisons except $p=0.01$ for C- versus D) except between D and most other ranks; only one site was ranked as D for the metric. Total hydropattern stress differed between all ranks for the timing of inundation metric ($p<0.001$ for all comparisons), except between B and C, which differed weakly ($p=0.07$). Total water quality stress differed between all ranks for the water quality metric ($p<0.001$ for all comparisons) except between A and B ($p=0.06$) and between C and C- ($p=0.08$), which differed only weakly.

2.5 Interspersion Metric

The interspersion metric rates sites based on the number and complexity of different vegetation patches. We expected different Ecological Systems to differ in their natural rates of interspersion (figure 3). To test this hypothesis, we tested for differences in metric ratings between systems using ANOVA, only comparing emergent marsh, alkaline depression, fen, wet meadow, and upper montane shrubland systems because other systems had too few samples for comparison. Based on post-hoc Tukey comparisons, upper montane shrubland sites had more interspersion than alkaline depressions ($p<0.001$), wet meadow had marginally greater interspersion than alkaline depressions ($p=0.06$), and upper montane shrublands had more interspersion than emergent marshes ($p=0.01$); other systems did not differ.

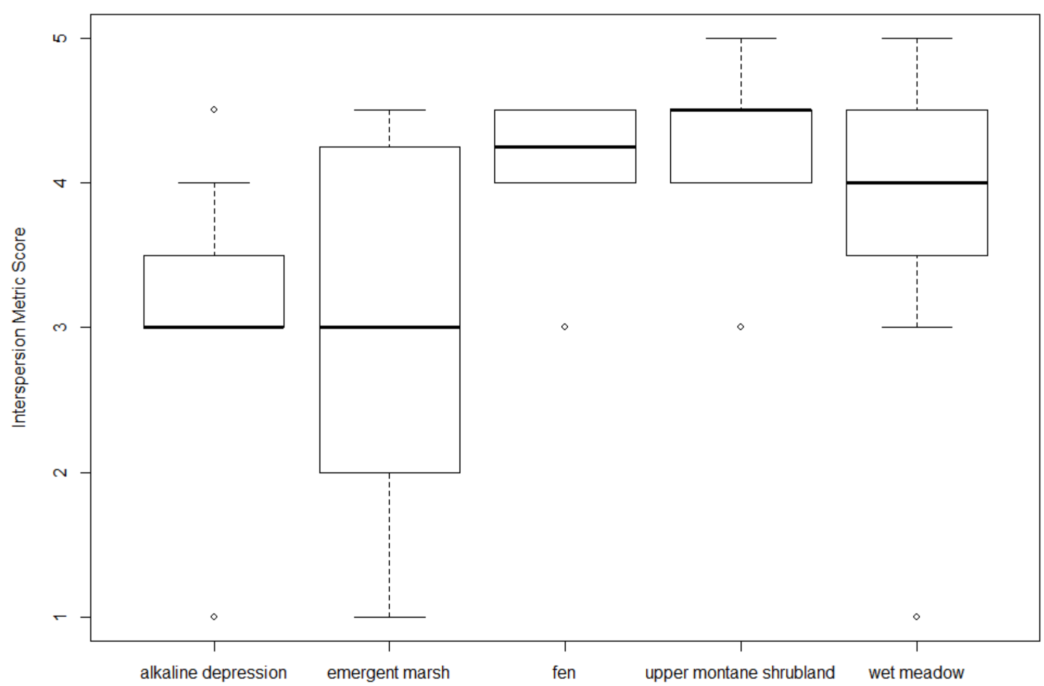

Figure 3. Boxplot of interspersion metric scores versus Ecological Systems, for common systems.There were 16 alkaline depression, 8 emergent marsh, 6 fen, 22 upper montane shrubland, and 43 wet meadow sites.

We then plotted interspersion ratings for each of these five systems versus total vegetation stress and Mean C values to evaluate whether interspersion appeared to be sensitive to stress levels. We made two groups based on rank, B and above and C and below, since so many system by rank categories had one or no sites in them. In general, stress index and Mean C values had little relation to interspersion metric rank classes (figure 4). Emergent marsh sites rated as B or above had somewhat higher vegetation stress values and somewhat lower Mean C values, though the trend was weak and not significant.

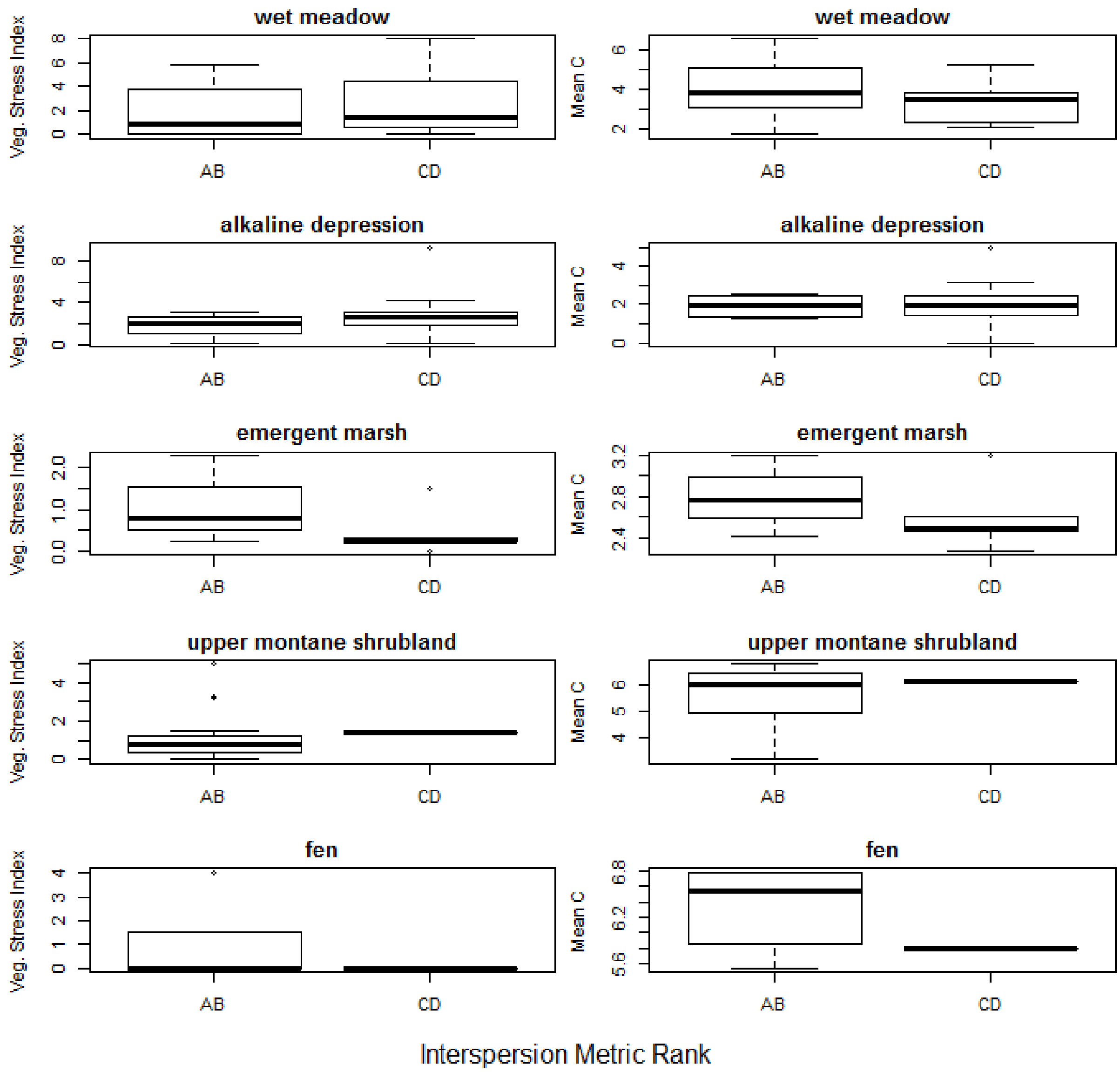

Figure 4. Interspersion metric ranks versus stressor index values and FQA ratings, by Ecological System. Fen and upper montane shrubland sites only had one site in the CD category; all other categories for all systems had at least three sites.

3.0 Overall URAP Scoring

URAP was largely based on Colorado Natural Heritage Program's (CNHP) draft wetland assessment field manual (Lemly and Gilligan, 2013). In the field manual, scores within categories are calculated with a weighted mean across metrics and then a final score is calculated with a weighted mean across categories. For example, within CNHP's physiochemical condition category, the substrate and soil disturbance metric is assigned a weight of 0.5 and turbidity and pollutants and algal growth metrics are assigned a weight of 0.25 each. The vegetation condition category is assigned the highest weight, 0.4, and the physiochemical condition category is assigned the lowest weight, 0.1.

We needed to create a new method for combining metrics into an overall score for several reasons. First, because we evaluated some metrics that were not used by CNHP, such as inundation timing, we needed to decide how to include these metrics in the final scoring. Second, we were dissatisfied with the strong emphasis on vegetation condition metrics in the final score and the inclusion of Mean C as the most heavily weighted vegetation condition metric. FQA values are useful to validate rapid assessment scores, but cannot be used independently if Mean C is also a large component of the rapid assessment scoring process. Last, in 2014, CNHP made many changes to their protocol, indicating that the draft field manual may not be an appropriate template.

After converting all ranks to their respective values (A=5, A-=4.5, B=4, C=3, C-=2, D=1), we explored five different methods of combining metrics together into a final overall URAP score, First, we calculated the mean of all metric values ("mean value"). Second, we took the mean of all values within each of the categories shown in table 2, then calculated the mean across categories ("mean category"). Third, we calculated the mean of values within categories shown in table 4 (physical structure and vegetation structure were combined into a single category), then calculated the mean across categories ("mean combined category"). For these two methods, whole wetland connectivity was placed in the hydrologic condition category instead of landscape context. Fourth, we calculated weighted means of metrics within each category, using weights and categories adapted from Lemly and Gilligan (2013, table 5), then calculated the mean across categories ("mean CNHP"). Fifth, we used weighted means for combining metrics within categories and for combining category scores ("mean full CNHP", table 5). We used an overall buffer score based on 100 m buffer width values, and we used algae metric values based on thresholds from algae ground cover estimates in all analysis. We calculated each score with and without the inclusion of the interspersion metric.

We tested correlations between overall scoring methods and other measures of site condition. We tested correlations among all sites surveyed for the Weber project and within groups of sites of the same Ecological System, including Uinta project sites for the analysis of the upper montane shrubland data to increase sample size. We tested overall scores versus five FQA metrics, Native CW Mean C, Native Mean C, Mean C, Adj. FQI, and CW Adj. FQI. The first two metrics were included because they were the least correlated with plant composition metrics; metrics most strongly correlated (>0.70) where not included. All of these FQA metrics were strongly correlated with assessment scores and stressors in previous research in Great Salt Lake and/or Snake Valley (Jones and others, 2014; Menuz and others, 2014). We also tested overall scores versus stressor data recorded in the field. We looked for outliers in plots of FQA or stressors versus site scores by Ecological System to see whether they could be correct by adjustment of scoring methods.

Table 4. 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 or when large patches dry algae were 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 or woody species are expected at sites.

All methods of calculating site scores were highly correlated with one another when tested across all Weber sites (Pearson correlation coefficients between 0.94 and 0.99, $p<0.001$ for all comparisons). All methods were also strongly correlated ($p<0.001$) with FQA metrics (Pearson correlation coefficients between 0.51 and 0.84) and stressor metrics (coefficients between -0.46 and -0.76). There was no clear pattern showing whether inclusion of the interspersion metrics improved models; correlations differed between methods with and without the metric by ≤0.04. All FQA metrics were correlated ($p<0.05$) with all scoring methods for wet meadow and upper montane shrubland sites

Table 5. Categories and weights used for testing URAP scoring methods, adapted from Lemly and Gilligan (2013). Categories and category weights are shown in bold.

Metric or Category	Weight
Landscape	**0.2**
Percent Intact Landscape	0.4
Overall Buffer	0.6
Vegetation[1]	**0.4**
Relative Cover Native Species	0.3
Absolute Cover Noxious Species	0.3
Horizontal Interspersion	0.16
Woody Species Regeneration	0.08
Woody Debris	0.08
Litter Accumulation	0.08
Hydrologic	**0.3**
Water Quality	0.2
Hydroperiod	0.3
Timing of Inundation	0.3
Connectivity-AA Edge	0.1
Connectivity-Whole Wetland Edge[2]	0.1
Physiochemical	**0.1**
Turbidity and Pollutants	0.25
Algae Growth	0.25
Substrate and Soil Disturbance	0.5

[1]Lemly and Gilligan (2013) also included Mean C in this category.

[2]Whole wetland connectivity not included in Lemly and Gilligan (2013).

and none were correlated with emergent marsh site scores (table 6). Mean C and Adj. FQI were correlated with scores for alkaline depressions for most sites. All scoring methods were correlated with both stress indices for wet meadow sites and none were for emergent marsh and upper montane shrubland sites. Alkaline depression sites were only correlated with stress indices when mean category scoring was used, with or without the interspersion metric. Emergent marsh sites had a small sample size and a very small range in Mean C values, which may partly explain the lack of correspondence between scoring methods and indices. Emergent marsh and upper montane shrubland sites also had the smallest range of total stress index values.

Based on these results, we decided to further develop the mean category method of scoring variables. This method had amongst the strongest correlations for emergent marsh FQA metrics, wet meadow FQA metrics and stressor indices, and alkaline depression stressor indices and performed well for alkaline depression and upper montane shrubland FQA metrics. Mean full CNHP performed similarly to the mean category method, except somewhat worse with alkaline depression stressor data and somewhat better with upper montane shrubland FQA data. We felt that the mean category method had one key advantage over the mean full CNHP method—the mean category method did not rely as heavily on plant community composition data, which is often time consuming to measure *and* often used to validate rapid assessment scores. We furthermore decided to exclude the interspersion metric for

Table 6. Information about sites used for calibration of URAP scoring.

System	# Sites	Mean C Range	% Scoring Methods Correlated (p<0.05) with Mean C	Total Stress Index Range	% Scoring Methods Correlated (p<0.05) with Total Stress Index
Emergent marsh	8	2.3 - 3.2	0%	0.06 - 5.7	0%
Alkaline depression	16	0 - 5	100%	0.4 - 18.9	20%
Wet meadow	37	1.7 - 6.6	100%	0 - 9.7	100%
Upper montane shrublandland[1]	22	3.2 - 6.8	100%	0.01 - 5.1	0%

[1]Sixteen sites from Uinta and six from Weber. All other systems only composed of Weber URAP sites.

scoring alkaline depression and emergent marsh sites and include it for scoring upper montane shrubland and wet meadow sites.

We next tested different ways to categorize variables in order to optimize the categorization. When testing methods, we included the interspersion metric for wet meadow and upper montane shrubland sites and excluded it for alkaline depression and emergent marsh sites. We tested placing the turbidity, algae, and water quality metrics into a water quality category separate from the hydrologic condition category. We tested adding substrate disturbance to the water quality category. We tested adding wetland edge connectivity to the landscape metric. We also tested down-weighting the connectivity metrics and water quality metrics by 50% compared to the other metrics; down-weighting had very little effect on scores and was not considered beyond initial exploratory analysis. Emergent marsh sites only showed marginally significant correlation with FQA metrics when water quality and hydrologic stressors were combined. Alkaline depression sites showed the lowest correspondence with stressors and upper montane shrubland sites had the highest correspondence with FQA metrics when soil disturbance was grouped with water quality stressors. The categories shown in table 4 consistently had the strongest or close to strongest correlations with FQA metrics and stressor indices across Ecological Systems; this categorization was used for the remainder of the analysis.

We conducted a preliminary analysis to evaluate which variables had a strong influence on overall scores. We systematically dropped each variable from the scoring process, recalculated overall scores, and then evaluated correlations between scores and Mean C and the total stress index. We considered changes in correlation of a ≥|0.20| strong evidence for keeping or dropping a variable, change between 0.10 and 0.20 as moderate evidence, and change between 0.05 and 0.10 as weak evidence. The results showed no evidence for keeping or dropping particular variables for alkaline depression and wet meadow sites based on correlations with Mean C values (table 7). For both emergent marshes and upper montane shrublands, there was evidence for keeping percent intact landscape and relative cover of native species and dropping soil and substrate disturbance and absolute cover of noxious weeds. There was no evidence for keeping or dropping particular variables for upper montane shrublands based on correlations with the total stress index value and only weak evidence for

Table 7. Metrics with evidence for retaining or dropping variable from scoring. Variables with strong evidence of retaining or dropping are in bold; correlations changed by an absolute value of ≥0.20 when these variables were dropped from the scoring. Variables with moderate evidence (change between 0.10 and 0.20) are shown in regular type black and variables with weak evidence (change between 0.05 and 0.10) are shown in grey.

Metric Name	Mean C				Total Stress			
	Alkaline Depression	Emergent Marsh	Upper Montane Shrubland	Wet Meadow	Alkaline Depression	Emergent Marsh	Upper Montane Shrubland	Wet Meadow
Overall Buffer		*Drop*				*Drop*		
Percent Intact Landscape		*Keep*	*Keep*		*Keep*	Drop		
Connectivity-Whole Wetland Edge		Keep				**Keep**		
Relative Cover Native Species		Keep	Keep		Keep	Drop		*Keep*
Absolute Cover Noxious Species		Drop	*Drop*		Drop	Keep		
Litter Accumulation		**Keep**						*Keep*
Connectivity-AA Edge						*Drop*		
Substrate and Soil Disturbance		Drop	Drop		**Keep**	**Keep**		
Turbidity and Pollutants						*Keep*		

keeping two wet meadow variables. There was strong evidence for keeping the soil and substrate disturbance metric for alkaline depression and emergent marsh sites based on the stress index. We did not drop any variables from the final analysis, but retained this information for future consideration.

With a final scoring method in place, we tested different versions of the buffer and algae metrics one more time. Field-based algae metric scores performed slightly better than scores based on thresholds in filamentous algae cover. There was little difference in using the different buffer width calculations. For the final scoring, we used the buffer width metric based on a 100 m buffer with no adjustment for problematic transects and the wet algae metric.

We created single-variable linear regression models of the final overall URAP site score versus the total stress index and Mean C. We examined outliers to determine whether any particular site type was systematically under- or over-predicted. We created models by ecoregion and for all sites; generally the same sites were outliers regardless of the group of data used in the models. In the model of total stress versus the overall score, the four sites with the largest absolute value of the residuals all had a low overall URAP score despite a relatively low amount of stress (figure 5). Low scores at these sites were driven in part by low scores for the vegetation composition category; all sites had less than 26% relative cover of native species and over 25% cover of noxious weeds, driven largely by *Phragmites australis* at three sites and *Elymus repens* at one site. Noxious weed cover may need to be incorporated into the total stress index since noxious weeds themselves are a form of stress. The scatterplot of overall score versus Mean C values suggested a potential polynomial relationship between the values, but the linear model with a single term had more support (figure 5). The four sites with the largest absolute value of residuals in the linear model all had relatively low overall scores despite relatively high Mean C values. These sites did not have any obvious characteristics in common, though they had low vegetation composition and/or vegetation structure scores.

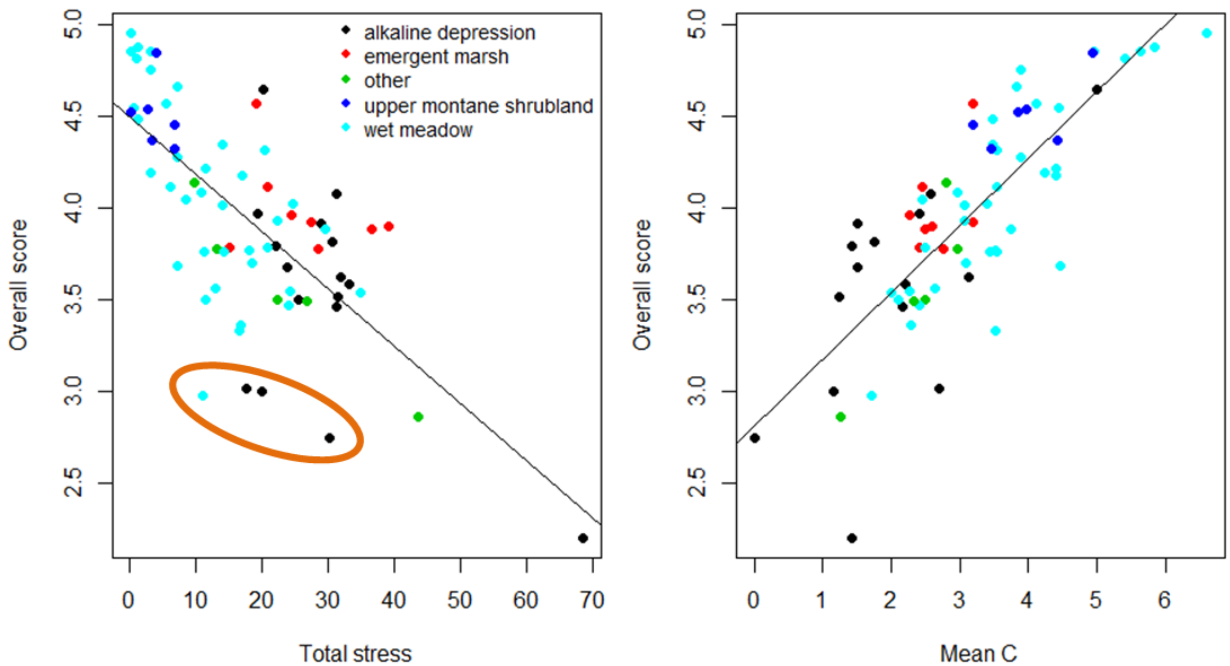

Figure 5. Overall URAP scores versus total stress (left) and Mean C (right), by Ecological System, for all sites in the Weber watershed. Best fit linear regression line is shown in black. Largest outliers are circled in orange in graph on left; these four sites had amongst the highest values for absolute cover of noxious weeds and amongst the lowest values for relative percent native species.

4.0 Plant Community Data

4.1 Low Cover Species

We evaluated vegetation data to determine the extent to which FQA metric values changed based on the presence of low-cover species. These species are difficult to detect and to identify in the field and we wanted to determine the effect they had on overall scoring. First, we compared the correlation between FQA metrics calculated using all recorded plant species and FQA metrics calculated using only species with at least 1% cover and only species with more than trace recorded cover. We identified the 50^{th} and 95^{th} quantiles of the difference in Mean C values for these comparisons and used linear regression to determine the extent to which changes in mean C values depended on the number of species dropped and the number of species used in the final calculation.

Weber sites had between 0 and 44 species per site recorded with less than 1% cover; 50% of sites had between 11 and 25 of these low cover species. As long as sites had a high percent of species with known C-values and known nativity, FQA metric values calculated across all species were very strongly correlated with metric values calculated with only those species with more than 1% cover (Pearson correlation coefficients between 0.76 and 0.99, $p<0.001$ for all comparisons). This correlation shows that sites would still be ranked similarly in relation to one another if low cover species were not included in the study. We wanted to investigate whether this pattern held true when looking at sites that spanned a smaller disturbance gradient than the Weber project sites. We therefore performed the same analysis with sites from the Uinta project, where sites were much more similar to one another. We found that dropping trace species still resulted in very strong correlations ($0.94<r<0.99$, $p<0.001$). However, when species with less than 1% cover were dropped, only cover-based FQA metrics had strong correlations. Richness-based metrics, including percent non-native species and FQI metrics, did not have significant correlations and Mean C and Native Mean C had weaker correlations ($0.51<r.55$, $p\leq0.01$). Missing species data appears more important when sites are very close to one another in composition.

Mean C values changed by a median of 0.10 and a 95th percentile of 0.58 when species with trace cover were dropped from the calculation. The difference in Mean C was lower when more species were used in the calculation and when fewer species were dropped from the analysis ($F(2, 68)=14.2$, $p=0.003$, adjusted $R^2=0.27$). When all species with less than 1% cover were dropped from calculations, Mean C changed by a median of 0.38 and a 95th quantile of 1.24. Change in Mean C decreased when more species were used in calculations ($F(1, 69)= 9.3$, $p<0.001$, adjusted $R^2=0.11$); number of dropped species had no effect.

4.2 Plot Data

We evaluated plot-based data to determine the effect of plot use and number of plots on FQA metrics and URAP vegetation composition metrics. Plot-based data was collected at three sites per stratum, for a total of 18 sites with plot data. A median of only one new species was found when surveyors went from plot 3 to plot 4 (figure 6). Seven sites had no new species found in the fourth plot, six sites had one new species, and the remaining sites had two or three species except for one site with 10 new species in the fourth plot. A median of 3.5 new species were found when searching the entire AA in addition to the four plots, with a maximum of 21 new species found in the AA. Three sites had no new species in the AA; one of these only had one species recorded in all four of the plots as well. Of the six sites with the most new species found in the AA, two were visited by groups with three botanists and at least two had the majority of additional species found in habitat that differed from the majority of the AA. Patterns of species accumulation by plot did not seem to depend on the Ecological System at a site (figure 6). Mean C and CW Mean C values calculated using mean species data from the plots and species data from the entire AA were highly correlated ($r>0.96$, $p<0.001$).

We calculated FQA metrics from data for the entire AA, from individual plots, and from mean values across species in three or four of the plots. We calculated the difference between each value when calculated from the four-plot data versus all other data sources and identified the median and 95th percentile values, focusing on the two FQA metrics used in URAP scoring, relative cover of native species and absolute cover of noxious species, and two C-value dependent metrics, Mean C and CW Mean C. Data collected within three of the four plots was usually most similar to data from the four plots, followed by data from the entire AA; data from individual plots were considerably less accurate than all other data (table 8). For relative cover of native species and absolute cover of noxious weeds, the median difference from the four plot data was considerably smaller for the three plot data than for the entire AA data, but the 95th percentile value was similar. In contrast, both the median and 95th value had a similar degree of difference for Mean C and the three plot data had a considerably smaller difference from CW Mean C. When relative cover of native species and absolute cover of noxious weeds values were converted to rankings (i.e., A, B, etc.), rankings were almost always the same regardless of whether data from three plots, four plots, or the entire AA were used. Only one of eighteen sites changed rank for the noxious weed metric when entire AA data were used instead of data from the four plots, and only one of the 72 three-plot values differed from its corresponding four-plot metric rank. Two and

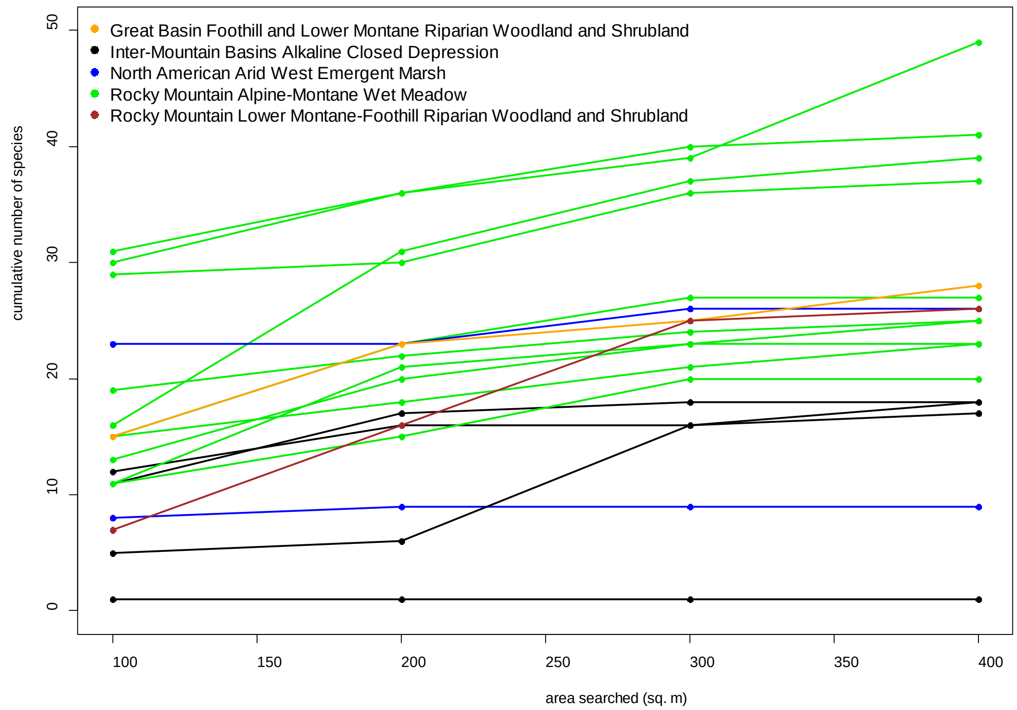

Figure 6. Cumulative number of species found with successive increases in area searched, for 18 sites with species searched in four 10 m x 10 m plots.

Table 8. Comparison of plant metric values calculated at different scales. Values shown are the 50th and 95th percentiles of the absolute value of the difference between values calculated from four-plot data and values calculated at the comparison scale indicated.

Comparison Scale		**Relative Cover Native**		**Absolute Cover Noxious**		**Mean C**		**CW Mean C**	
	# Comparisons	**50%**	**95%**	**50%**	**95%**	**50%**	**95%**	**50%**	**95%**
Entire AA	18	2.9	11.0	0.1	2.1	0.07	0.43	0.19	0.82
Three plot mean	72	1.2	9.0	0.02	2.0	0.08	0.33	0.08	0.40
Individual plot	72	4.1	24.5	0.1	5.9	0.29	1.06	0.24	1.32

three sites differed in relative native cover ranks when data from the entire AA or from three plots, respectively, were used instead of data from all four plots. Ranks frequently changed when data from only a single plot were used to calculate either metric.

We matched sites with plot-based data with sites in the same strata and Ecological System in order to evaluate whether plots helped observers record more plant species. Whenever possible, matched sites also were close to one another and had similar elevations. We then used a paired one-sided t-test in to determine whether sites with plot data had more recorded species than their paired site. We only were able to match 14 of the 18 sites with plot data with similar sites in order to assess the effect of using plots on overall species richness. Nine of the sites with plots had greater species richness, one had identical species richness, and four had lower species richness than their paired plotless site. There was a mean difference in sample estimates between the groups of sites of 2.7 species, though the t-test was inconclusive ($p=0.10$, $t=1.35$, $df=13$).

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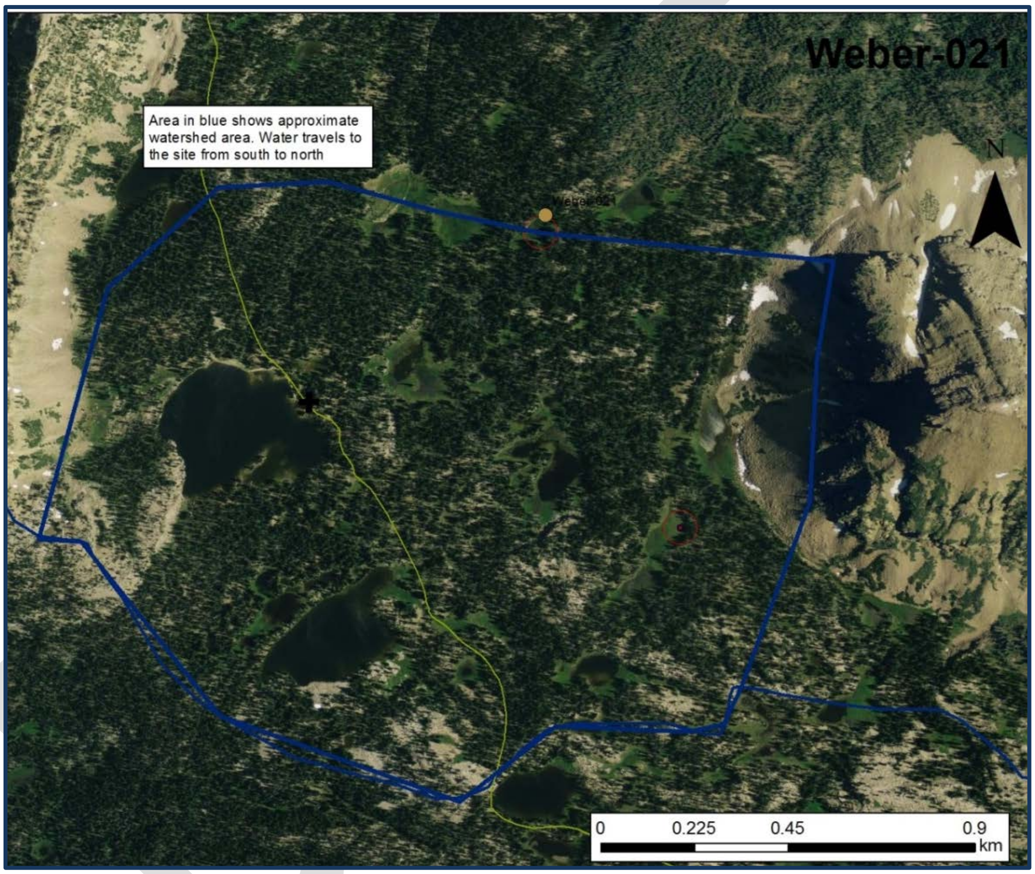
Appendix B.

Utah Rapid Assessment Method—Method for Evaluating Ecological Integrity in Utah Wetlands

Office Evaluation Method, Version 2.0- Draft

UTAH RAPID ASSESSMENT PROCEDURE
Method for Evaluating Ecological Integrity in Utah Wetlands
Office Evaluation Method, Version 2.0- DRAFT



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Version date: May 2015

Utah Rapid Assessment Procedure:
Method for Evaluating Ecological Integrity in Utah Wetlands
Office Evaluation Method
Version 2.0- Draft

Cover:

Landscape map showing approximate contributing area boundaries (blue polygon) and location of trail in relation to the wetland on the northern edge of the map (brown circle). Site is in the Uinta Mountains off the Mirror Lake Highway near the Notch Mountain trail.

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Appendices

Section 1: Introduction

The Utah Rapid Assessment Procedure (URAP) is a survey protocol developed by the Utah Geological Survey (UGS) 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).

Prior to conducting a field survey using URAP, it is important to conduct an initial office assessment of potential sites. Sites that have been randomly selected for field surveys may first need to be evaluated to determine whether they are actually wetlands and to determine land owner contact information to obtain permission to survey. All sites that will be surveyed should be assessed in the office to obtain basic landscape data, particularly in regards to site hydrology. Additionally, site maps for field surveys must be prepared in the office.

The primary focus of this document is to provide guidance for employees of the Utah Geological Survey (UGS) who are using URAP to assess condition of randomly selected wetlands for the 2014 Weber watershed project, funded under Environmental Protection Agency (EPA) grant CD-96812601-0. This document is also intended to provide guidance for other users of URAP, though full development of the office evaluation procedure for those without access to ArcGIS is not yet complete. The freely available GoogleEarth software (https://www.google.com/earth) can be used in place of ArcGIS to produce maps and evaluate landscape features. In section 5, we provide suggestions for alternative sources of landscape stressor data for those without access to specific data layers used by the UGS.

Section 2: Initial Site Evaluation

2.1 Evaluation of target site

An assessment area (AA) is the bounded wetland area within which sampling occurs. URAP was developed for use with circular fixed-area 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. Evaluation methods outlined below were adapted from methods used by the Colorado Natural Heritage Program (Lemly and Gilligan, 2013).

The location of most AAs for the Weber River watershed project are randomly selected using National Wetland Inventory (NWI) data. Before site visits, we will evaluate randomly placed points to determine whether or not they actually appear to be wetland. Wetland for this project is any area that meets the definition used by the U.S. Fish and Wildlife Service (USFWS) for NWI mapping, which includes areas at least periodically flooded or saturated by water and, if soils and vegetation are present, hydrophytic vegetation and predominantly hydric soils (Cowardin and others, 1979). Permanently flooded areas with water deeper than 2 m, where emergent plant species usually cannot grow, are considered deepwater habitat, not wetland by Cowardin and others (1979), though we will exclude areas with water more than 1 m deep for the safety of field surveyors. We will generate 40-m radius buffers around randomly selected study sites in ArcGIS and then determine whether AAs need to be moved, reshaped, or excluded. 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) There should be no more than 10% upland inclusions within the AA and no more than 10% water >1 m deep, including water in a stream channel or in the center of a pond. The AA should be shifted or reshaped to avoid upland and deep water on its edge (i.e., only inclusions *within*, not on the edge of, the AA are acceptable, figure 1a).
4) The AA should be established in a single wetland. Features that denote wetland boundaries include above-grade roads, major water control structures, dikes, and major channel confluences (figure 1b).
5) The majority of an AA should be placed within a single Ecological System.
6) Do not move the AA if you cannot determine whether a wetland is present in the imagery. For these sites, surveyors will determine AA location in the field.

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 free-form AAs; avoid biasing placement towards or away from interesting features or difficult to sample vegetation.

If the AA must be moved from the original placement, first determine whether the selected point is within 60 m of land cover that could be wetland. Likelihood that land cover is wetland is classified as one of the categories listed below. All wetlands in the first category will be surveyed and a subset of wetlands in the second and third categories are surveyed in order to determine the overall accuracy of the NWI data. Features in the last category are removed from the sample frame with no further evaluation. Evaluation of whether sites are wetlands is based on examination of aerial imagery as well as topographic position and proximity to potential water sources using geospatial data listed in appendix A. The evaluation categories include the following:

1) Probably or definitely wetland: Sites that are fairly likely to be wetlands, with at least 75% certainty (figure 2).
2) Possibly wetland or unclear: Sites that have a 25 to 75% chance of being wetlands or a site that is unclear or impossible to assess based on the imagery (figure 3a).
3) Probably not wetland: Sites that are probably not wetlands (5-25% likelihood), but this fact is not unambiguously clear (figure 3b).
4) Almost certainly not wetland: Sites that are almost certainly not a wetland (<5% likelihood). Area may be clearly developed or barren.

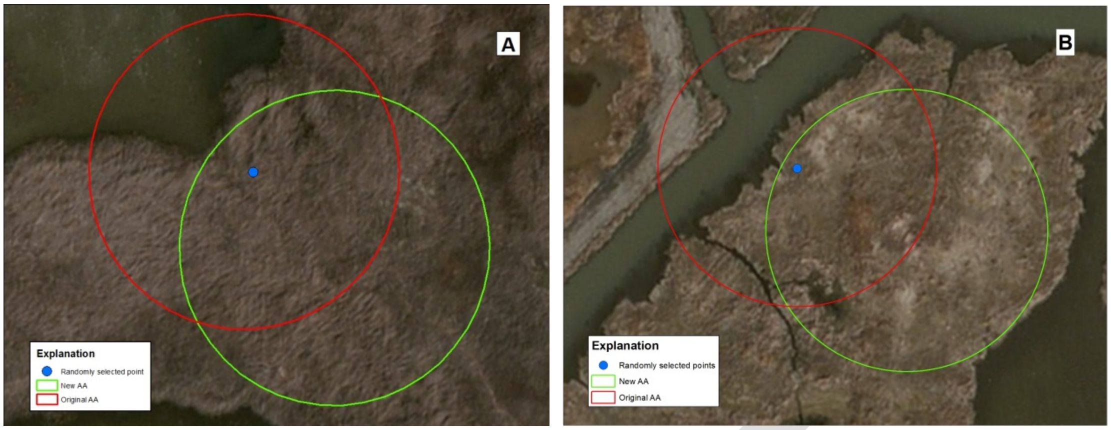

Figure 1. Examples of moving the original AA to a more appropriate survey location. On left (A), AA created by original sample point (red circle) has inclusions of open water on its edge. If this water is more than 1 m deep, AA location should be shifted so that inclusions are not directly on the AA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

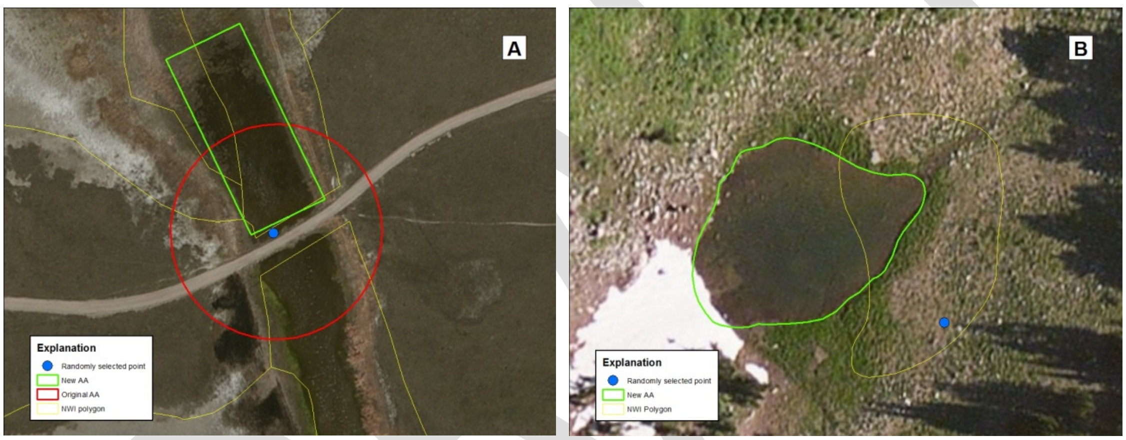

Figure 2. Sites that are probably or definitely wetlands. Site on left (A) was redrawn as a rectangular AA, though a circular AA potentially may also fit. At the site on right (B), the randomly selected point originally fell on the edge of the NWI polygon (yellow circle). A free-form AA was drawn in red around the probable wetland area. The free-form AA is large enough to sample (0.15 ha), whereas the original NWI polygon was not.

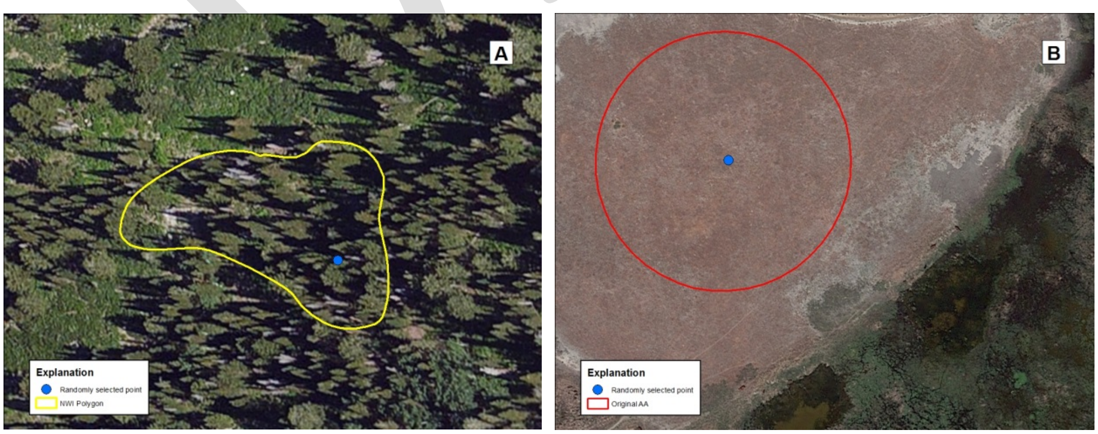

Figure 3. Sites that is possibly wetland or unclear (A) and site that is probably not wetland (B). In map on left, area was mapped as scrub/forested wetland in NWI data. It is difficult to tell with the canopy cover but this site should be listed as possibly

wetland or unclear. On right, site appears to not be wetland due to the lack of green coloration, but it is still possible that the site may be wetland.

Next, determine whether the AA needs to be moved or reshaped. If the AA does not follow the general principles outlined above (e.g., <20% upland and deep water, crossing wetland boundaries), move or reshape the AA. If the potential boundaries of the wetland in the imagery are unclear, the AA boundary will be established in the field. For boundaries established in the field, make site maps appropriately to accommodate potential changes. Whenever possible, keep the AA 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 and circular wetland cannot be drawn.* Rectangular AAs should 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 0.5 ha 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 free-form 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. Free-form 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, draw the AA 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.

2.1 Landowner contact information

Obtain landowner information for sites that are selected for analysis. First, determine whether ownership is state, private, federal, or tribal. Next, determine the individual or entity that owns the land. If the land is a managed wetland area, record the name of the reserve or waterfowl management area as well as the organization or individual who owns the property. If the land is not a managed wetland area, search for additional contact information for the land owner, particularly a contact phone number. You may also add remarks about access to the site to make note of access issues visible in aerial imagery, including sites that are owned by multiple land owners. Geospatial parcel data with land owner names and mailing addresses are available for most counties.

Section 3: In-depth Site Evaluation

3.1 Obtaining soil data

The Web Soil Survey (WSS) provides soil data that give a general idea of soil properties that may be encountered in the AA. However, it is important to remember that the information provided by WSS is not 100% accurate, nor is it designed to be applied at a small scale. On-site observations take precedence to information in the WSS. The WSS should be used as a tool to help confirm observed soil characteristics and to provide additional data to characterize soil appearance.

For each site, record soil survey data for the predominant soil unit mapped for the AA and for any other soil units that make up more than 10% of the AA. Record the Map Unit Name, slope, and the percent of the AA in the map unit. Also record the hydric rating, drainage class, depth to water table, and flooding frequency. The hydric rating indicates the percentage of the map unit components that predominantly have hydric soils. A rating above 66% is considered "Predominantly hydric" and a rating below 33% is considered most likely "Nonhydric". Drainage class indicates how frequently the map unit soil is wet under natural circumstances and is assigned one of seven classes including excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. Depth to water table is the expected depth to the zone of the soil that is saturated for at least a month. Flooding frequency is the expected frequency at which areas are flooded by overflowing streams or runoff from slopes and is assigned one of six classes including none (< once/500 years), very rare (<1%/year), rare (1-5%/year), occasional (5-50%/year), frequent (>50%/year), and very frequent (>50%/year for every month in year). Following is the process to obtain soil data using the WSS:

1) Go to the Web Soil Survey site at: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm and click on the START WSS "green" button.
2) Under the "Area of Interest" (AOI) tab on top of the screen, click on the "Quick Navigation" drop down tab, select "Latitude and Longitude", enter the AA center coordinates, and click view. You can also manually scroll to the AA if you are familiar with the area.
3) Click on the "define AOI by rectangle" button on the tool bar of the Interactive Map and roughly highlight an area slightly larger than the AA. You will need to have a map of the AA boundary open in ArcGIS or printed out to get a rough idea of this location.
4) After you have selected the AOI, click on the "Soil Data Explorer" tab near the top of the page, then click on "Land classification" followed by "Hydric Rating by Map Unit" and finally, "View Rating". A table will appear below the map that summarizes the hydric rating for all the different soil units in the AOI map you created.
5) The "Soil Properties and Qualities" tab contains the other information that needs to be collected for the units identified above and added to the form. The first is the drainage class. Click on the "Properties and Qualities Ratings" tab on the left side of the screen, then "Soil Qualities and Features", next "Drainage Class" and view rating. The rating is located in the table that appears under the soil map. For the other two features, close the "Soil Qualities and Features" and click on "Water Features". Water table data is located in "Depth to Water Table" and flooding is located in "Flooding Frequency Class" by clicking on view rating and referring to the table that appears.

The "USA Soil Survey" layer can be found in the ArcGIS online database. This spatial layer can be used to identify soil survey map unit boundaries and to obtain most of the information above except for depth to water table and drainage class.

3.2 Evaluation of site hydrology

3.2.1 Determine hydrologic contributions to site

In ArcGIS, use aerial imagery, watershed boundaries, flowlines, and elevation data to determine the likely sources of water to sites. For sites connected to streams (either directly or through canals), the contributing area to the wetland is likely to be the entire watershed upstream of the site, which can be determined by using the watershed boundary dataset. Inter-basin water transfers (e.g., aqueducts carrying water to places it would not naturally reach) can complicate the contributing area, and should only be considered if they are very close to the wetland site or likely to have a substantial influence on the site hydrology. The contributing area for depression, slope, and other wetlands not connected to streams is assumed to be the land upslope from the wetland that is likely to drain to the wetland. Breaks will generally be made on ridgelines, though breaks may also be added in relatively flat terrain such as through farmland. Using surface topography to estimate groundwater contributions is prone to error, but, in the absence of more detailed groundwater studies, is the best possible approximation. In addition to determining the overall contributing area to the site, look for evidence of potential water additions to the site such as urban run-off, agricultural return flows, and ditching. Once you have determined the contributing area, write up a brief statement on the major source(s) of water to the site, including any sources that are unclear in imagery and need to be verified in the field. Hydrologic write-ups will be verified in the field. See figures 4 and 5 for examples of hydrologic site write-ups.

Figure 4. Example write-ups of site hydrology. For site on left (A): Site may primarily receive water from runoff in surrounding area. It is unclear whether site has input to the south or an outlet to the north, but does not seem to be connected to a stream or river. Inspect site for possible inlets and outlets. For site on right (B): Site may receive water from surface flow upslope to the south (check for culverts, ditching or signs of seeps or flow near road), from the alluvial aquifer, and overbank flooding from the stream channel. Irrigation ditches north of the stream are most likely disconnected hydrologically and would generally have little to no influence on site.

3.2.2. Evaluate potential hydropattern stressors

Next, determine which of the stressors present are likely to have a major role in controlling site hydroperiod. Stressors are listed as trace/not present, low, moderate, or high and are marked to denote whether they are present within 200 m of the site or more distant. Stressors likely to be negligible, such as small areas of development far from the wetland site, should be marked as trace/not present. To determine severity of water withdrawal and groundwater pumping, evaluate the distribution and density of diversion points in the watershed. Consider the severity of each stressor in relation to the overall water budget at the site. Seepage from an irrigation ditch will have a much larger effect on a playa that is naturally dry most of the year than on a groundwater-fed slope wetland that receives a constant influx of water. Increased duration of inundation of several weeks is a major change for systems that are normally only temporarily flooded (surface water during brief periods of the growing season) but not as important of a change for sites that are semi-permanently flooded (surface water present throughout growing season). See the office evaluation field form for a list of evaluated stressors (appendix B).

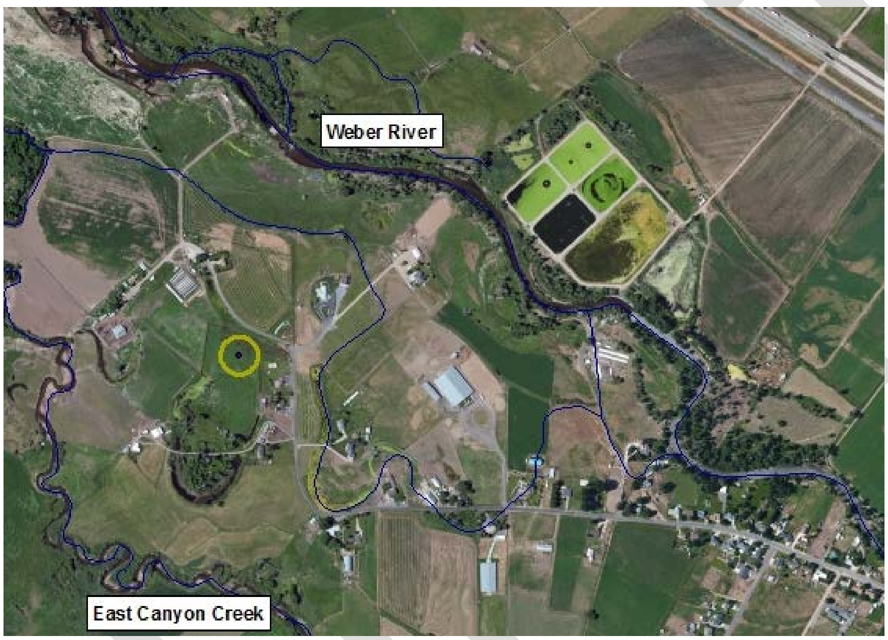

Figure 5. Example write-up of site hydrology: Site probably receives water from ditches off East Canyon Creek. Look for connection with Weber River and associated ditching, but East Canyon Creek source seems more likely.

3.3 Evaluation of water quality

3.3.1 Evaluate water quality stressors

For water quality evaluation, we are going to look at land cover, point source dischargers, Superfund sites, mines, oil and gas wells, and evidence of large sources of sediment (e.g., landslides, forest fires, quarries). Stressors will be evaluated both within 2 km of the site as well as in the contributing area and will be listed as none/trace, low, moderate, or high severity. The evaluated contributing area can be smaller than the whole watershed based on major breaks in hydrology. For example, inputs can be diluted when the input stream joins a larger river or because of dilution by major tributaries. Major reservoirs may serve as breaks in water quality (though impoundments may have less of an effect due to their often shorter water holding time [Miller and Hoven, 2007]). One or several very distant stressors can be considered none/trace. One very proximal stressor that directly feeds into the

AA can be considered moderate or severe. Land cover classes will be considered none/trace, low, moderate, or high based on whether they constitute very little, <20%, 20-60%, or >60% of the evaluated contributing area, respectively. The severity of point-based features should be evaluated based on the density of points and proximity to the AA. If there are only a few point source stressors in the area, you may want to investigate each stressor to determine likelihood of hydrologic connectivity; otherwise, look only at the aggregated total of the stressors. See the office evaluation form for a list of evaluated stressors (appendix B).

3.3.2 Obtain 303(d) Listing Information

Under the Clean Water Act, states are required to submit a list of impaired and threatened waters to the EPA every two years. This list is known as the 303(d) list. Evaluations are conducted in assessment units (AUs), areas delineated around lakes, stream segments, or watersheds that contain generally homogenous physical, chemical, and biological conditions. Wetlands located in AUs with impaired waters may be likely to have impaired water quality if the impaired waters are hydrologically connected to the wetland. This connection is most likely to exist for wetlands adjacent to major rivers and lakes. The most recent 303(d) list for Utah was produced by the Utah Division of Water Quality in the 2012-2014 Integrated Report and was not finalized at the time of the 2014 Weber watershed wetland assessments (Utah DWQ, 2014). We nonetheless obtained the preliminary data from this report for office evaluations in 2014. For each site, list the AU unique identifier and the AU category and sub-category. Category 1 AUs are fully supporting all water quality standards, Category 2 AUs were not fully assessed but supporting where assessed, and Category 3 sites have insufficient data but some record of exceedances. Categories 4 and 5 sites are both impaired; the former have approved Total Daily Maximum Loads (TMDL) studies whereas the latter do not. For these AUs, list all impaired parameters. For all sites, record whether the AU water quality is likely connected to the site's wetland water quality. Data for adjacent AUs can also be recorded if they are likely to contribute water to the site. The following process can be used to obtain AU data for each site:

1) Determine the unique identifier of the AU where the site is located. The best method to determine this identifier is to read the boundary descriptions presented in the 2012-2014 Integrated Report. Most river and stream watershed boundaries are similar to those used in the 2010 report, which can be viewed in the publically available Beneficial Use and Water Quality Assessment Map (http://mapserv.utah.gov/SurfaceWaterQuality). Boundaries from the 2010 report can also be determined in ArcGIS using the AGRC Image Server. For lake AU identifiers, search for the name of the lake in the 2012-2014 Integrated Report.
2) Determine the reporting year, assessment status, and impaired attributes of the AU. For lakes, look at the list of impaired lakes from 2014 in Chapter 6 of the 2012-2014 integrated report. This list includes both 2012 and 2014 results; look at the 2014 results starting on page 13. If a lake of interest is on the list, circle *Impaired Lake* under category and circle all impairments listed under Cause. For streams and rivers, look at the list in Chapter 5 of the integrated report. Circle the assessment unit category and write in the sub-category. List all impairments for Category 4 and 5 sites.

3) Evaluate whether the water quality of the wetland is likely to be related to the AU water quality. This is likely for wetlands that receive much of their water from assessed streams and lakes and unlikely for isolated wetlands and groundwater-fed wetlands.
4) If the AU is not assessed, determine whether an adjacent AU has been assessed and is likely to contribute water to the wetland. If so, record relevant information on the form and explain the likely connection between the assessed AU and the wetland of interest.

Section 4: Prepare Site Maps

4.1 Preparing site maps

Site maps should be prepared before wetland surveys are conducted. Useful maps include a detailed map of the AA, a buffer map showing the landscape surrounding the site, and a landscape map showing some or all of the contributing area to the AA. These maps will be important for evaluating some site attributes, in particular those related to the wetland buffer and to site hydrology. Maps can be made in GoogleEarth or ArcGIS and should contain the most detailed and up-to-date aerial imagery available for the area. Maps should include a title with the unique site identifier, scale bar in meters, north arrow, AA boundary, original sample point, and new center point if the site was moved.

The detailed AA map shows the AA as well as the potential area where the AA may be moved to in the field. To create this map, in ArcGIS, generate a 140 m buffer around the original center point for the AA. This distance is the outermost edge that a circular AA can be moved if site adjustments needs to be made in the field (figure 6a).

The buffer map shows the area that will be evaluated in the field for the Landscape Context metrics. Generate both a 200 m and 500 m buffer around the new AA boundary (not the center point) in ArcGIS to produce this map. In some cases, it may be useful to include additional information on the map, such as water related land use (figure 6b).

The landscape map will vary in scale and is an aid in identifying the contributing area and possible sources of water quality degradation and hydropattern alterations. The map should include most or all of the contributing area determined above in *3.2.1 Determine hydrologic contributions to site.* When the entire contributing area is very large, the map extent can be truncated at a major break in hydrology, such as a major reservoir or input point of a major tributary (figures 7 and 8). Some wetlands may have very limited contributing areas (figure 9). Contributing area boundaries can be manually drawn on maps or visualized with existing watershed boundary data. The landscape map should include any features useful in evaluating site hydrology and stressors that may affect the site. Data on density and types of roads, oil and gas wells, point source dischargers, mines, water related land use, and streams may all be helpful in evaluating site hydrology; see appendix A for a list of potential data sources. Add any layers and labels to the final map that will be helpful to identify features in the contributing area that will not be readily apparent on the map or in the field.

4.2 Overlaying grids on site maps

Grids can be overlain on detailed site and buffer maps in order to help with field estimates for some attributes, such as the percent cover of agriculture in the 200 m buffer. Below is a process for creating grids on maps in ArcGIS where each grid square will represent 5% of the total AA or total buffer area. Once the grids are created, they can be turned on and off by right clicking on the Data Frame, selecting Properties, and then clicking the grids on and off under the Grids tab. Custom grids will need to be made for non-standard AAs and their buffers. Following are the steps to create a grid in ArcGIS:

1) Look at the map in layout view.
2) Right click on the Data Frame (which will be called Layers) and select Properties.
3) Click on the tab labeled Grids and select New Grid.
4) Select Measured Grid from the list of options and then Properties. Under Intervals, enter the appropriate number of meters for the X and Y axis. Five percent of a 0.5 ha standard circular AA is ~250 m^2, so the axes should each be $\sqrt{250}$ or approximately 15.81 m. For the 200 m buffer, the distance is 93.79 (this is 5% of the 200 m buffer only, excludes area of the AA). For non-standard AAs, use the following equation to calculate axes length: *length* = $\sqrt{AA\ Area * 0.05}$. The axes length for non-standard AA buffer grids is *length*=$\sqrt{(Area\ of\ 200\ m\ buffer - AA\ Area) * 0.05}$. Once you have entered the axes lengths, select OK.
5) Select OK for the next two screens. You may want to give the grid a name under Grid Name, such as "standard AA grid" or "standard buffer grid". This can be done in the Data Frame Properties under Grids. Double click on the reference grid to highlight and then rename.
6) If you want to get rid of the labels, highlight the grid you just created and select Properties. In the Labels tab, deselect all Label Axes. You can also change the line width and color under the Lines tab. The default width and color are generally acceptable.

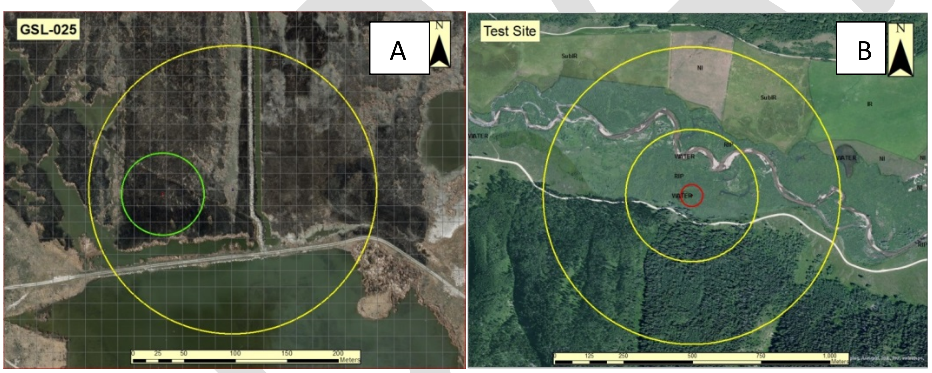

Figure 6. Detailed site map where AA was moved, with 140 m buffer (left, A), and buffer map (right, B). Buffer map includes data on water related land use to show which fields to the north are irrigated.

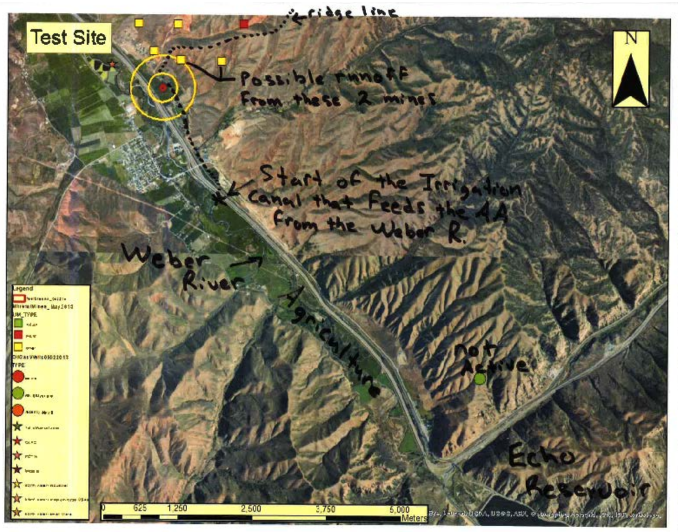

Figure 7. Landscape map showing part of contributing area to wetland site shown in center of yellow circles. Contributing area is truncated at the Echo Reservoir. Notes have been added to point out key features that relate to water source and potential water contamination. The town of Henefer and its water treatment plant are along the Weber River past the point where water is diverted from the river to the site, so they most likely do not contribute contaminants to the AA.

Figure 8. Landscape map showing part of contributing area to wetland site shown in center of yellow circles. Point source dischargers listed as major are circled on the map. The contributing area is not truncated at a major break in hydrology, but instead shows the contributing area up to the point where important stressors are included on the map.

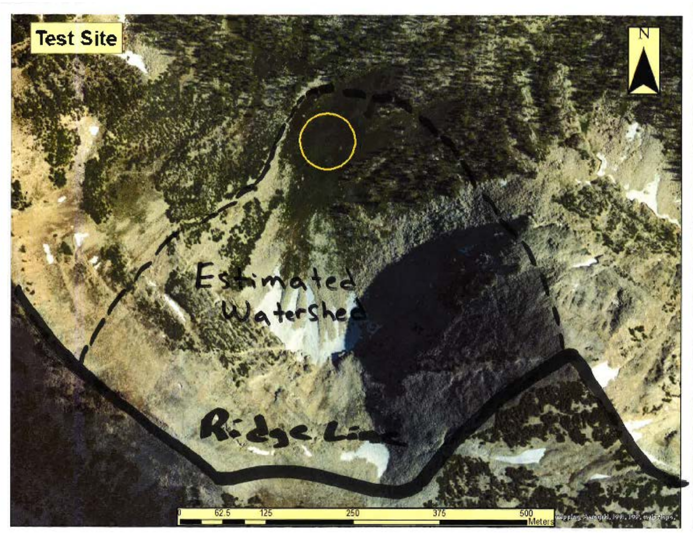

Figure 9. Landscape map showing AA (yellow circle) with very small contributing area. Main water sources may be from snow runoff, direct precipitation, and/or groundwater discharge, but will have to be evaluated in the field.

Section 5: Potential Data Sources

The UGS uses a number of geospatial data layers to assist in conducting office evaluations of survey sites. Most of these layers are publically available, and all layers used by UGS are listed in appendix A. Landscape analysis is conducted by the UGS in ArcGIS. For those without access to ArcGIS, similar analysis can be conducted with the same layers in free, open source GIS applications such as QGIS (http://www.qgis.org/en/site). Analysis can also be conducted in GoogleEarth. In many cases, aerial imagery alone may be adequate to detect stressors on the landscape.

Data on point source dischargers and other EPA-regulated stressors can be found at the Enforcement and Compliance History Online (ECHO) database (http://echo.epa.gov). ECHO can be used in a variety of ways, but one option is to search under Advanced Tools, and then Advanced Facility Search. Searches can be conducted by state and United States Geological Survey 8 digit hydrologic digit code (HUC8) watershed. Under the Facility Characteristics tab, you can filter by active/operating dischargers, major facilities, and facilities with clean water permits. You can then click on individual features to determine their receiving waters and their potential connectivity to the study site of interest. The Superfund Program is in the process of transferring data to a new database, the Superfund Enterprise Management System (SEMS). Data through November 2013 is currently publically available in the CERCLIS Public Access Database (http://cumulis.epa.gov/supercpad/cursites/srchsites.cfm). Superfund sites can be searched by state and county or by site attributes including current National Priorities List status or contaminant types.

References

Cowardin, L.., Carter, V., Golet, F.C., and LaRoe, E.T., 1979, Classification of wetlands and deepwater habitats of the United States: Washington, D.C., U.S. Fish and Wildlife Service Northern Prairie Wildlife Research Center Online http://www.npwrc.usgs.gov/resource/wetlands/classwet/index.htm.

Fennessy, M.S., Jacobs, A.D., and Kentula, M.E., 2007, An evaluation of rapid methods for assessing the ecological condition of wetlands: Wetlands, v. 27, no. 3, p. 543-560.

Lemly, J., Gilligan, L., and Fink, M., 2011, Statewide strategies to improve effectiveness in protecting and restoring Colorado's wetland resource: Fort Collins, Colorado Natural Heritage Program, 149 p.

Miller, T., and Hoven, H., 2007, Ecological and beneficial use assessment of Farmington Bay wetlands—Assessment and site-specific nutrient criteria methods development: Salt Lake City, Utah Division of Environmental Quality and Institute for Watershed Sciences, contract deliverable to the U.S. Environmental Protection Agency for grant CD988706-03, 751 p.

[Utah DWQ] Utah Department of Environmental Quality Division of Water Quality, 2014, 2012-2014 integrated report: Salt Lake City, available online at http://www.waterquality.utah.gov/WQAssess/currentIRoct.htm.

Appendix A:

Data used for office site evaluation

GIS Layers and How to Use Them

Data Sources

1) U:\GWP\Wetland\GIS\statewideReference- Statewide features that should all contain metadata (right click on file and select Item Description). The suggested way to work with these features is listed below for each feature. In some cases, data has been clipped and processed for the 2014 study area.
2) UGS SDE Features that start with the UGGP prefix are found in the UGS SDE
3) AGRC SDE Features that start with the SGID prefix are found in the AGRC SDE. Connection instructions are located here: http://gis.utah.gov/data/how-to-connect-to-the-sgid-via-sde
4) AGRC Image Server to obtain aerial imagery. Directions to connect can be found at the following url: http://gis.utah.gov/data/utah-sgid-image-server/ You can also obtain elevation hillshade data and a map of the water quality assessment units here.
5) DNR SDE Features that start with the UNDR prefix are found in the UDNR SDE. Connect by downloading the file in U:\GWP\Wetland\GIS\connectionFileSDE and saving it under C:\Users\(your name)\AppData\Roaming\ESRI\Desktop10.X\ArcCatalog. For Windows XP, the path name will be C:\Documents and Settings\<youname>\Application Data\ESRI\Desktop10.2\ArcCatalog. The Application Data folder may be hidden.

Editing Files in the UGS SDE

Every day when you start working with edited files from the UGS SDE, you MUST first update your file to make sure you have the most up-to-date version. When you are done making edits, you MUST then share your edits with the rest of the team. Get in the habit of doing the following every day, even if you do not plan on making any edits. This will ensure that you and your co-workers are all working with the most up-to-date version of the data.

1) On the Editor menu in ArcGIS, select Start Editing and the name of the file you want to edit
2) On the Version Manager menu, select Reconcile. In the morning, the default settings are appropriate for bringing in any edits that your co-workers might have done. In other words, define conflicts by object and resolve conflict in favor of the Target Version.
3) If you plan on making edits, leave the file in edit mode. Otherwise, go to stop editing.
4) At the end of the day, if the file is still in edit mode, *whether or not you have made any changes*, do the following. Select Reconcile and change the conflict resolution to In favor of the Edit Version. Next, select Post. This will push changes to the database to share with co-workers.

List of Files

1) **Imagery Including Infrared (HRO collected spring or fall, NAIP collected in summer)**
    a. AerialPhotography_Color\NAIP2011_Color1Meter_4Band
    b. AerialPhotography_Color\NAIP2009_Color1Meter_4Band
    c. AerialPhotography_Color\HRO2006_Color1Foot (most of Upper and Lower Weber)

d. AerialPhotography_Color\HRO2009_Color1Foot (west side of Lower Weber)
e. AerialPhotography_Color\HRO2012Color6Inch_4Band (west side of Lower Weber)
f. Layers that are listed as 4Band can be turned to color infrared images, which helps highlight areas with high amounts of chlorophyll and thus healthy plant growth. To turn files to color infrared, first right click on the file name and select Properties. Select the Symbology tab. Change the Red channel to Band_4, the green channel to Band_1 and the blue channel to Band_2.
g. Aerial imagery can also be added as an ESRI basemap. Go to the plus sign to add layers, select Add Basemap, select Imagery, and then Add.
h. 2014 imagery from Google: To add the services to ArcMap simply go to Add Data -> GIS Servers then choose Add WMTS Server or Add WMS Server depending on your choice.
WMTS link:
https://discover.agrc.utah.gov/wmts/1.0.0/WMTSCapabilities.xml
WMS link:
https://discover.agrc.utah.gov/wms

2) Hydrology

a. **Major Streams:** URAP2014\URAP2014.gdb\majorWeberFlowlines File of major flowline features in the Weber River watershed. This data was taken from USGS National Hydrography Dataset (NHD) with some additional lines and attribution added and may frequently be inaccurate in the vicinity of Great Salt Lake. The Name field may be useful when referring to features.
b. **All Streams:** URAP2014\NHDH1602_20140529.gdb\Hydrography\NHDFlowline File of all mapped flowlines in the Weber watershed from NHD.
c. **GSL Streams:** UGGP.UGGPADMIN.GreatSaltLake\UGGP.UGGPADMIN.GSL_LiDAR_FlowPath Flowlines mapped around Great Salt Lake by UGS.
d. **Lakes:** URAP2014\NHDH1602_20140529.gdb\Hydrography\NHDWaterbody Polygon file with lakes, reservoirs, pond, etc. mapped by NHD.
e. **Watershed boundaries:** URAP2014\NHDH1602_20140529.gdb\WBD Watershed boundaries are shown at different scales. The WBDHU6 file is the entire Weber River watershed and WBDHU12 is the finest-scale watershed data available. The boundaries should generally show all the area that drains on the surface to the outlet of a watershed.
f. **Statewide NHD data:** statewideReference\NHDH_UT_20140529.gdb The lakes, watersheds, and flowlines can be found following a similar path to that outlined above
g. **Points of diversion:** URAP2014\URAP2014.gdb\pointsOfDiversion Points indicating the approximate location where water is diverted. Features with an A in the SUMMARY_ST field have been approved for diversion, but may or may not have been constructed yet. The SOURCE field helps indicate where the source of water for diversion is coming from. Information in the CFS and ACFT column generally indicate how much water is allowed to be diverted, but the amount of water can be aggregated over several points in a group so this number can be deceptive. Type of diversions are as follows:
   i. DRAIN: Excess collection/control system (surface or groundwater) from which a point of diversion maybe established.

ii. POINT TO POINT: Point To Point diversions are not developed points of diversion. The reference is to a stream segment from which stock may drink. Often designated in 40 acre parcels.
iii. REDIVERSION: Diversion point, which diverts water which was previously diverted and released upstream. Usually associated with reservoir storage.
iv. RETURN: Point where water that has been non-consumptively used is returned back to the natural stream.
v. SPRING: Concentrated discharge of ground water coming out at the surface as flowing water.
vi. SURFACE: Streams, rivers, creeks, any water above ground.
vii. UNDERGROUND: Wells, tunnels, sumps, and underground drains.

3) **Elevation**
   a. **GSL Elevation (1 m resolution):** L:\GEOSHARE\Elevation\DEM1m\LiDAR.gdb\GSLDEM
   b. **Statewide elevation (10 m resolution):** DEM\10m_DEM_Utah_Extended.tif
4) **Ownership and management information**
   a. **Management Units:** UGGP.UGGPADMIN.Wildlife.GSLOwnership
   b. **General Land Ownership Information:** statewideReference\landOwnership\LandOwnership.gdb\LandOwnership_20140423 Private land owner specific information not available.
5) **Stressors**
   a. **Grazing Allotments:** SGID10.FARMING.GrazingAllotments Allotments on both BLM and Forest Service Land; also, under statewideReference\landCoverLandUse\BLMGrazingAllotments_091113.gdb for more BLM-only allotments with additional meta-data.
   b. **Roads:** statewideReference\roads\AGRC_Roads_20140401.gdb\Roads for statewide roads, statewideReference\roads\USFS_TransportationRoadCoreFS_20130215.gdb\TransporationRoadCoreFS_20130215 for Forest Service-only roads (which are mostly duplicated in the statewide layer, but may contain some unique roads).
   c. **Trails in the Forest Service:** statewideReference\roads\Trails_UintaWasatchCacheNF.shp.
   d. **Mapped water related land use data:** UDNR.WRE.WeberRiverLU2007.
   e. **2011 modelled land cover data:** statewideReference\landCoverLandUse\nlcd_2011_landcover_2011_edition_2014_03_31_clipped.img.
   f. **Dams:** URAP2014\URAP2014.gdb\dams Locational information on dams is often incorrect. Use the DamType field to determine size of dam and Name field to determine likely location of dam if unclear in imagery.
   g. **Oil and gas wells:** URAP2014\URAP2014.gdb\oilGasWells. Field UGS_status shows whether feature is plugged and abandoned or (mostly) active. Mostly active features may be temporarily out of use, but not yet permanently removed. LA_PA_Date is the date that well was plugged and abandoned. Additional information on metadata for this file, including types of wells, is available for the statewide layer.

h. **Superfund Sites:** statewideReference\EPA_facilities\superfundPolygons.shp This file contains polygon features of the approximate location of Superfund sites in the Weber River watershed. Additional information about Superfund sites located near wetlands of interest can be found by searching for the Superfund site name under http://www2.epa.gov/region8/utah-cleanup-sites.

i. **Mines:** UDNR.OGM.MineralMines Use the field Status to determine whether or not a mine is Active or Retired. Some mines that are shown as Active may not show any surface disturbance. These mines may either be underground mines, or the mine permit may be processed but the mine not yet active (mine_stat field may say PRO).

j. **Water quality assessment units:** map server (where aerial imagery is) under SurfaceWaterQuality. Units are probably from 2010 report so may not always line up with the latest integrated report.

k. **Point source discharge permits (UPDES facilities):** statewideReference\EPA_facilities\UPDESfacilities_05092013_UTM.shp The field Permit_Typ indicates whether feature is considered “major” by the EPA. Major municipal dischargers include all facilities with design flows of greater than one million gallons per day and facilities with EPA/State approved industrial pretreatment programs. Major industrial facilities are determined based on specific ratings criteria developed by the EPA/State. MainType indicates the particular type of discharge permit received by a facility. Storm water-construction permits will often be fairly minor and temporary in nature and can be ignored. Definition of categories of dischargers follow:
    i. Biosolids - Biosolids are the nutrient-rich organic materials resulting from the treatment of sewage sludge.
    ii. Concentrated Animal Feeding Operation (CAFO) - CAFOs are animal feeding operations where there are more than 1,000 animal units.
    iii. Publicly Owned Treatment Works (POTW) - Any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of a liquid nature.
    iv. Storm Water - Construction – Permits associated with construction activities.
    v. Storm Water - Industrial - Permit requirements associated with non-construction activities at industrial facilities.
    vi. Storm Water - Medium/Large Municipal Separate Storm Sewer System (MS4s).
    vii. Storm Water - Small Municipal Separate Storm Sewer System (MS4s).
    viii. Blank (e.g., Standard-only) - A standard-issued individual NPDES permit without any additional permit components.

Appendix B:

Office evaluation field form

Site ID:________________

FEATURES TO VERIFY IN THE FIELD (mark on maps and make comment on question)

Verif-ied?	**ID**	**Description**
		`

Soil Survey Data

Map Unit Name: ____ Slope:_____________________________
Percent of AA: _______ Hydric Rating: ________ Drainage Class: _______________________________________
Depth to Water Table: _____________________________ Flooding Frequency: ___________________________

Map Unit Name: ____ Slope:_____________________________
Percent of AA: _______ Hydric Rating: ________ Drainage Class: _______________________________________
Depth to Water Table: _____________________________ Flooding Frequency: ___________________________

Map Unit Name: ____ Slope:_____________________________
Percent of AA: _______ Hydric Rating: ________ Drainage Class: _______________________________________
Depth to Water Table: _____________________________ Flooding Frequency: ___________________________

Sources of Site Hydrology	**Field Verified? Yes No**

Controls on Site Hydropattern

Within 200 m?	**Stressor**	**Severity, or N if trace/not present**	**Notes**
Y N	Control structures that regulate inflow into AA (e.g., dams, gates, stop logs, etc.)	N L M H	
Y N	Control structures that regulate outflow from AA	N L M H	
Y N	Impounding dam, dike, levee, weir, berm, road fill affecting outflow from AA (make note or circle feature(s) present)	N L M H	
Y N	Dam, dike, levee, weir, berm, road fill that blocks water to AA	N L M H	
Y N	Ditches or modified channels feeding AA	N L M H	
Y N	Ditches, drain tiles increasing outflow from AA	N L M H	
Y N	Pavement and other impervious surface in contributing area	N L M H	
Y N	Irrigation return flows	N L M H	
Y N	Upgradient water withdrawal (surfaced, ground)	N L M H	
Y N	Other:__________________________________	N L M H	

Site ID:__________

Potential Stressors to Water Quality

Stressor	Severity within 2 km of site	Severity in shed	Shed distance evaluated (km)
Severity: N: Extent none or trace, L: low severity or <20% of area, M: moderate severity or 20-60% of area; H: high severity or >60% of land cover Evaluate based on percent of area for features in italics; otherwise evaluate based on density and proximity of the stressors			
Developed land and other impervious surface with high likelihood of run-off	N L M H	N L M H	
Cropland (potential sources of pesticides, fertilizers, sediment)	N L M H	N L M H	
Livestock grazing (pastures, rangeland, not animal feeding operations)	N L M H	N L M H	
Facilities listed as "Major" in the UPDES program. **List types (#):**	N L M H	N L M H	
Non-major UPDES CAFO permittees	N L M H	N L M H	
Non-major UPDES biosolid and POTW permittees	N L M H	N L M H	
Non-major UPDES industrial stormwater permittees	N L M H	N L M H	
Non-major UPDES municipal separate storm sewer system (MS4) permittees	N L M H	N L M H	
Presence of Superfund sites or other sites with known groundwater or surface water contamination **List sites:**	N L M H	N L M H	
Oil and gas extraction, mines	N L M H	N L M H	
Large sources of sediment (visible in imagery and close to water sources) not from features listed above, such as from timber harvest, landslides, dirt roads, fires, construction, off-road vehicles, mining, gas/oil extraction. **List sources:**	N L M H	N L M H	
Notes on water quality stressors:			

Data on 303(d) assessment

Assessment Unit (AU) ID (e.g., UT16020102-019): ____

Report Year:________ Category: *1 2 3 4 5 Impaired Lake* Sub-Category:________________________________

Circle impairment(s): *NONE OE bio./invert E. coli DO total P TDS other(s):*__________________________

Is AU water quality likely connected to wetland water quality? Yes:_____ No:_____

Explain____

Adjacent AU(s) IDs (if likely to contribute water): ____

Report Year:________ Category: *1 2 3 4 5 Impaired Lake* Sub-Category:________________________________

Circle impairment(s): *NONE OE bio./invert E. coli DO total P TDS other(s):*__________________________

Notes on adjacent AU(s), including distance to site:____

____

Appendix C.

URAP User's Manual, Version 1.0

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

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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 m^2 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

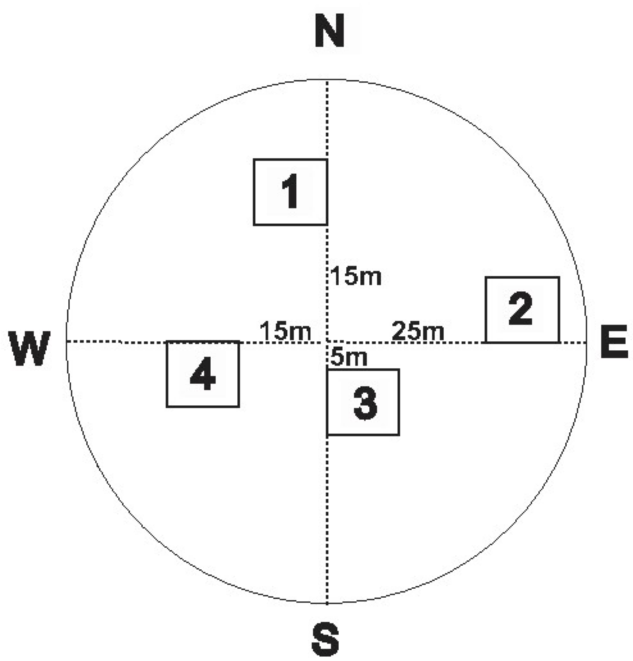

Figure 1. Level 3 plot layout for standard 0.5 hectare circular plot.

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.

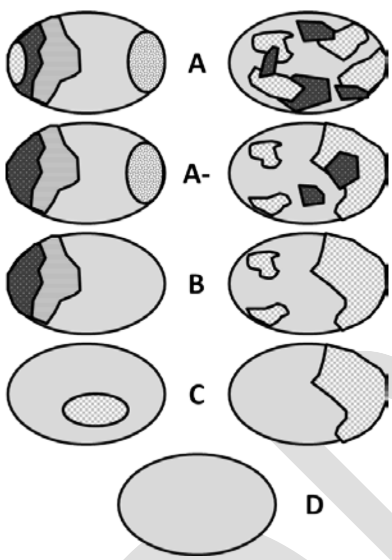

Figure 2. Diagram for rating horizontal interspersion.

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)

Paperwork In Folder (one folder per crew)

- 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

Group Field Gear

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

Suggested Plant Identification Aids

- 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

Individual Field Gear

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.

[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:

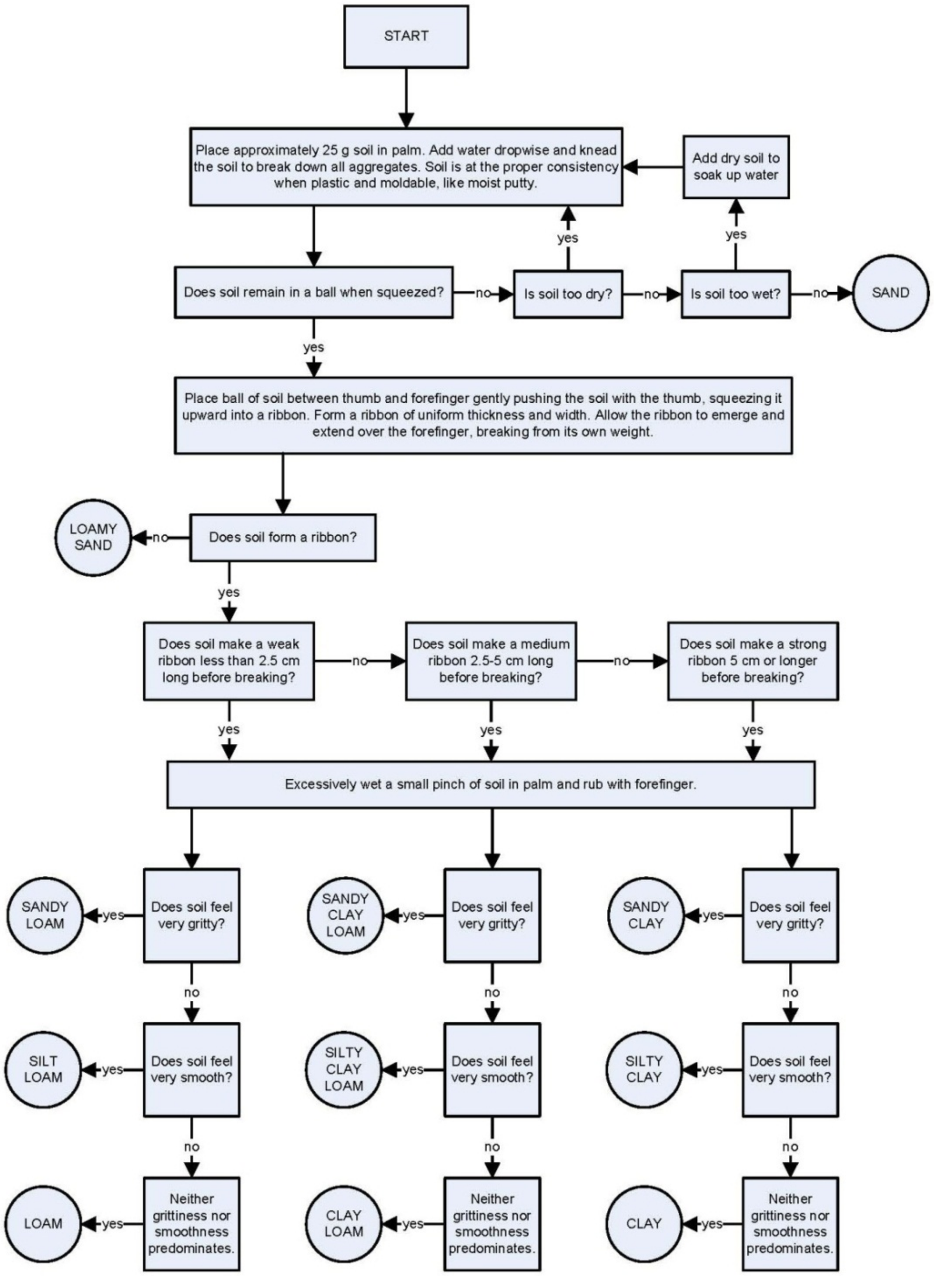
1. Determine strata (vegetation layers) present in the area. Strata include trees (DBH ≥7.6 cm), saplings and shrubs (DBH < 7.6 cm), herbaceous plants, and woody vines.
2. Estimate the percent of the assessment area covered by each strata. For example, all tree species combined (including trunks and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

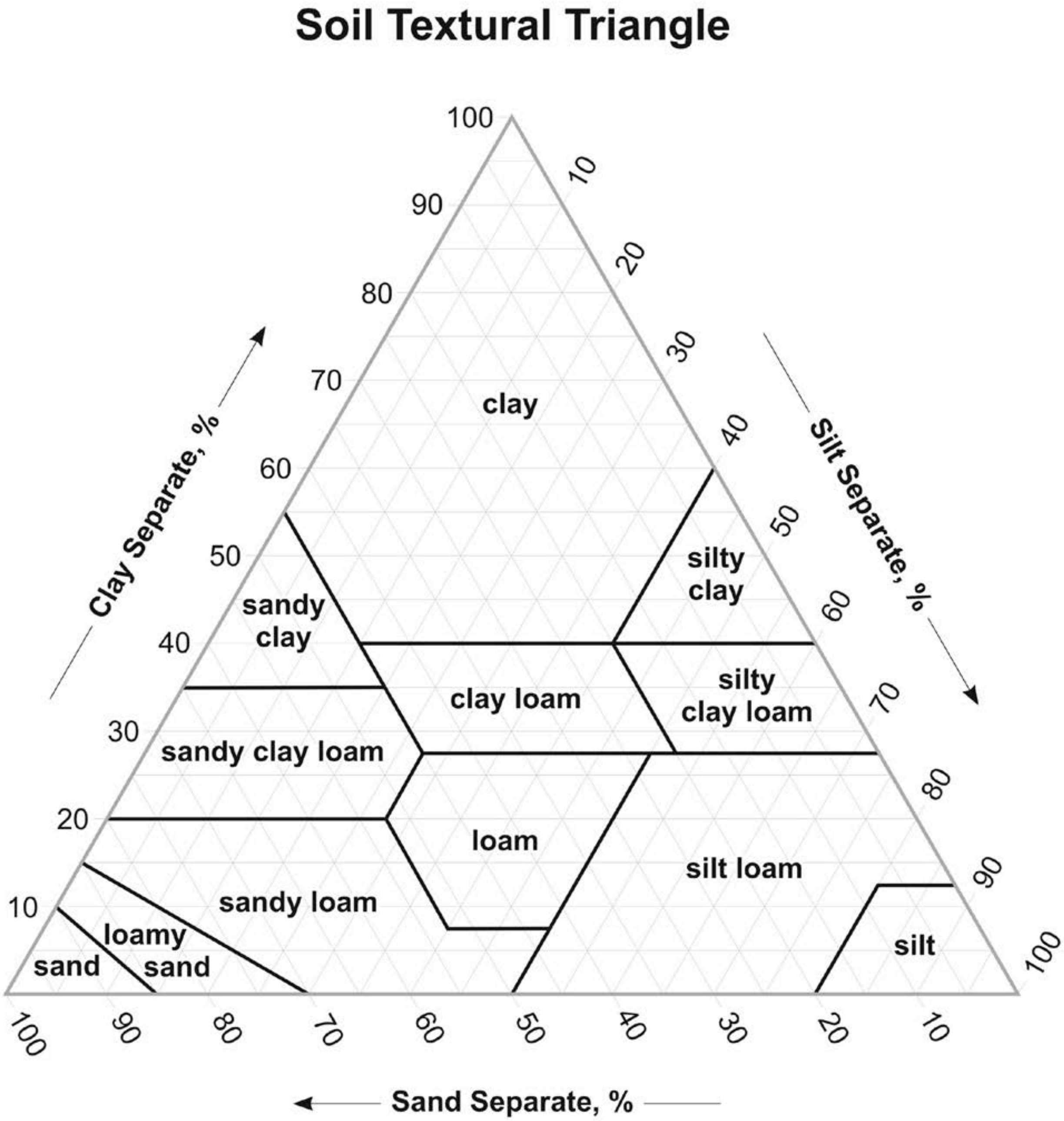
Presence of at least one primary (P) or two secondary (S) features indicates that site has wetland hydrology. Features in italics apply to only one region; indicators that begin with a single * apply to the Western Mountains region and those with ** apply to the Arid West region. *** under type refers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

All Soils – soils with any soil texture

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.

Sandy Soil Types 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.*

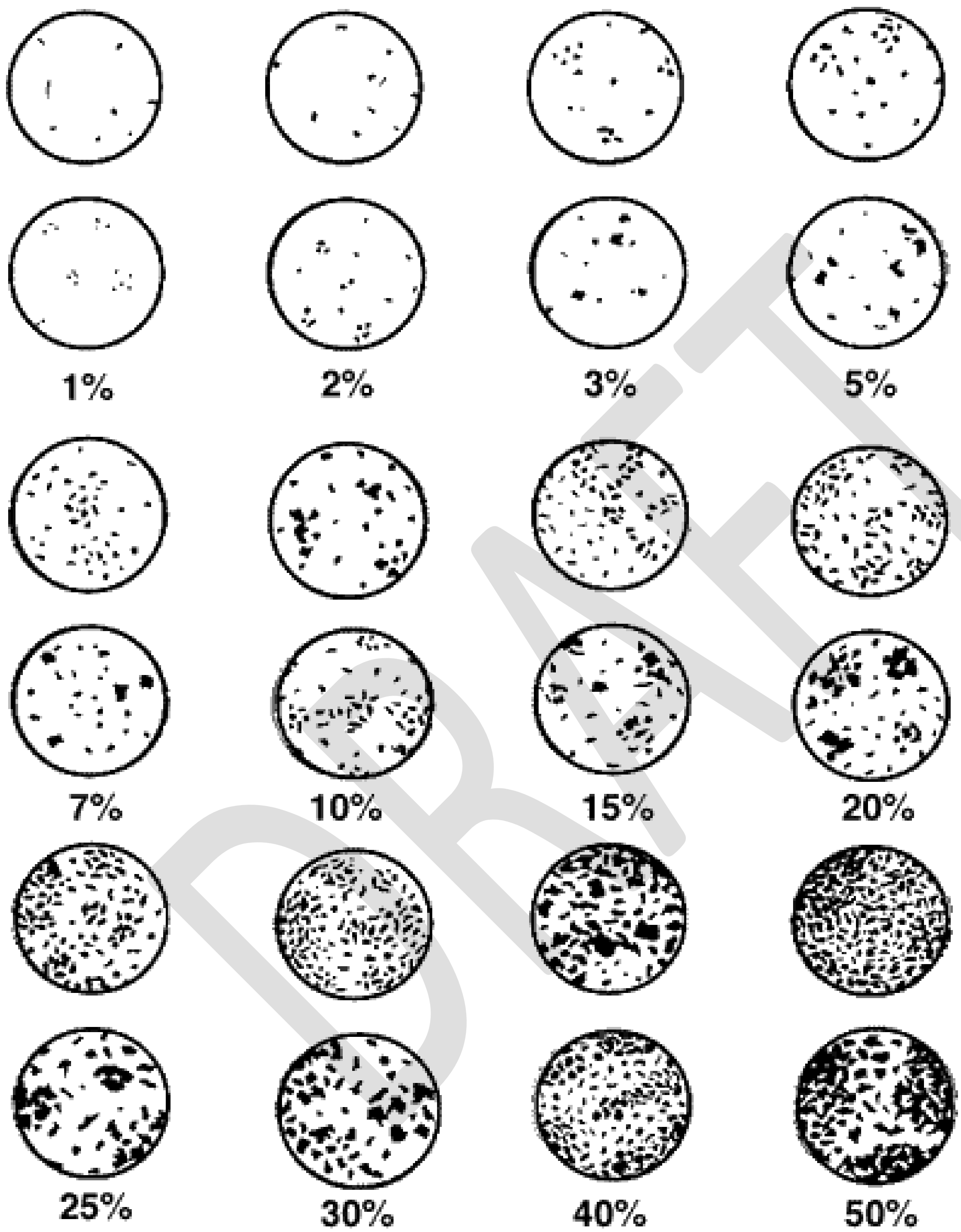
****F6.Redox Dark Surface (dark surface with redox concentration):** A dark surface layer with **redox concentrations.** Depth and location: **≥10cm** thick entirely **within 30cm of** the mineral soil. Matrix color and redox features: matrix value ≤ 3 and chroma≤ 1 with ≥ 2% distinct, prominent redox 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.*

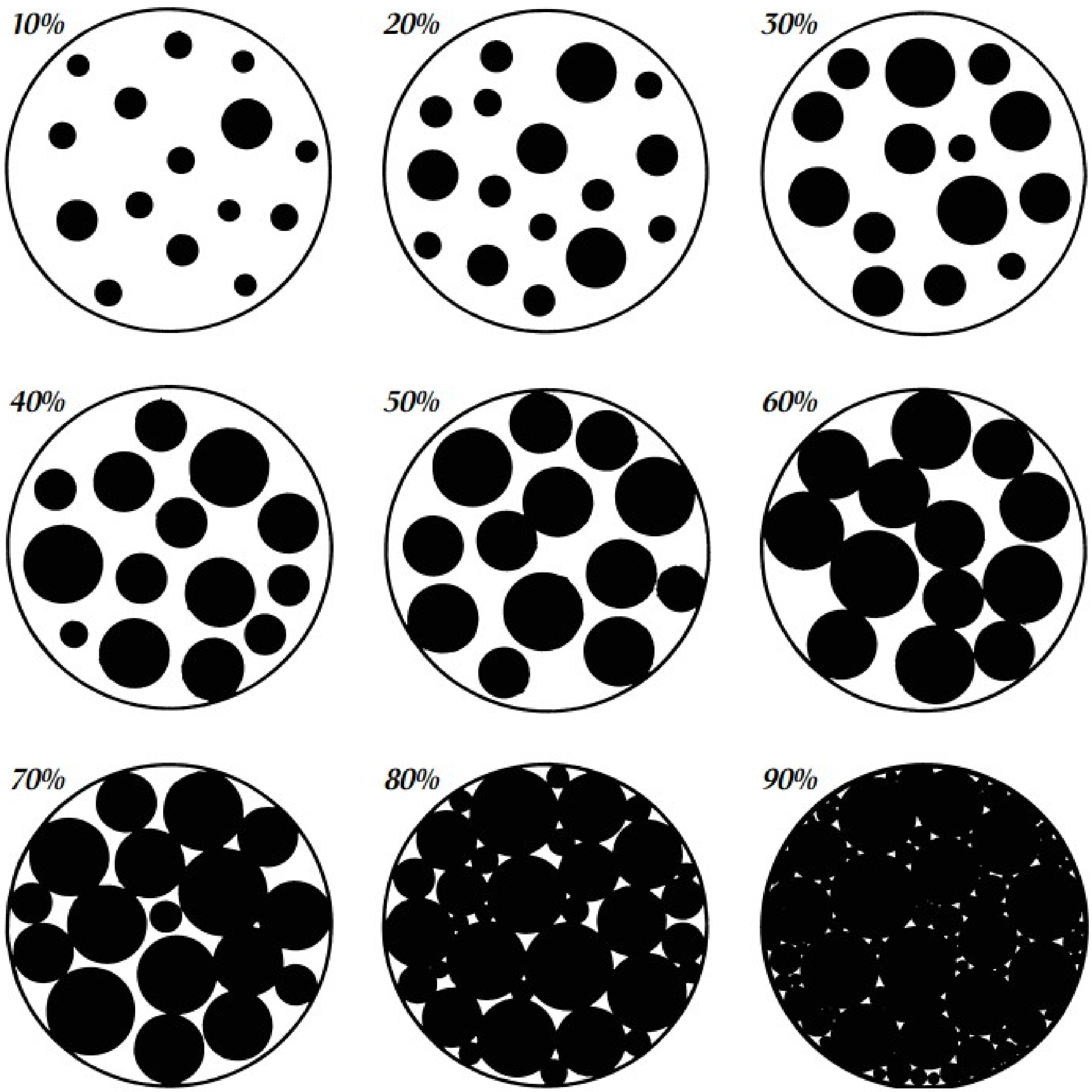
***F9. Vernal Pools:** In closed depressions that are subject to ponding, presence of a depleted matrix with ≥60%, chroma of ≤2 in a layer 5 cm thick entirely within the upper 15 cm of the soil.

Plant Cover Reference Cards[9]



Plant Cover Reference Card[10]

[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	Severity: Hydroperiod	Severity: Water Contaminates Nutrients / toxins	Severity: Sedimentation	Severity: Vegetation Stress
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:

<table>
<tr><th colspan="2">Timing of Inundation</th></tr>
<tr><th>Rank</th><th>State</th></tr>
<tr><td>A</td><td>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.</td></tr>
<tr><td>B</td><td>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</td></tr>
<tr><td>C</td><td>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</td></tr>
<tr><td>C-</td><td>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)</td></tr>
<tr><td>D</td><td>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</td></tr>
<tr><td>Flag</td><td>Comments:</td></tr>
</table>

<table>
<tr><th colspan="4">Algae Growth (Evaluate for wet sites whenever possible, can do both if site hydrology is very variable)</th></tr>
<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 in comments 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 in comments below).</td></tr>
<tr><td>Flag</td><td colspan="3">Comments:</td></tr>
</table>

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

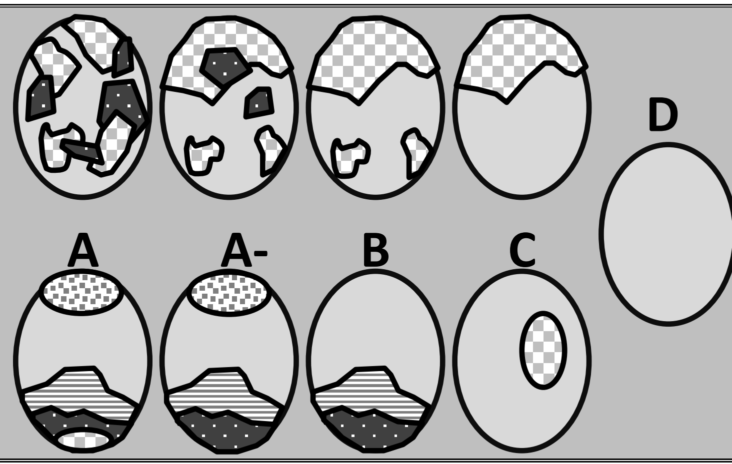
Substrate and Soil Disturbance (Evaluate in terms of the combination of severity and extent)

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 (m²)**	**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, <u>including under water, vegetation or litter cover</u>)					
Cover lichens (all cover, <u>including under water, vegetation or litter cover</u>)					
Cover algae(all cover, <u>including under water, vegetation or litter cover</u>)					
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:

V1.2 July 31, 2014

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 **$50\ m^2$ = 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										

V1.2 July 31, 2014

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)	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):

Appendix D.

Notes about Plant Species Data

Introduction

This appendix documents assumptions that were made regarding plant species' attributes and species' identifications.

Life Form and Species Duration

Life form and species duration information was obtained from the U.S. Department of Agriculture's PLANTS database. Species listed in the database as "subshrub, shrub" were coded as shrubs, species listed as "subshrub, forb, herb" were coded as forb, and species listed as "tree, shrub" were coded as either tree or shrub based on surveyor experience with the species in the field. All undetermined species were still coded as a life form type based on surveyor notes and listed genera. The final list of life forms used in the analysis is shown in table D1. For species duration, species listed as "annual, biennial", "annual, biennial, perennial", and "biennial, perennial" in the PLANTS database were all coded as biennial and species listed as "annual, perennial" were coded as perennial. Whenever possible, species identified only to genus were coded with duration if all possible or all likely members of the genus in Utah or the study area were a particular duration.

Table D1. Life form codes used for species and number of unique species coded as particular life form type.

Life Form	Number of unique species
Aquatic	1
Aquatic emergent	11
Aquatic floating	2
Aquatic submerged	12
Forb	287
Graminoid	155
Vine	8
Woody	1
Woody shrub	46
Woody tree	20

Assignment of C-Values

C -values for the state of Utah were derived by taking the mean of values available in Colorado, Montana, and Washington. Values were rounded to the nearest whole number, with values ending in 0.5 rounding up to the nearest whole number. In most cases, species were only identified to the species level, though C-values were sometimes listed only for particular subspecies or varieties. If a subspecies or variety was the only one located in Utah or all subspecies or varieties of a species had the same C-value, than that C-value was assumed to apply at the species level as well. In some cases, we also looked further into whether subspecies were present throughout Utah or only in a particular region in order to determine which, if any, C-value was appropriate to use. If a species were assigned a C-value of 0 for one state, but was considered native in Utah, we only took the mean of the C-values where the species was considered native. All species native to Utah were given a C-value greater than zero or left blank and all Utah non-native species were given a value of 0. Nineteen species were missing C-values, including one species found at three sites and five species found at two sites. Most of these species had less than 1% cover at all sites and all had 3% or less cover.

Species Identified Only to Genus

Some species identified only to the genera level were still assigned species attribute information, such as nativity, C-value, and wetland indicator status. First, we identified those genera that could be reliably identified to the genus level in the field, based on surveyor opinion and on determining the accuracy of specimen determinations to the genera level. Next, for each reliable genus, we determined all possible and all likely species for that genus in Utah and the study area. Last, we determined whether the list of possible or likely species all had similar or the same values for the nativity, C-value, and wetland indicator status attributes. For example, all species in the *Callitriche* genus known to Utah are native and obligate with a C-value of either 5 or 6. See table D2 for a list of the values that were used for the reliable genera.

Missing Data

At most sites, at least 80% of species by number and by cover was of known nativity with assigned C-values. Over 20% of species by number had unknown nativity and unknown C-values at four sites, including three sites in the Foothills stratum and one site in the Valleys stratum. However, these four sites had 94% or more species *by cover* with known nativity and C-values. Three additional sites, including one Montane Zone and three Wetlands, had less than 80% of species by number with known C-values, but over 80% of species by number with known nativity and over 80% of species by cover with known nativity and C-values. Four sites had between 21 and 34% of species' cover with unknown nativity and unknown C-values, but all four had 84% or more species *by number* with known values. These sites included three in the Montane Zone and one in the Uintas.

Additional Notes about Individual Species and Genera

- *Atriplex*: Annual *Atriplex* species were collected at 12 sites around Great Salt Lake and at one site in the Foothills stratum. There are three similar-looking annual *Atriplex* species that are likely to be found around Great Salt Lake, based on examination of plant keys and consultation with an unpublished draft guide to Great Salt Lake wetland plants. These species include the native species *A. dioica* and the introduced species *A. micrantha* and *A. prostrata* (*A. prostrata* is listed as native in the PLANTS database, but introduced in *Flora of North America*). *A. micrantha* can be easily distinguished from the other two species when in fruit whereas the other two species are primarily separated based on leaf characteristics that are often difficult to determine. All specimen were identified as either *A. micrantha* or *A. prostrata* based on fruit characteristics when available and on leaf characteristics, though misidentification of fruitless specimen is possible.
- *Castilleja*: Some species recorded as *C. miniata* at high elevation may have been *C. rhexifolia*, but specimen of *Castilleja* were generally not collected so the identification cannot be verified. *Castilleja* identifications for records without specimen data were not changed in the database. Both species are native with similar C-values.

- *Ligusticum tenuifolium:* We updated all species' records listed as *Conioseliunum scopulorum* to *L. tenuifolium* because we found that collections of *L. tenuifolium* were consistently misidentified as *C. scopulorum*.
- *Mimulus*: It was difficult to distinguish between *M. guttatus* and *M. glabrata*. Specimen that could be either of these two species were all identified as *M. guttatus*.
- *Phragmites australis* : All *P. australis* seen on the edge of Great Salt Lake was assumed to be the non-native subspecies *P. australis* ssp. *australis*. At other locations where the species was recorded, it was treated as a non-native noxious weed, but the species name in the database was left with the binomial level of determination.
- *Platanthera aquilonis*: All specimens in this genus were identified as *P. aquilonis*, even though in some cases it was difficult to distinguish this species from *P. sparsifolia*. The difference between the two species is based on the size of the column, but this was sometimes difficult to measure in dried flowers.
- *Poa pratensis: P. pratensis* was considered introduced though it is listed as both native and introduced in the PLANTS database because the only likely subspecies known to Utah is introduced.
- *Polygonum*: In 2013, flower and fruit samples from specimen of *Polygonum* sect. *Polygonum* from were sent to Mihai Costea, associate professor and herbarium curator at Wilfrid Laurier University, to assist with identification. According to the online Flora of North America, there are three members of the section known from Utah, including *P. ramosissimum, P. aviculare*, and *P. argyrocoleon*. Most specimen from around Great Salt Lake were identified as either *P. patulum,* an uncommon introduced species that has been found in several states in North America, or an unusual form of the native species, *P. ramosissimum,* with tubercled achenes, which has been recorded in salt-marshes of California, though two of the specimens were identified as *P. aviculare*. There are collections of *P. ramosissimum* from as early as the late 1800s in the vicinity of Great Salt Lake (http://intermountainbiota.org), which indicates that this species (or a similar, but misidentified species) is most likely native to Great Salt Lake. In 2013, we decided to call the *P. ramosissiumum/patulum* specimen *P. ramosissimum* based on the assumption that it is more likely that this native species still persists than that an uncommon new introduced species has become very common around Great Salt Lake. For the Weber watershed project, Great Salt Lake specimen in this section of *Polygonum* were all identified as *P. ramosissiumum*, in large part due to comparison with last years' specimen and Costea 2013 identifications. Only two specimens in sect. *Polygonum* were located outside of the Great Salt Lake region; these were both identified as *P. aviculare.*
- *Rubus idaeaus: R. idaeaus* was assumed to be the native subspecies.
- *Vicia americana:* After examination of all similar specimen, it was determined that specimen identified as either *Vicia* or *Lathyrus* that were not in flower or fruit were *V. americana*. Identification was based on likely species in the area, lack of hair on the stem (likely candidate *Lathyrus* species would have some hairs), and comparison of stipule and other attributes with known specimen. As further justification for making this assumption, the most likely *Lathyrus* species in the study area, *L. lanszwertii*, has a similar C-value to *V. americana*.
- *Viola*: *Viola* specimen were identified based on leaf shape and arrangement of fruit whenever possible when flowers were not available.

Table D2. Genera assigned nativity, C-value, and/or wetland indicator status, with notes on how status was assigned. Updates were based on both variation within the genus, ability to correctly ID genus, and degree to which missing data impacted analysis

Genus	Nativity	C-Value	Wetland Indicator		Justification
			Arid West	Western Mtns.	
Abies	Native	4			All Utah species are native with C-value either 4 or 5
Antennaria	Native	5			All likely species are native with C-value of 5 or 6
Atriplex	Introduced	0			Nativity and C-value based on assumption that species are either *Atriplex prostrata* or *A. micrantha*, the only two identified herbaceous *Atriplex* species collected
Callitriche	Native	5	OBL	OBL	All Utah species native and OBL, with C-value of either 5 or 6
Dodecatheon	Native		FACW	FACW	All Utah species native and all likely species FACW
Eleocharis	Native	5	OBL	OBL	All likely species native and OBL with C-value of 4 or 6 (*E. palustris* and *E. quinqueflora* most likely species)
Epilobium	Native				All Utah species native
Maianthemum	Native	6		FAC	All Utah species native with C-value 6 and FAC in WMVC
Myriophyllum			OBL	OBL	All Utah species OBL
Picea	Native			FAC	All Utah species native and FAC in WMVC
Polemonium	Native				All Utah species native
Potamogeton			OBL	OBL	All Utah species OBL
Schedonorus	Introduced	0	FACU		All Utah species introduced and FACU in arid west
Sonchus	Introduced	0			All Utah species introduced with C-value of 0
Symphyotrichum	Native	5			Species recorded in the field for the Weber project as either *S. foliaceum* or *S. spathulatum.* Species are both native with C-value of 5
Tamarix	Introduced	0			All Utah species introduced with C-value of 0
Thalictrum	Native				All Utah species native
Triglochin	Native	6	OBL	OBL	All Utah species native, OBL, and with C-value of 6 or 7
Typha	Native	2	OBL	OBL	All Utah species native (except hybrid which would be very unlikely), OBL, with C-value of 2 or 3

Appendix E.

Table of Plant Species Listed in Report

Table E-1.Plant species referenced in report, with species' attributes, sorted by scientific name.

Family	Scientific Name	Common Name	Nativity	Growth Form	Duration	C-value	Wetland Indicator Ratings	
							Arid West	Western Mountains
Asteraceae	Achillea millefolium	common yarrow	Native	forb	Perennial	3	FACU	FACU
Ranunculaceae	Aconitum columbianum	Columbian monkshood	Native	forb	Perennial	6	FACW	FACW
Asteraceae	Agoseris glauca	pale agoseris	Native	forb	Perennial	5	FAC	UPL
Poaceae	Agrostis gigantea	redtop	Introduced	graminoid	Perennial	0	FACW	FAC
Poaceae	Agrostis stolonifera	creeping bentgrass	Introduced	graminoid	Perennial	0	FACW	FAC
Poaceae	Alopecurus pratensis	meadow foxtail	Introduced	graminoid	Perennial	0	FACW	FAC
Asteraceae	Anthemis cotula	stinking chamomile	Introduced	forb	Annual	0	FACU	FACU
Asteraceae	Arctium lappa	greater burdock	Introduced	forb	Biennial	0		
Asteraceae	Arctium minus	lesser burdock	Introduced	forb	Biennial	0	FACU	UPL
Rosaceae	Argentina anserina	silverweed cinquefoil	Native	forb	Perennial	3	OBL	OBL
Asteraceae	Arnica cordifolia	heartleaf arnica	Native	forb	Perennial	6		
Chenopodiaceae	Atriplex micrantha	twoscale saltbush	Introduced	forb	Annual	0		
Chenopodiaceae	Bassia hyssopifolia	fivehorn smotherweed	Introduced	forb	Annual	0	FAC	FACW
Poaceae	Bromus tectorum	cheatgrass	Introduced	graminoid	Annual	0		
Poaceae	Calamagrostis canadensis	bluejoint	Native	graminoid	Perennial	5	FACW	FACW
Ranunculaceae	Caltha leptosepala	white marsh marigold	Native	forb	Perennial	6	OBL	OBL
Brassicaceae	Cardaria draba	whitetop	Introduced	forb	Perennial	0		
Asteraceae	Carduus nutans	nodding plumeless thistle	Introduced	forb	Biennial	0	FACU	UPL
Cyperaceae	Carex microptera	smallwing sedge	Native	graminoid	Perennial	4	FAC	FACU
Cyperaceae	Carex nebrascensis	Nebraska sedge	Native	graminoid	Perennial	5	OBL	OBL
Cyperaceae	Carex praegracilis	clustered field sedge	Native	graminoid	Perennial	4	FACW	FACW
Cyperaceae	Carex utriculata	Northwest Territory sedge	Native	graminoid	Perennial	4	OBL	OBL
Asteraceae	Cichorium intybus	chicory	Introduced	forb	Biennial	0	FACU	FACU
Apiaceae	Cicuta maculata	spotted water hemlock	Native	forb	Biennial	3	OBL	OBL
Asteraceae	Cirsium arvense	Canada thistle	Introduced	forb	Perennial	0	FACU	FAC

Family	Scientific Name	Common Name	Nativity	Growth Form	Duration	C-value	Wetland Indicator Ratings	
							Arid West	Western Mountains
Asteraceae	Cirsium scariosum	meadow thistle	Native	forb	Biennial	6	FAC	FAC
Asteraceae	Cirsium vulgare	bull thistle	Introduced	forb	Biennial	0	FACU	FACU
Cuscutaceae	Cuscuta	dodder		forb				
Boraginaceae	Cynoglossum officinale	gypsyflower	Introduced	forb	Biennial	0	FACU	FACU
Poaceae	Danthonia intermedia	timber oatgrass	Native	graminoid	Perennial	6	FACU	FACU
Poaceae	Deschampsia cespitosa	tufted hairgrass	Native	graminoid	Perennial	5	FACW	FACW
Dipsacaceae	Dipsacus fullonum	Fuller's teasel	Introduced	forb	Biennial	0	FAC	FAC
Poaceae	Distichlis spicata	saltgrass	Native	graminoid	Perennial	4	FAC	FACW
Poaceae	Echinochloa crus-galli	barnyard grass	Introduced	graminoid	Annual	0	FACW	FAC
Elaeagnaceae	Elaeagnus angustifolia	Russian olive	Introduced	woody tree	Perennial	0	FAC	FAC
Cyperaceae	Eleocharis palustris	common spikerush	Native	graminoid	Perennial	4	OBL	OBL
Poaceae	Elymus repens	quackgrass	Introduced	graminoid	Perennial	0	FAC	FAC
Onagraceae	Epilobium ciliatum	fringed willowherb	Native	forb	Perennial	3	FACW	FACW
Equisetaceae	Equisetum arvense	field horsetail	Native	forb	Perennial	3	FAC	FAC
Rubiaceae	Galium aparine	stickywilly	Native	forb vine	Annual	2	FACU	FACU
Geraniaceae	Geranium richardsonii	Richardson's geranium	Native	forb	Perennial	6	FACU	FAC
Rosaceae	Geum macrophyllum	largeleaf avens	Native	forb	Perennial	5	FACW	FAC
Poaceae	Hordeum brachyantherum	meadow barley	Native	graminoid	Perennial	4	FACW	FACW
Poaceae	Hordeum jubatum	foxtail barley	Native	graminoid	Perennial	2	FAC	FAC
Brassicaceae	Isatis tinctoria	Dyer's woad	Introduced	forb	Biennial	0		
Juncaceae	Juncus arcticus	arctic rush	Native	graminoid	Perennial	3	FACW	FACW
Juncaceae	Juncus mertensianus	Mertens' rush	Native	graminoid	Perennial	7	OBL	OBL
Juncaceae	Juncus saximontanus	Rocky Mountain rush	Native	graminoid	Perennial	6	FACW	FACW
Brassicaceae	Lepidium latifolium	broadleaved pepperweed	Introduced	forb	Perennial	0	FAC	FAC
Asteraceae	Leucanthemum vulgare	oxeye daisy	Introduced	forb	Perennial	0	UPL	FACU
Apiaceae	Ligusticum tenuifolium	Idaho licorice-root	Native	forb	Perennial	8	FACW	FACW
Asteraceae	Madia glomerata	mountain tarweed	Native	forb	Annual	1	FACU	FACU

Family	Scientific Name	Common Name	Nativity	Growth Form	Duration	C-value	Wetland Indicator Ratings	
							Arid West	Western Mountains
Scrophulariaceae	Mimulus guttatus	seep monkeyflower	Native	forb	Perennial	5	OBL	OBL
Scrophulariaceae	Pedicularis groenlandica	elephanthead lousewort	Native	forb	Perennial	7	OBL	OBL
Poaceae	Phalaris arundinacea	reed canarygrass	Introduced	graminoid	Perennial	0	FACW	FACW
Poaceae	Phleum alpinum	alpine timothy	Native	graminoid	Perennial	6	FAC	FAC
Poaceae	Phleum pratense	timothy	Introduced	graminoid	Perennial	0	FACU	FAC
Poaceae	Phragmites australis	common reed	Introduced/Native	graminoid	Perennial	0/3	FACW	FACW
Pinaceae	Pinus contorta	lodgepole pine	Native	woody tree	Perennial	4	FAC	FAC
Poaceae	Poa bulbosa	bulbous bluegrass	Introduced	graminoid	Perennial	0		
Poaceae	Poa pratensis	Kentucky bluegrass	Introduced	graminoid	Perennial	0	FAC	FAC
Poaceae	Poa trivialis	rough bluegrass	Introduced	graminoid	Perennial	0	FACW	FAC
Polygonaceae	Polygonum ramosissimum	bushy knotweed	Native	forb	Annual	2	FAC	FAC
Poaceae	Polypogon monspeliensis	annual rabbitsfoot grass	Introduced	graminoid	Annual	0	FACW	FACW
Potamogetonaceae	Potamogeton crispus	curly pondweed	Introduced	aquatic submerged	Perennial	0	OBL	OBL
Rosaceae	Potentilla diversifolia	varileaf cinquefoil	Native	forb	Perennial	5	FACU	FACU
Poaceae	Puccinellia distans	weeping alkaligrass	Introduced	graminoid	Perennial	0	FACW	FACW
Asteraceae	Rudbeckia occidentalis	western coneflower	Native	forb	Perennial	6	FAC	FAC
Polygonaceae	Rumex crispus	curly dock	Introduced	forb	Perennial	0	FAC	FAC
Chenopodiaceae	Salicornia rubra	red swampfire	Native	forb	Annual	5	OBL	OBL
Cyperaceae	Schoenoplectus acutus	hardstem bulrush	Native	graminoid	Perennial	5	OBL	OBL
Cyperaceae	Schoenoplectus pungens	common threesquare	Native	graminoid	Perennial	5	OBL	OBL
Brassicaceae	Sisymbrium altissimum	tall tumblemustard	Introduced	forb	Biennial	0	FACU	FACU
Caryophyllaceae	Spergularia maritima	media sandspurry	Introduced	forb	Perennial	0	FACW	FAC
Potamogetonaceae	Stuckenia pectinata	sago pondweed	Native	aquatic submerged	Perennial	3	OBL	OBL
Chenopodiaceae	Suaeda calceoliformis	Pursh seepweed	Native	forb	Perennial	3	FACW	FACW
Asteraceae	Symphyotrichum ascendens	western aster	Native	forb	Perennial	3	FAC	FACU
Asteraceae	Symphyotrichum eatonii	Eaton's aster	Native	forb	Perennial	6	FAC	FAC
Tamaricaceae	Tamarix	tamarisk	Introduced	woody tree	Perennial	0		

Family	Scientific Name	Common Name	Nativity	Growth Form	Duration	C-value	Wetland Indicator Ratings	
							Arid West	Western Mountains
Tamaricaceae	Tamarix chinensis	five-stamen tamarisk	Introduced	woody tree	Perennial	0	FAC	FAC
Asteraceae	Taraxacum officinale	common dandelion	Introduced	forb	Perennial	0	FACU	FACU
Poaceae	Thinopyrum ponticum	tall wheatgrass	Introduced	graminoid	Perennial	0		
Fabaceae	Trifolium fragiferum	strawberry clover	Introduced	forb	Perennial	0	FACU	FACU
Fabaceae	Trifolium pratense	red clover	Introduced	forb	Biennial	0	FACU	FACU
Fabaceae	Trifolium repens	white clover	Introduced	forb	Perennial	0	FACU	FAC
Typhaceae	Typha	cattail	Native	forb	Perennial	2	OBL	OBL
Urticaceae	Urtica dioica	stinging nettle	Native	forb	Perennial	3	FAC	FAC
Liliaceae	Veratrum californicum	California false hellebore	Native	forb	Perennial	3	FACW	FAC
Scrophulariaceae	Verbascum thapsus	common mullein	Introduced	forb	Biennial	0	FACU	FACU