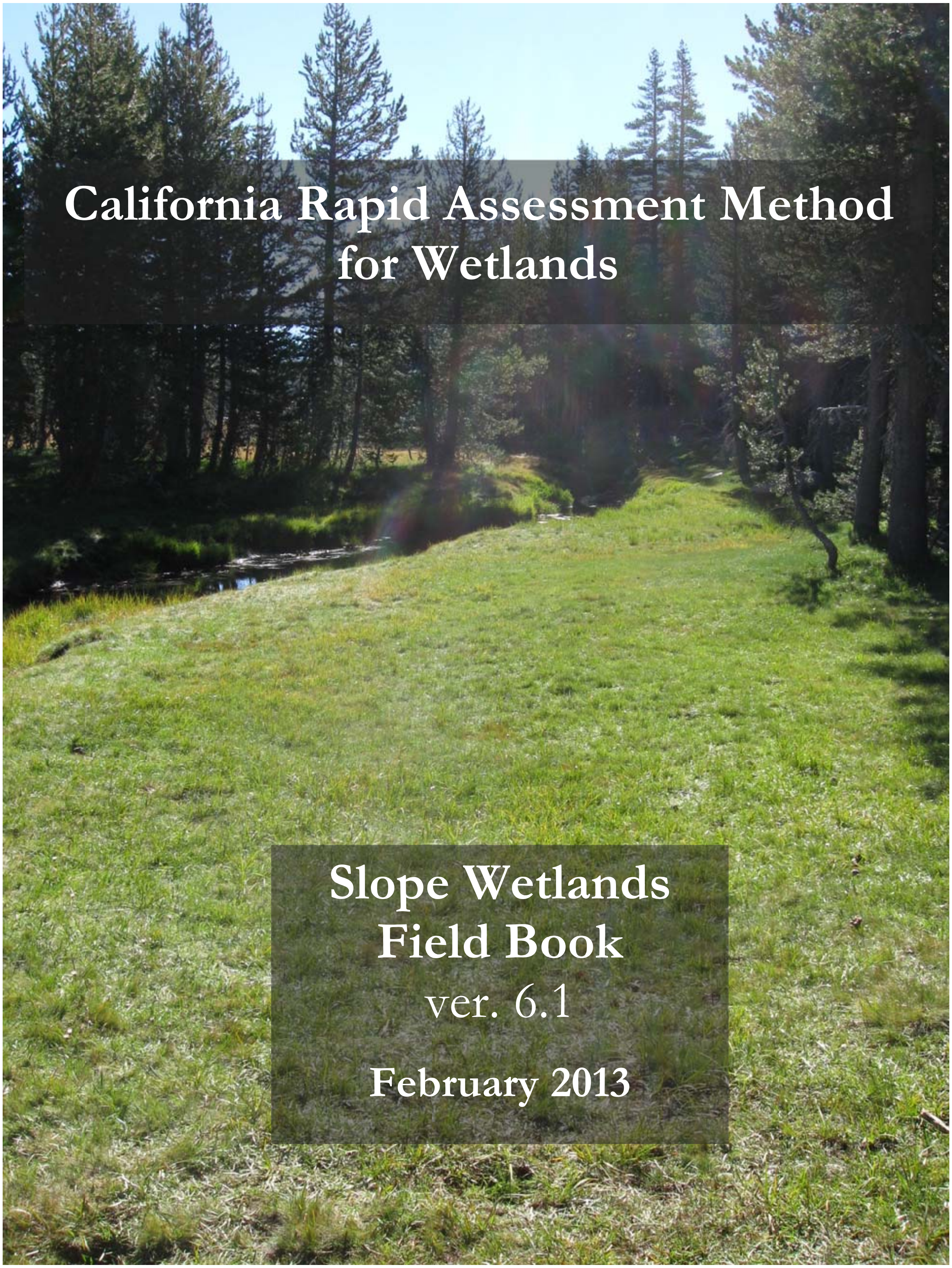
California Rapid Assessment Method for Wetlands



Slope Wetlands Field Book

ver. 6.1

February 2013

This Slope Wetlands Field Book, version 6.1, dated February 2013 is the most current version available (as of September 2014). This module has completed the Verification Phase of development, and will be further tested in the Validation Phase of development during the spring and summer of 2015. See additional notes on Page 5 for Field Book status.

Basic Information Sheet: Slope Wetlands

Assessment Area Name:	
Project Name:	
Assessment Area ID#:	
Project ID#:	**Date**
Assessment Team Members for This AA:	
Assessment Area Size:	
Surface water present during the assessment? □ Yes □ No **Flowing?**	
Briefly describe the hydrology of the AA (e.g., water sources, channels, swales, etc.)	
AA Category: □ Pre-Restoration □ Post-Restoration □ Pre-Mitigation □ Post-Mitigation □ Pre-Impact □ Post-Impact □ Ambient □ Reference □ Training □ Other:	
Which best describes the type of wetland? □ Channeled Wet Meadow (assoc. with a fluvial channel) □ Non-Channeled Wet Meadow □ Forested Slope □ Seep or Spring	
Are peat soils present in the AA? □ Yes □ No	
AA Encompasses: □ entire wetland □ portion of the wetland	
Which best describes the dominant hydrologic state of the AA at the time of assessment? □ ponded/inundated □ saturated soil, but no surface water □ moist □ dry	
What is the apparent hydrologic regime of the wetland? *Perennial* slope wetlands contain surface water year-round, *seasonal* slope wetlands support surface water for 4-11 months of the year (in > 5 out of 10 years.) *Temporarily flooded* slope wetlands possess surface water between 2 weeks and 4 months of the year. □ perennial □ seasonal □ temporarily flooded	

Photo Identification Numbers and Description:

	Photo ID No.	Description
1		Looking North into the AA
2		Looking South into the AA
3		Looking East into the AA
4		Looking West into the AA
5		
6		
7		
8		
9		
10		

Site Location Description (including County and USGS Topographic Quadrangle if known)**:**

Comments:

Scoring Sheet: Slope Wetlands

AA Name:				**Date**	
Attribute 1: Buffer and Landscape Context				**Comments**	
Aquatic Area Abundance Score (D)			Alpha	Numeric	
Buffer					
Buffer submetric A: Percent of AA with Buffer	Alpha	Numeric			
Buffer submetric B: Average Buffer Width					
Buffer submetric C: Buffer Condition					
Raw Attribute Score = $D+[C \times (A \times B)^{1/2}]^{1/2}$ (do not round)				**Final Attribute Score = (Raw Score/24) x 100**	
Attribute 2: Hydrology					
Water Source			Alpha	Numeric	
Hydroperiod					
Hydrologic Connectivity (all but Channeled)					
Hydro Connectivity submetric A: Bank Height Ratio	Alpha	Numeric			
Hydro Connectivity submetric B: Percent Dewatered					
Hydrologic Connectivity for Channeled (*avg. of submetrics A-B*)					
Raw Attribute Score = sum of numeric scores				**Final Attribute Score = (Raw Score/36) x 100**	
Attribute 3: Physical Structure					
Structural Patch Richness			Alpha	Numeric	
Topographic Complexity					
Raw Attribute Score = sum of numeric scores				**Final Attribute Score = (Raw Score/24) x 100**	
Attribute 4: Biotic Structure					
Plant Community Composition (submetric A is not applicable for Non-Channeled meadows)					
Plant Community submetric A: Number of plant layers	Alpha	Numeric			
Plant Community submetric B: Number of Co-dominant species					
Plant Community submetric C: Percent Invasive species					
Plant Community submetric D: Number of Encroachment groups					
Plant Comm. Composition *(avg. of submetrics A-D or B-D)*					
Horizontal Interspersion			Alpha	Numeric	
Plant Life Forms					
Raw Attribute Score = sum of numeric scores				**Final Attribute Score = (Raw Score/36) x 100**	
Overall AA Score (average of four final Attribute Scores)					

Identify Wetland Type

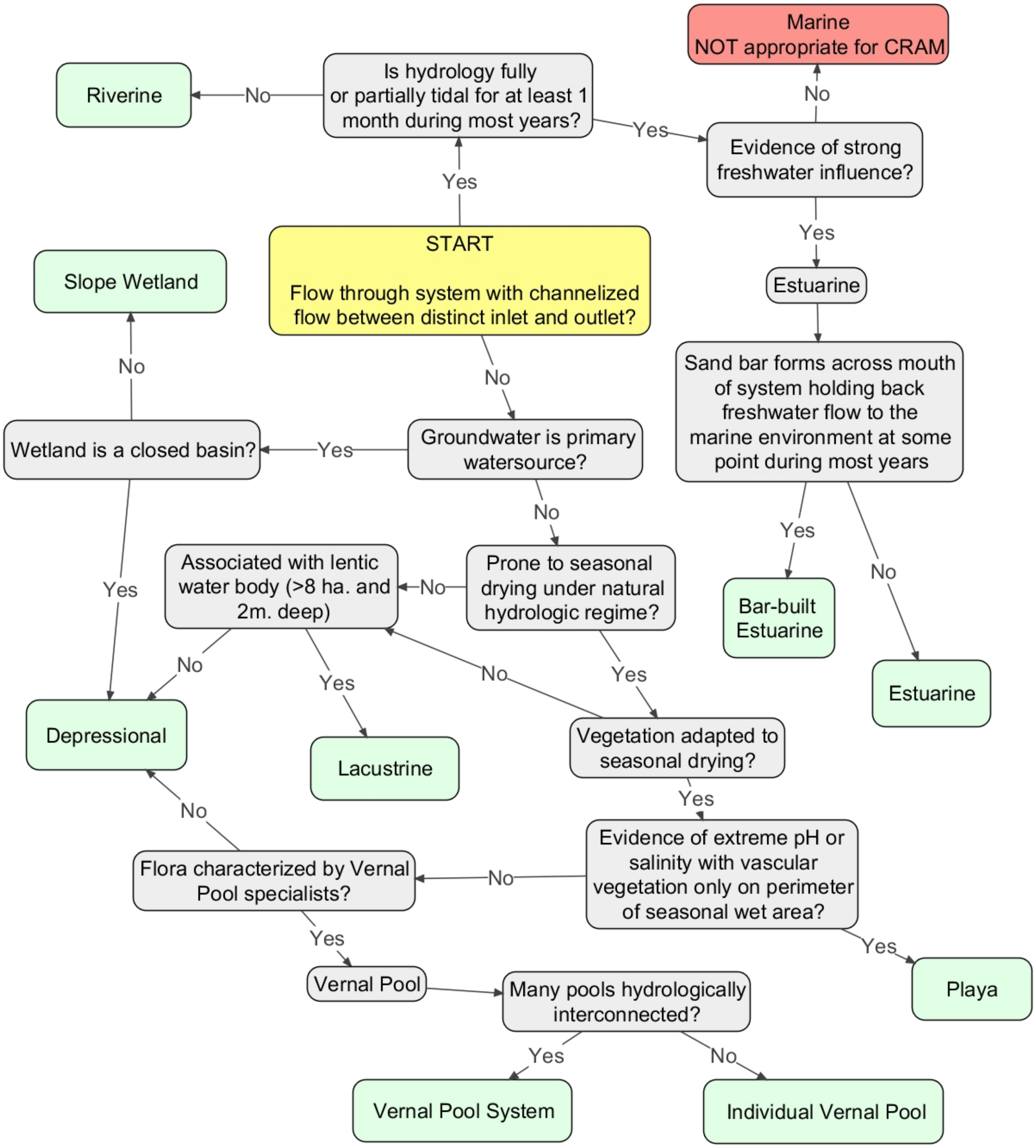


Figure 1: Flowchart to determine wetland type.

Slope Wetlands

Slope Wetland is a broad category of groundwater-dominated wetlands inclusive of wet meadows, forested slopes, seeps and springs sub-types. In these wetlands groundwater may emerge into the root zone or across the ground surface seasonally or perennially, but mainly has unidirectional flow. The term "slope" refers to the uni-directional flow of ground and surface water within the wetland, rather than to a geomorphic feature (e.g. hillslope, toe-slope).

The wetland sub-types are currently at different stages of development:

- Both the Channeled Wet Meadow and Non-Channeled Wet Meadow sub-types were included in the Verification Phase of module development during 2012. This fieldbook (February 2013) represents modifications made during field testing and module development through that phase. Field testing during 2012 was focused in the Sierra Nevada and Modoc regions, however the intent is that this fieldbook is appropriate for use statewide. Additional field testing in Summer 2013 in the Santa Rosa area, and in Spring 2014 in Central and Southern California confirmed that the information contained in this fieldbook for the Wet Meadow sub-type has completed the Verification phase of development and is ready for future testing in the Validation phase of development during Summer 2015.
- The Forested Slope wetland sub-type was NOT included in the Verification Phase of module development during 2012. In 2013 and 2014 a limited number of field sites were tested during the Verification Phase of development in Santa Rosa, and Central and Southern California. This fieldbook (February 2013) represents the currently best available information for conducting assessments in Forested Slope wetlands, however the practitioner should be aware that the module has only undergone very limited field testing at this time, and may experience future revisions as the formal development process proceeds.
- The Seeps and Springs wetland sub-type was NOT included in the Verification Phase of module development during 2012. In 2014 a limited number of field sites were tested during the Verification Phase of development in Central and Southern California. This fieldbook (February 2013) represents the currently best available information for conducting assessments in Seeps and Springs wetlands, however the practitioner should be aware that the module has only undergone very limited field testing at this time, and may experience future revisions as the formal development process proceeds.

Wet Meadow

Wet meadows depend on groundwater rising to the surface or into the root zone for a period of time long enough to create hydric soil conditions that supports wetland vegetation.

According to the existing CRAM classification system for wetlands, a wetland should be classified as wet meadow if it meets all four of the following requirements:

- The overall hydrology of the meadow that contains the AA is dominated by groundwater, rather than dominated by channelized surface flow between distinct inlets and outlets, although a channel with surface flow may be present;
- Variations in the moisture of the root zone of the AA are mainly controlled by variations in water-table height (i.e., minimum depth to saturated soil or minimum depth to the surface of the free-standing piezometric level, relative to the wetland surface);

- Less than 50% of the area is perennially or seasonally covered by standing (i.e., not flowing) and open (i.e., not supporting at least 5% cover of vegetation) surface water;
- Less than 30% of the AA is forested (over at least 0.2 ha).

A wet meadow AA can include a variety of geomorphic features or elements, including areas of bare mineral sediment, peat or highly organic soils, cobbles and boulders, fluvial channels, bedrock outcrops, natural levees, breaks in topographic slope, paleo shorelines, etc. They can have seasonal and perennial areas of standing open water that do not cover more than about 50% of the AA.

Wet meadows have fine-textured soil material (Weixelman et al 2011) which can be either mineral or peat soils, or a combination of both. While previous detailed studies and classifications have separated meadows with peat soils from those with mineral soils (e.g. Cooper and Wolf, 2005; Weixelman and Cooper, 2009; Weixelman et al, 2011), this module of CRAM does not make distinctions based upon the soil or mix of soil types present within the wetland. This module is appropriate to assess wet meadows of all soil types and mixes of types.

Groundwater can enter the root zone of a wet meadow by rising vertically or by flowing from adjacent uplands. For California as a whole, the natural moisture regimes of most wet meadows are mainly controlled by groundwater driven by local precipitation. In other words, precipitation (rain, snow, fog drip, etc) provides moisture to the groundwater basin that then feeds the wetland, through upwelling, emergence along toe slopes, or interactions with surface water. In alpine wet meadows, the melt water from wet meadow snowpacks strongly influences local water table heights (Laubhan et al 2004). In the Central Valley and sub-alpine Coast Ranges, fog drip can be an important source of groundwater for wet meadows (Dawson 1998, USNPS 2009).

Natural sources of water other than groundwater that can influence wet meadows include over-bank flooding from rivers and streams, surface runoff from adjacent uplands, and direct precipitation, which can include rainfall, snowfall, frost, dew, and fog drip. However, groundwater fluctuations dominate the moisture regime of the root zone of wet meadows, especially during the growing season. The plant community of wet meadows is highly correlated to spatial and temporal variability in groundwater height as well as average seasonal groundwater heights (Loheide et al 2008 and references cited therein).

Wet meadows associated with fluvial channels are influenced by the flow levels throughout the year, as well as the magnitude and frequency of stream flooding. Groundwater recharge can occur during overbank flooding, while horizontal recharge can occur through channel banks during high flows that do not exceed the channel banks. In addition, beaver dams can impact local water levels, overbank flooding, and in-channel and floodplain sediment deposition.

Although wet meadows are dominated by groundwater in the root zone, some meadows are associated with fluvial riverine channels while others do not contain any distinct channel and have only sub-surface flow or surface sheet flow. The meadows with channels often have unique features that are not found in those without channels. These systems need to be assessed differently using CRAM, and so the CRAM classification splits wet meadows into two types: Channeled Meadows and Non-channeled Meadows.

Channeled Meadow sub-type:

Meadows associated with fluvial channels often have a zone of woody riparian vegetation such as willow or alder species, which other meadows may not have. They also have more complex topography than Non-channeled Meadows due to the variation in elevation from channels, floodplain benches, oxbows, natural levees, or other riverine features. These types of meadows are sometimes called "riparian meadows" because they occur along streams or rivers (Weixelman et al. 2011). However, CRAM uses a more inclusive definition of the word riparian, which is based on the definition used by the Technical Advisory Team for the California Wetland and Riparian Area Protection Policy, and thus does not use the word to describe wet meadows associated with a channel.

Riparian: Riparian areas exist between aquatic and non-aquatic areas and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology interconnect aquatic areas and connect them with their adjacent non-aquatic areas. They can include wetland areas, non-wetland aquatic areas, and those portions of non-aquatic areas that significantly influence exchanges of energy and matter with aquatic areas (NRC 2002).

Riparian areas are the zone of transition between any aquatic feature and adjacent uplands, not just the area along riverine systems with woody vegetation. In order to remain consistent with this widely accepted use of the word riparian, the meadow type associated with riverine channels has been termed the Channeled Meadow sub-type. However it should be clear that this refers to the same systems that are termed Riparian low, middle, and high gradient in the hydrogeomorphic classification of Weixelman et al. 2011 (Figure 2).

This sub-type includes meadows that have a channel through the majority of the meadow. Due to variations in water and/or sediment supply, groundwater upwelling or infiltration, concentration of surface flows, variations in slope, or disturbance, channels conveying surface water through a meadow can appear or disappear. In instances with a discontinuous channel through a meadow, the practitioner should decide if the majority of the meadow contains a distinct channel.

Non-channeled Meadow sub-type:

Many meadows do not contain a stream or river channel and are dominated by groundwater throughflow or surface water sheet flow. They may have ditches or rills but not complete channels. These usually have few or no woody species and the vegetation is dominated by graminoids and forbs. They sometimes have conifers or shrubs where part of the meadow is drying and upland species are encroaching, or when woody species adapted to wetland conditions are present. The gradient can range from very flat to steep, depending on the landscape position of the meadow (Figure 2).

CRAM Classification	Channeled Wet Meadow	Non-Channeled Wet Meadow
Hydrogeomorphic Classification (Weixelman et al, 2011)	Riparian Low Gradient Riparian Middle Gradient Riparian High Gradient	Subsurface Low Gradient Subsurface Middle Gradient Subsurface High Gradient Basin Peatland Mound Peatland Discharge Slope Peatland Depressional Seasonal Depressional Perennial Lacustrine Fringe Dry Discharge Slope

Figure 2. Classification of Wet Meadow wetlands in CRAM and the relation to Hydrogeomorphic classification (Weixelman et al, 2011).

Forested Slope

Forested slope wetlands are separated from wet meadows, also called non-forested slope wetlands, by the percent coverage of trees. Forested Slope Wetlands are slope wetlands larger than 0.5 acres (0.2 ha) that form due to a seasonal or perennial emergence of groundwater into the root zone and in some cases onto the ground surface, and that support more than 30% cover of tall woody vegetation, as evidenced in aerial imagery, a LiDAR-derived tree height hillshade, or other sources of plant height information (Cayce et al., 2012). These wetlands can adjoin non-forested slope wetlands (i.e., wet meadows). They can include wetland areas with less than 30% woody cover (i.e., non-forested slope wetlands) that are not larger than 0.5 acres (0.2 ha). Mapping standards exist to define the boundary of forested slope wetlands within forested areas, where the boundary may not be obvious (see Cayce et al., 2012).

Seeps and Springs

These wetlands occur on hillsides or at the base of dunes, hills, alluvial fans, levees, etc. Springs are indicated by groundwater emerging and flowing across the ground surface and sometimes through indistinct or very small rivulets, runnels, and other features that are too small to be called a creek or riverine system. They often lack the features of riverine channels, such as a thalweg or floodplain. Seeps are similar to springs but lack a single-dominant origin of surface flow. Most of the flow is confined to the root zone and is not evident on the ground surface. Seeps and Springs may have, or may lack woody vegetation; no distinction is made in CRAM.

Establish the Assessment Area (AA)

Selection of the AA will be based upon the purpose of the assessment. For example, for ambient assessments, the AA will be based upon the location randomly selected from the Sample Universe (the map of all of the wetlands of that class within the area of interest). For project assessments, the AA will be based upon the established Sample Frame (the map of the wetland class within the project footprint, filled completely with potential AAs). In both instances, the exact AA boundaries should be defined based upon field conditions and specific features (Tables 1 and 2).

For wet meadows the AA should at least encompass the gradient from the upland edge to the core, or lowest central elevation of the wetland. The recommended AA size is 1 ha (Table 3), however variations on this size recommendation allow for assessment of all slope wetland systems.

For small wetlands of all types (1 ha or smaller), the AA should include the entire wetland (Figure 3) and any directly overhanging riparian vegetation. For medium sized wetlands, the AA should ideally be a 1 ha rectangle with one edge oriented perpendicular to the overall wetland flow direction. The rectangle should extend from the upland edge to either the channel centerline (Figure 4), the topographic low point of the meadow or wetland (Figure 5), or all the way across the wetland to the opposite upland edge (Figure 6). In larger wetlands, the AA size can be increased up to 2 ha so that it can include the upland edge and channel centerline or topographic low point. Variations in AA size for wetlands between 1 and 2 ha should consider the purpose of the assessment and maximize the variability within the wetland and the practitioners' ability to accurately assess the area defined. It is acceptable to include the entire wetland in the AA if it is smaller than 2 ha and the practitioner decides that it is appropriate. Alternatively, the AA can include a 1.0 ha portion of a wetland that is between 1 and 2 ha in total area, or such a wetland could be split into 2 AAs of equal size.

In very large meadows it may not be possible to create AAs that all include the upland edge. In these systems a random grid of 1 ha AAs can be placed within the boundaries of the wetland (Figure 7). One or more of these can be assessed, depending on the purpose of the assessment. Where the boundaries of the wetland overlap with the squares in the grid, those squares that have more than half of their area within the wetland boundary will be included in the Sample Frame for assessment. See the CRAM manual and the Technical Bulletin at www.cramwetlands.org for additional guidance on assessing large areas for project evaluations.

The upland edge of all wetlands will include any woody riparian vegetation that directly overhangs the wetland. The entire footprint (i.e the dripline) of any particular tree or shrub that overhangs the wetland is included in the AA. If riparian vegetation does not overhang the wetland, include an area 2 meters wide extending landward from the upland transition as part of the AA.

Figure 3. The AA in a small meadow encompasses the entire wetland, with boundary drawn at the upland transition edge, inclusive of overhanging vegetation.

Figure 4. The AA in a medium Channeled meadow extends from the upland edge (inclusive of overhanging vegetation) to the center of the riverine channel, and is oriented with long edge perpendicular to the overall direction of flow in the meadow.

Figure 5. The AA in a medium Non-Channeled meadow extends from upland edge (inclusive of overhanging vegetation) to center low point of meadow.

Figure 6. The AA in a medium sized meadow that extends across the entire meadow, from upland edge to upland edge (inclusive of overhanging vegetation).

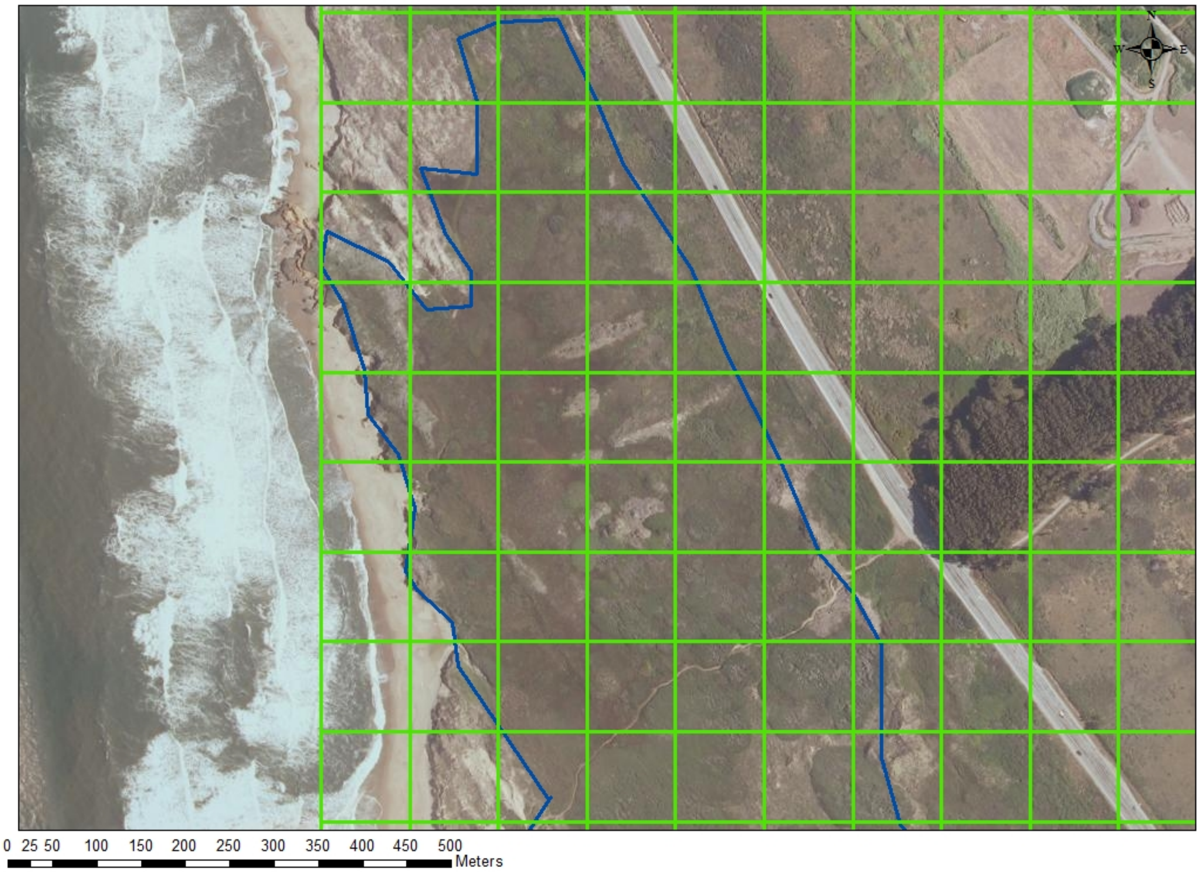


Figure 7. A random grid (green lines) placed over the extent of the wetland resource (blue polygon).

The upland transition zone should be identified by the practitioner, and is defined based upon a suite of geomorphic and vegetative indicators, such as breaks in slope, limit of stands of conifers, change in plant community, change in soil moisture, etc.

Table 1: Examples of features that *should* be used to define AA boundaries for Slope Wetlands.

**Please refer to the CRAM Photo Dictionary at www.cramwetlands.org for photos of each of the following examples.*

- major changes in meadow confinement or slope
- major fluvial channel confluences
- diversion ditches
- end-of-pipe large discharges
- water falls
- open water areas more than 30 m wide on average or broader than the wetland
- transitions between wetland types (e.g. depressional, lacustrine, etc)
- weirs, culverts, dams, drop- structures, levees, and other flow control, grade control, or water height control structures
- frequently used paved roadways that threaten wildlife
- artificial berms, levees, dikes, dams, etc that direct or confine runoff
- uplands at least 10m wide
- Project boundaries (when the purpose is to assess a project- see guidance on CRAM website)

Table 2: Examples of features that should *not* be used to define AA boundaries for Slope Wetlands.

**Please refer to the CRAM Photo Dictionary at www.cramwetlands.org for photos of each of the following examples.*

- **at-grade**, unpaved, single-lane, infrequently used roadways or crossings
- bike paths and jogging trails **at grade**
- bare ground within what would otherwise be the AA boundary
- equestrian trails
- fences (unless designed to obstruct the movement of wildlife)
- property boundaries, unless access is not allowed or the purpose is to assess a project within a boundary
- spatial changes in land cover or land use along the wetland border
- state and federal jurisdictional boundaries (unless required for the purpose of the assessment)

Table 3: Recommended maximum and minimum AA sizes for Slope Wetlands.

Note: Wetlands smaller than the recommended AA sizes can be assessed in their entirety.

Wetland Type	Recommended AA Size and Shape
Wet Meadow	1.0 ha (e.g., a rectangle about 200m x 50m); no minimum size, maximum size is 2.0 ha (e.g. a rectangle about 200m x 100m). Shape should be a rectangle with edge oriented perpendicular to the overall meadow flow direction extending from at least the upland transition edge to the low point of the meadow (or channel centerline). If size allows, extend AA from upland transition edge across to the opposite upland transition edge. If the entire meadow fits within the size limitations, assess the entire meadow, with the AA boundary following the upland transition edge, plus any overhanging vegetation.
Forested Slope	1.0 ha (e.g., a rectangle about 200m x 50m); no minimum size, maximum size is 2.0 ha (e.g. a rectangle about 200m x 100m). Shape should be a rectangle with edge oriented perpendicular to the overall wetland flow direction extending from at least the upland transition edge to the low point of the wetland (or channel centerline). If size allows, extend AA from upland transition edge across to the opposite upland transition edge. If the entire wetland fits within the size limitations, assess the entire wetland, with the AA boundary following the upland transition edge, plus any overhanging vegetation.
Seeps and Springs	0.5 ha (e.g., a square 75m x 75m, but shape can vary); no minimum size, maximum size is 2.0 ha.

Attribute 1: Buffer and Landscape Context

CRAM includes two metrics to assess the Buffer and Landscape Context attribute of wetlands: the Aquatic Area Abundance metric and the Buffer metric. The Buffer metric is composed of three submetrics: (1) percentage of the AA perimeter that has a buffer; (2) the average buffer width; and (3) the condition or quality of the buffer.

Metric 1: Aquatic Area Abundance

Definition: The aquatic area abundance of an Assessment Area is assessed in terms of its spatial association with other areas of aquatic resources, such as other wetlands, lakes, streams, etc. Wetlands close to each other have a greater potential to interact ecologically and hydrologically, and such interactions are generally beneficial.

Wetlands are often important components of local mosaics of multiple types of habitat. The components of such mosaics tend to be inter-connected by the flow of water and movements of wildlife, such that they have additive influences on the timing and extent of many landscape-level processes, including flooding, filtration of pesticides and other contaminants, and wildlife support. In turn, these processes can strongly influence the form and function of wetlands. The functional capacity of a wetland is therefore determined not only by its intrinsic properties, but by its relationship to other habitats across the landscape. Several researchers have concluded that landscape-scale variables are often better predictors of stream and wetland integrity than localized variables (Roth *et al*. 1996; Scott *et al*. 2002). Wetlands that are close are better able to provide refuge and alternative habitat patches for metapopulations of wildlife, to support transient or migratory wildlife species, and to function as sources of colonists for primary or secondary succession of newly created or restored wetlands

For the purposes of CRAM, 500 m is the maximum distance between wetlands and other water-dependent habitats that does not by itself function as a barrier to the easy regular movements of small mammals, birds, amphibians, or reptiles. Greater distances between the wetland of interest and neighboring habitats are considered breaks in landscape connectivity.

Special Considerations for Isolated Wetlands: Isolated wetlands will score lower in this metric than wetlands that are close to other aquatic resources. These wetlands may be highly functioning on an individual basis, but this metric measures the potential to connect to other areas of aquatic resources that can provide the landscape level functions outlined above. Within the landscape, wetlands occur within a hydrologic continuum between being completely “isolated” and connected with other aquatic areas. At its simplest, spatial isolation is the result of the distances between wetlands or other aquatic areas. For a particular landscape setting, the frequency distribution of these distances will be a function of both wetland density and the pattern of their distribution (i.e., dispersed or clumped). These spatially isolated wetlands tend to only receive inputs of water from direct precipitation, groundwater, and within-catchment runoff. Although wetlands can be geographically isolated in the landscape and completely surrounded by upland habitat (Tiner 2003b), hydrologic interactions between such wetlands and other waters can occur via ground-water connections or intermittent surface-water connections during flooding (e.g., spillage and/or through longer duration soil-water pathways). In some instances, these wetlands may have little opportunity for groundwater interactions with other wetlands due to the geometry of the watershed and groundwater basins. However, the same wetlands may be connected with other wetlands through wildlife interactions.

Procedure to Assess this Metric for Slope Wetlands

Aquatic Area Abundance for slope wetlands should be assessed by measuring the proportion of aquatic resources along four transects in the cardinal directions in the landscape surrounding the AA.

On digital or hardcopy site imagery, draw a straight line extending 500 m from the AA boundary in each of the four cardinal compass directions, in lines originating from the approximate center point of the AA (Figure 8). Along each transect line, estimate the percentage of the segment that passes through wetland or aquatic habitat of any kind, including riverine wetlands or open water. Use the worksheet below to record these estimates.

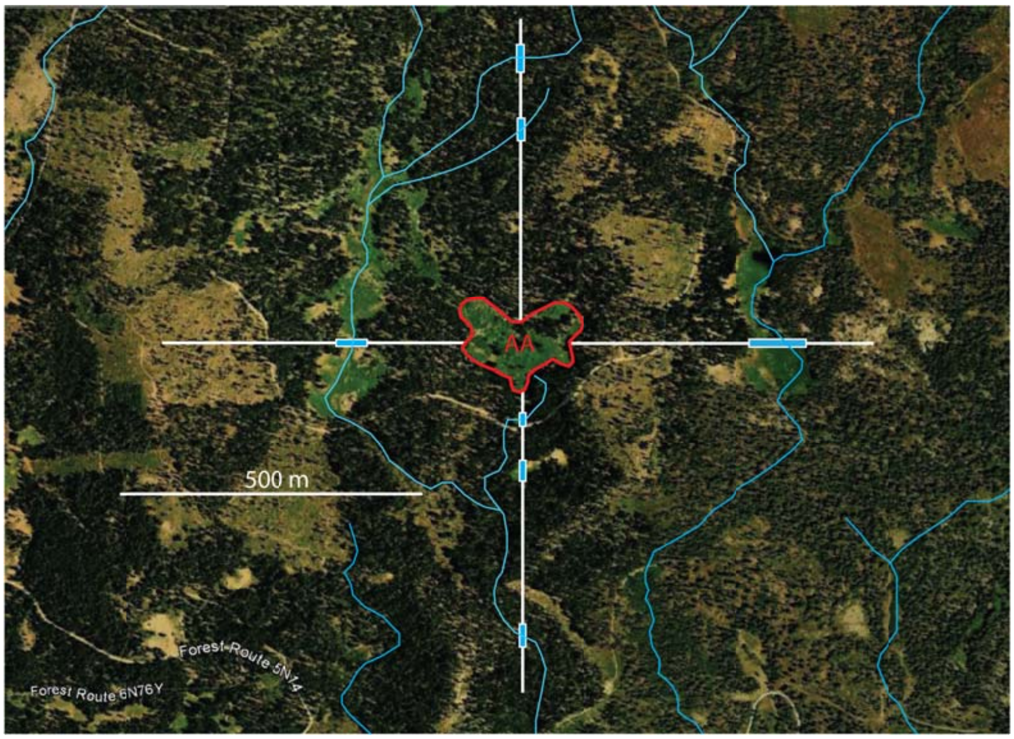


Figure 8. Example of Aquatic Area Abundance measurement. Areas of aquatic habitat (here, either other wet meadow or riverine wetland) are highlighted in blue. This example has an average of 20% of the transects passing through aquatic habitat, and thus scores as a "C".

Worksheet for Aquatic Area Abundance Metric

Percentage of Transect Lines that Contains Wetland Habitat of Any Kind	
Segment Direction	Percentage of Transect Length That is an Aquatic Feature
North	
South	
East	
West	
Average Percentage of Transect Length That Is an Aquatic Feature	

Table 4: Rating for Aquatic Area Abundance.

Rating	Alternative States
A	An average of 46 – 100 % of the transects is an aquatic feature of any kind.
B	An average of 31 – 45 % of the transects is an aquatic feature of any kind.
C	An average of 16 – 30 % of the transects is an aquatic feature of any kind.
D	An average of 0 – 15 % of the transects is an aquatic feature of any kind.

Metric 2: Buffer

Definition: The buffer is a zone of transition between the immediate margins of a wetland and its surrounding environment that is likely to help protect the wetland from anthropogenic stress and natural disturbance. For the purposes of CRAM, the buffer is an area adjoining the AA that is in a natural or semi-natural state and currently not dedicated to anthropogenic uses that would severely detract from its ability to entrap contaminants, discourage visitation into the AA by people and non-native predators, or otherwise protect the AA from anthropogenic stress and natural disturbance. Because regulation and protection of wetlands historically did not extend to adjacent uplands, these areas in some cases have been converted to recreational, urban, agricultural, or other human land uses and might no longer provide their critical buffer functions for wetlands. Areas adjoining wetlands that probably do not provide protection are not considered buffers.

Buffers can protect wetlands by filtering pollutants, providing refuge for wetland wildlife during times of high water levels, acting as barriers to disruptive incursions by people and pets into wetlands, and moderating predation by ground-dwelling terrestrial predators. Buffers can also reduce the risk of invasion by non-native plants and animals, by either obstructing terrestrial corridors of invasion or by helping to maintain the integrity and therefore the resistance of wetland communities to invasions. The ability of buffers to protect a wetland increases with buffer extent along the wetland perimeter. For some kinds of stress, such as predation by feral pets or disruption of plant communities by cattle, small breaks in buffers may be adequate to nullify the benefits of an existing buffer. However, for most stressors, small breaks in buffers caused by such features as trails and small, unpaved roadways probably do not significantly disrupt the buffer functions.

Procedure to Assess this Metric for Slope Wetlands

The assessment should be conducted first in the office, using aerial imagery and land-use maps, as available. The office work should then be verified in the field. This metric is assessed by visually estimating the total percentage of the perimeter of the AA that adjoins land cover types that usually provide buffer functions (see Table 5). To be considered as buffer, a suitable land cover type must be at least 5 m wide and extend along the perimeter of the AA for at least 5 m. The maximum width of the buffer is 250 m. At distances beyond 250 m from the AA, the buffer becomes part of the landscape context of the AA.

Special Notes:

**Any area of open water at least 30 m wide that is directly adjoining the AA, such as a lake, large river, or large slough, is not considered in the assessment of the buffer (Figure 9). Such open water is considered to be neutral, and is neither part of the wetland nor part of the buffer. There are three reasons for excluding large areas of open water (i.e., more than 30 m wide) from Assessment Areas and their buffers.*

1) *Assessments of buffer extent and buffer width are inflated by including open water as a part of the buffer.*
2) *While there may be positive correlations between wetland stressors and the quality of open water, quantifying water quality generally requires laboratory analyses beyond the scope of rapid assessment.*
3) *Open water can be a direct source of stress (i.e., water pollution, waves, boat wakes) or an indirect source of stress (i.e., promotes human visitation, encourages intensive use by livestock looking for water, provides dispersal for non-native plant species), or it can be a source of benefits to a wetland (e.g., nutrients, propagules of native plant species, water that is essential to maintain wetland hydroperiod, etc.).*

**However, any area of open water that is within 250 m of the AA but is not adjoining the AA is considered part of the buffer.*

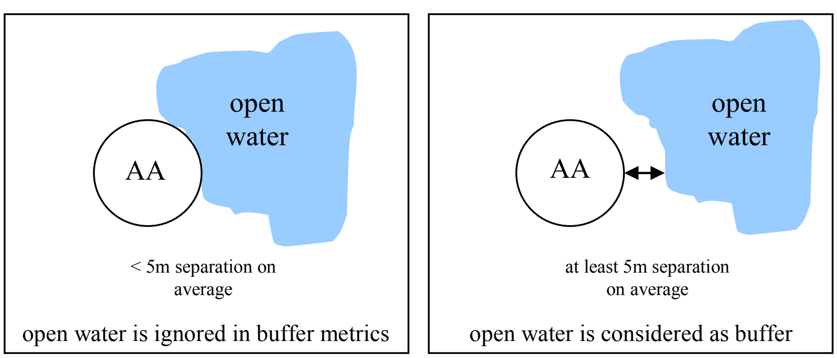


Figure 9: Diagram showing when open water is considered in the Buffer metrics.

Table 5: Guidelines for identifying wetland buffers and breaks in buffers.

**Please refer to the CRAM Photo Dictionary at www.cramwetlands.org for photos of each of the following examples.*

Examples of Land Covers Included in Buffers	**Examples of Land Covers Excluded from Buffers** Notes: buffers do not cross these land covers; areas of open water adjacent to the AA are not included in the assessment of the AA or its buffer.
• at-grade bike and foot trails, or trails (with light traffic) • horse trails • natural upland habitats • nature or wildland parks • range land and pastures • railroads (with infrequent use: 2 trains per day or less) • roads not hazardous to wildlife, such as seldom used rural roads, forestry roads or private roads • swales and ditches • vegetated levees	• commercial developments • fences that interfere with the movements of wildlife (i.e. food safety fences that prevent the movement of deer, rabbits and frogs) • intensive agriculture (row crops, orchards and vineyards) • golf courses • paved roads (two lanes or larger) • active railroads (more than 2 trains per day) • lawns • parking lots • horse paddocks, feedlots, turkey ranches, etc. • residential areas • sound walls • sports fields • urbanized parks with active recreation • pedestrian/bike trails (with heavy traffic) • active logging operations

Submetric A: Percent of AA with Buffer

Definition: This submetric is based on the relationship between the extent of buffer and the functions they provide to aquatic areas. Areas with more buffer typically provide more habitat values, better water quality and other valuable functions. This submetric is scored by visually estimating from aerial imagery (with field verification) the percent of the AA perimeter that is surrounded by at least 5 meters of buffer land cover.

Procedure to Assess this Metric for Slope Wetlands

In the examples below (Figure 10), most of the AA has buffer, however a portion of each perimeter does not have buffer, as it is directly adjacent to either a road, houses, or a golf course. The remaining portion of the perimeter does have at least 5 m of buffer land cover, in these examples either upland, or other wetland area.

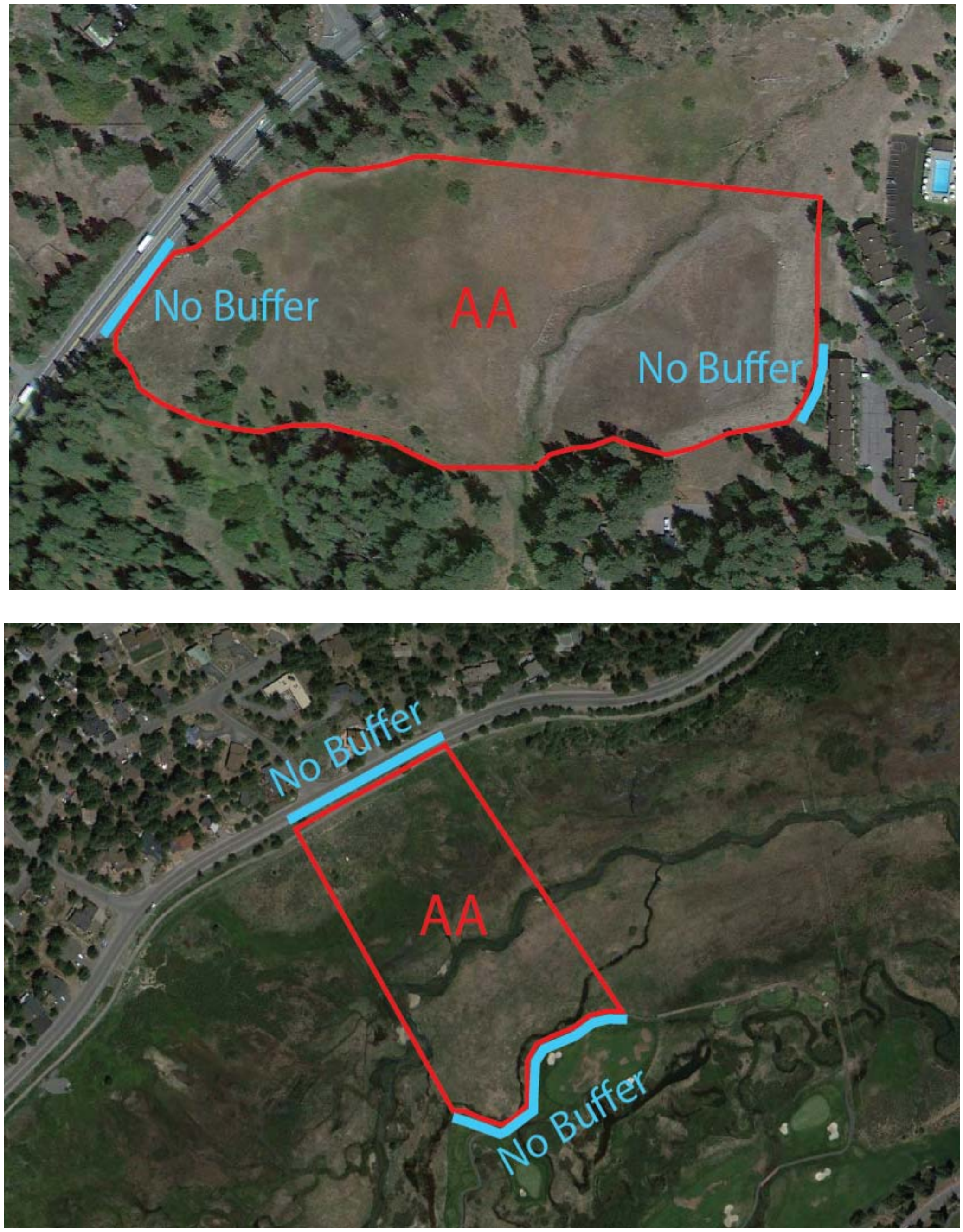


Figure 10: Diagrams of AAs with buffer and non-buffer land cover types. In the top example, the AA has approximately 85% buffer, with the road and the houses representing adjacent non-buffer land cover. In the lower example, the AA has approximately 65% buffer, with the road and the golf course representing adjacent non-buffer land cover.

Percent of AA with Buffer Worksheet.

In the space provided on the datasheet, make a quick sketch of the AA, or perform the assessment directly on the aerial imagery; indicate where buffer is present, estimate the percentage of the AA perimeter providing buffer functions, and record the estimate amount in the space provided.

Table 6: Rating for Percent of AA with Buffer.

Rating	Alternative States (excluding directly adjoining open-water areas)
A	Buffer is 75 - 100% of AA perimeter.
B	Buffer is 50 – 74% of AA perimeter.
C	Buffer is 25 – 49% of AA perimeter.
D	Buffer is 0 – 24% of AA perimeter.

Submetric B: Average Buffer Width

Definition: The average width of the buffer adjoining the AA is estimated by averaging the lengths of eight straight lines drawn at regular intervals along the upland edge of the AA from its perimeter outward to the nearest non-buffer land cover or 250 m, whichever is first encountered. It is assumed that the functions of the buffer do not increase significantly beyond an average width of about 250 m. The maximum buffer width is therefore 250 m. The minimum buffer width is 5 m, and the minimum length of buffer along the perimeter of the AA is also 5 m. Any area that is less than 5 m wide and 5 m long is too small to be a buffer. See Table 5 above for more guidance regarding the identification of AA buffers.

A wider buffer has a greater capacity to serve as habitat for wetland edge-dependent species, to reduce the inputs of non-point source contaminants, to control erosion, and to generally protect the wetland from human activities. Also see the buffer rationale presented above.

Procedure to Assess this Metric for Slope Wetlands

This procedure can be performed initially in the office using the site imagery, and then revised based on the field visit. The procedure has four steps as presented in Table 7 below.

Table 7: Steps to estimate Buffer Width.

Step 1	Consider only the area around the AA perimeter previously identified as buffer.
Step 2	Draw 8 straight lines 250 m in length, starting at the AA boundary, and perpendicular to the AA, for the areas identified as having buffer, radiating out in a starburst pattern (in the cardinal compass directions). Lines should stop when they intersect non-buffer land cover.
Step 3	Estimate the length of each line as they extend away from the AA. Record these lengths on the worksheet below.
Step 4	Calculate the average buffer width. Record this width on the worksheet below.

Special Note:

**Any area of open water that is within 250 m of the AA but is not directly adjoining the AA (separated from the AA boundary by 5m or more of upland or other wetland type) is considered part of the buffer, and thus Buffer Width lines should extend across the open water and be included in the buffer width.*

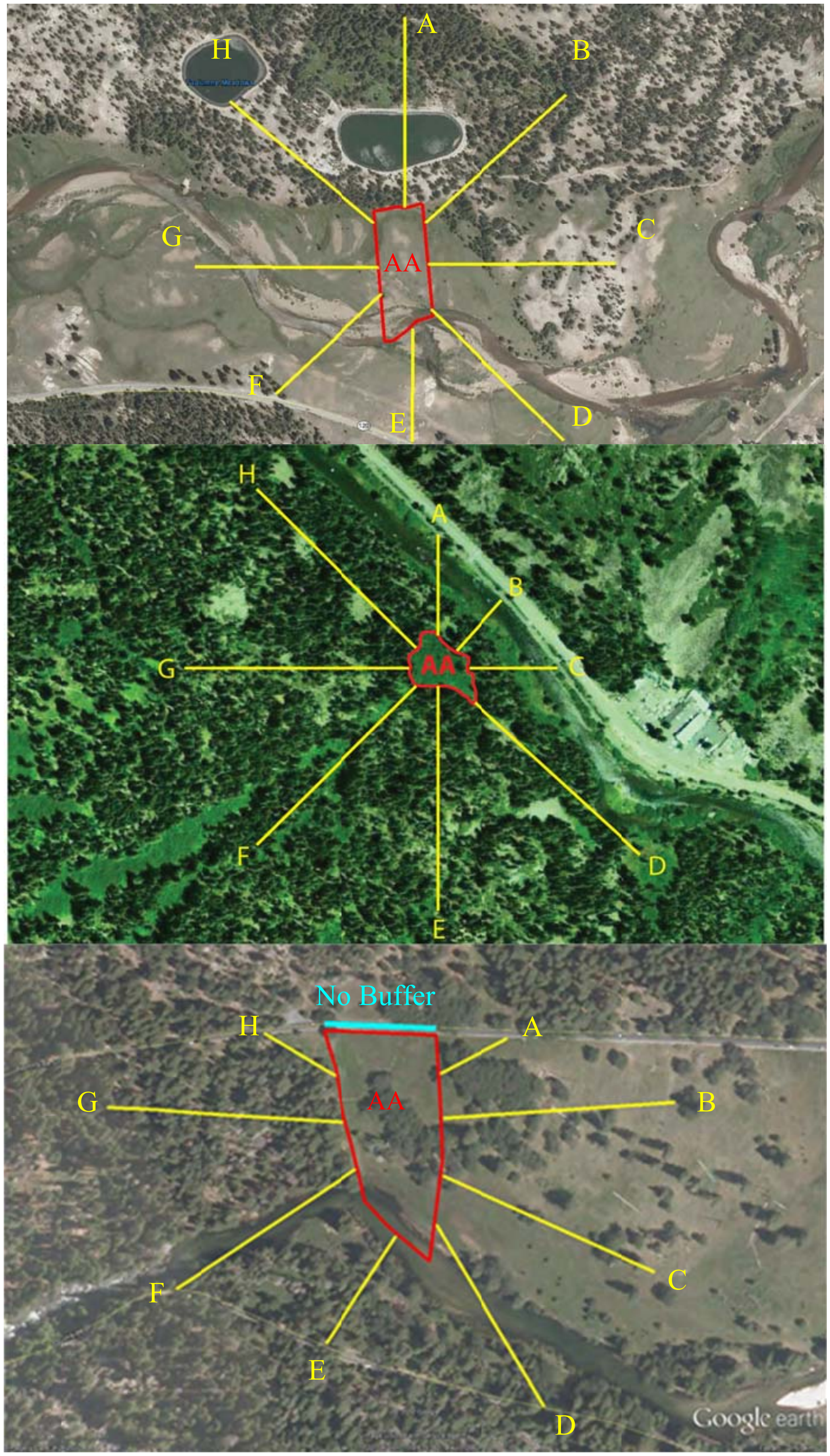


Figure 11. Examples of Buffer Width measurements. In the third example there is no buffer to the north, so the buffer lines are evenly distributed around areas that have buffer.

Worksheet for calculating Average Buffer Width of AA

Line	Buffer Width (m)
A	
B	
C	
D	
E	
F	
G	
H	
Average Buffer Width	

Table 8: Rating for Average Buffer Width.

Rating	Alternative States
A	Average buffer width is 190 – 250 m.
B	Average buffer width 130 – 189 m.
C	Average buffer width is 65 – 129 m.
D	Average buffer width is 0 – 64 m.

Submetric C: Buffer Condition

Definition: The condition or composition of the buffer, in addition to its width and extent around a wetland, determines the overall capacity of the buffer to perform its critical functions. The condition of a buffer is assessed according to the extent and quality of its vegetation cover, the overall condition of its substrate, and the amount of human visitation. Buffer conditions are assessed only for the portion of the wetland border that has *already been identified as buffer (*i.e., as in Figure 10). Thus, evidence of direct impacts (parking lots, buildings, etc.) by people are excluded from this metric, because these features are not included as buffer land covers; instead these impacts are included in the Stressor Checklist.

Procedure to Assess this Metric for Slope Wetlands

Buffer condition must be assessed in the field. Prevalence of native vegetation, absence of exotic vegetation, absence of recent substrate disturbance, and absence of trash or debris are assumed to indicate good buffer conditions. Low impact human visitation includes activities like hiking, bird-watching, or other passive recreation. Moderate or intense human visitation could include activities such as off-road ATV use, 4WD parks, homeless encampments, construction of terrain parks for bikes, or other activities that disturb the soil or plant communities. For the purpose of assessing substrate condition in the buffer, evidence of problems more than 5 years old should not be considered. Grazing should be considered for potential soil disturbance, rather than considered as human visitation. Indicators of potential soil disturbance from grazing include: bare ground > 10%, an obvious reduction in plant vigor or growth, > 20% of new growth is composed of woody plants that have been browsed on, and > 20% cover of disturbance indicator plant species (D. Weixelman, pers. comm.). Disturbance species include introduced or non-native herbaceous species as well as early successional native herbaceous species. Some examples include Kentucky bluegrass (*Poa pratensis*), primrose monkeyflower (*Mimulus primuloides*), tinker's penny (*Hypericum anagalloides*), and yarrow (*Achillea millefolium*). If any of these indicators of heavy grazing is present there is significant soil disturbance from intensive grazing. Narratives for Buffer Condition ratings are provided in Table 9.

Table 9: Rating for Buffer Condition.

**Please refer to the CRAM Photo Dictionary at www.cramwetlands.org for photos of each of the following examples.*

Rating	Alternative States
A	Buffer for AA is dominated by native vegetation, has undisturbed soils, and is apparently subject to little or no human visitation.
B	1) Buffer for AA is characterized by an intermediate mix of native and non-native vegetation (25-75%), but mostly undisturbed soils and is apparently subject to little or low impact human visitation.
	OR
	2) Buffer for AA is dominated by native vegetation, but shows some soil disturbance and is apparently subject to little or low impact human visitation.
C	Buffer for AA is characterized by substantial (>75%) amounts of non-native vegetation AND there is at least a moderate degree of soil disturbance/compaction, and/or there is evidence of at least moderate intensity of human visitation.
D	Buffer for AA is characterized by barren ground and/or highly compacted or otherwise disturbed soils, and/or there is evidence of very intense human visitation, or there is no buffer present.

Attribute 2: Hydrology

Hydrology includes the sources, quantities, and movements of water, plus the quantities, transport, and fates of water-borne materials, particularly sediment as bed load and suspended load. Hydrology is the most important direct determinant of wetland functions (Mitch and Gosselink 1993). The physical structure of a wetland is largely determined by the magnitude, duration, and intensity of water movement. For example, substrate grain size, depth of wetland sediments, and total organic carbon in sediments tend to be inversely correlated to duration of inundation in a lacustrine wetland. The hydrology of a wetland directly affects many physical processes, including nutrient cycling, sediment entrapment, and pollution filtration. For example, Odum and Heywood (1978) found that leaves in freshwater depressional wetlands decomposed more rapidly when submerged. The hydrology of a wetland constitutes a dynamic habitat template for wetland plants and animals.

Metric 1: Water Source

Definition: Water Sources directly affect the extent, duration, and frequency of saturated or ponded conditions within an Assessment Area. Water Sources include direct inputs of water into the AA as well as any diversions of water from the AA. Diversions influence the water source because they affect the ability of the AA to function as a source of water for other habitats while also directly affecting the hydrology of the AA.

A water source is direct if it supplies water mainly to the AA, rather than to areas through which the water must flow to reach the AA. Natural sources of direct water inputs for slope wetlands include groundwater, precipitation and surface water flows. Examples of unnatural, direct sources include stormdrains that empty directly into the AA or into an immediately adjacent area. Indirect sources that should not be considered in this metric include large regional dams that have ubiquitous effects on broad geographic areas of which the AA is a small part. However, the effects of urbanization on hydrological dynamics in the immediate watershed containing the AA ("hydromodification") *are* considered in this metric; because hydromodification both increases the volume and intensity of runoff during and immediately after rain events and reduces infiltration that supports base flow discharges during the drier seasons later in the year.

Engineered hydrological controls such as weirs, flashboards, grade control structures, check dams, plug and pond restoration methods, etc., can serve to demarcate the boundary of an AA, but should not be considered in the assessment of this metric. These features may temporarily impound water, but they are not the source of the water. The water source metric looks beyond the scale of the AA to the upstream watershed within about 2 km.

Wetlands depend on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate (National Research Council 2001). Consistent, natural inflows of water to a wetland are important to their ability to perform and maintain most of their intrinsic ecological, hydrological, and societal functions and services. The flow of water into a wetland also affects its sedimentary processes, geo-chemistry, and basic physical structure. Sudol and Ambrose (2002) found that one of the greatest causes of failed wetland mitigation or restoration projects is inadequate or inappropriate hydrology.

Procedure to Assess this Metric for Slope Wetlands

The assessment of this metric is assessed initially in the office using the site imaging, and then revised based on the field visit. This metric focuses on *direct* sources of water as defined above. The natural sources will tend to be more obvious than the unnatural sources. Evaluation of this metric should therefore emphasize the identification of the unnatural sources or diversions that directly affect the dry season conditions of the AA.

The office work should initially focus on the immediate margin of the AA and its wetland, and then expand to include the smallest watershed or storm drain system that directly contributes to the AA or its immediate environment, such as another part of the same wetland. Only consider the immediate 2 km of watershed area upstream of the AA. Indicators of unnatural water sources include adjacent intensive development, irrigated agriculture, and wastewater treatment discharge.

Water Source should be evaluated based on dry season conditions of the wetland (e.g., post snowmelt peak of the water year). The dry season is the most stressful time of the year for many wetland flora and fauna, and is when water source-related stresses will be most evident.

Table 10: Guidelines for features to consider (left column) or that should not be considered (right column) for Water Source.

Examples of features to consider as negatively affecting Water Source	Examples of features that should not be considered as negatively affecting Water Source
• adjacent developments • stormdrains • irrigated agriculture (including irrigated pasture), or direct irrigation in the meadow (e.g. flood irrigation) • golf courses • wastewater treatment discharge • houses with septic systems • surface water diversion • ground water extraction • dams or other artificially impounded water • paved roads • significant density of logging roads	• Large regional dams >2 km upstream • Plug and pond restoration • Beaver dams • Low intensity logging

Table 11: Rating for Water Source.

Rating	Alternative States
A	The freshwater sources that affect the dry season moisture regime of the AA, such as the extent and duration of groundwater-affected moisture in the root zone, are mainly natural groundwater fluctuations, but might also include direct precipitation, natural runoff, or natural flow from an adjacent freshwater body, or the AA naturally lacks water in the dry season. There is no indication that dry season conditions are substantially controlled by artificial or modified water sources.
B	The freshwater sources that affect the dry season moisture regime of the AA are mostly natural, but also obviously include occasional or small effects of modified hydrology, as evidenced by developed land or irrigated agricultural land that is likely to provide runoff or groundwater to the AA, but which comprises less than 20% of the immediate drainage basin within about 2 km upstream of the AA, or that is characterized by the presence of a few small stormdrains or scattered homes with septic systems adjacent to or nearby the AA.
C	The freshwater sources that affect the dry season moisture regime of the AA are substantially affected by such factors as urban runoff, direct irrigation, pumped water, artificially impounded water, water remaining after diversions, regulated releases of water through a dam, artificial recharge, or other artificial hydrology. Indications of substantial artificial groundwater hydrology include developed or irrigated agricultural land that comprises more than 20% of the immediate drainage basin within about 2 km upstream of the AA. OR The groundwater in the root zone of the AA during the dry season is substantially controlled by injection wells, recharge basins, subsurface drains, upstream diversions of water or other artificial processes within, adjacent to, or nearby the AA.
D	Natural groundwater sources that affect the dry season moisture regime of the AA have been eliminated, or nearly eliminated, based on presence of extraction wells, siphons, or artificial surface or subsurface drainage.

Metric 2: Hydroperiod

Definition: Hydroperiod is the characteristic frequency and duration of inundation or saturation of a wetland during a typical year.

Natural slope wetlands typically experience daily, seasonal, and inter-annual variations in groundwater height that are governed by diurnal increases in evapotranspiration and longer term variability in groundwater recharge and movement that is governed by variability in rainfall and runoff. However anthropogenic actions can also cause deviations in groundwater height, recharge, and movement. These deviations may increase or decrease the amount or duration of water supporting the wetland, and thus, have effects upon the condition of the wetland or the functions it provides.

Procedure to Assess this Metric for Slope Wetlands

This metric considers deviations from the natural hydrograph of the wetland, based upon a suite of visible indicators of change in the patterns of filling and drying in the wetland. Table 12 lists some example indicators of altered hydroperiod; indicators such as 'evidence of aquatic wildlife mortality' may be present due to the climatic year, thus more than one indicator is typically desired to indicate an altered hydrograph.

Hydroperiod should be evaluated during the dry season (e.g., post snowmelt peak of the water year), with indicators expected to vary based upon the amount of precipitation during the water year. This metric should take into account the type of water year during which the assessment is being conducted, but score the metric based upon a typical water year.

Table 12: Field Indicators of Altered Hydroperiod.

**Please refer to the CRAM Photo Dictionary at www.cramwetlands.org for photos of some of the following examples.*

Direct Evidence	Indirect Evidence
Reduced Extent and Duration of Inundation or Saturation	
• Upstream spring boxes • Impoundments that reduce the amount of water available to the meadow • Pumps, diversions, ditching that move water ***from*** the wetland	• Evidence of aquatic wildlife mortality • Encroachment of upland vegetation well into the wetland • Stress or mortality of hydrophytes or wetland plant species • Compressed or reduced plant zonation • Transition to fewer wetland obligate plant species, if known • Oxidation of peat substrate (however, may require additional knowledge beyond field observation) • Incision or widening of adjoining fluvial channels
Increased Extent and Duration of Inundation or Saturation	
• Berms, dikes, levees • Pumps, diversions, ditching that move water ***into*** the wetland	• Late-season vitality of annual vegetation, given the water year • Increase in extent and abundance of wetland obligate plant species, if known • Recently drowned wetland vegetation • Extensive fine-grained sediment deposits on the wetland surface • Formation of surface pools, pannes, etc • Increased wetness outside of non-channeled meadows due to overflow (e.g. into adjacent non-meadow areas) • Standing surface water that extends into the late summer months (e.g. July or August) beyond expected, and not associated with a recent storm event • Aggradation of adjoining fluvial channels

Table 13: Rating of Hydroperiod for Slope Wetlands.

Rating	Alternative States (based on Table 13)
A	All indications are that the hydroperiod, or duration of shallow groundwater within the AA is characterized by natural patterns of rise and fall, without alterations OR The amount and duration of shallow groundwater is altered so that the hydroperiod mimics the pattern of natural conditions.
B	The amount of water supplied to the wetland via the surface (as opposed to via groundwater) is enhanced compared to natural conditions, but thereafter, the AA is subject to natural drawdown or drying. OR The duration of groundwater supply or inundation is extended later into the year than would be expected for natural conditions.
C	The amount of water supplied to the wetland is consistent with natural supply, but thereafter, the AA is subject to more rapid drawdown or drying OR The duration of groundwater supply or inundation is shortened compared to what would be expected for natural conditions.
D	Both the patterns of groundwater rise and fall are altered compared to natural conditions, with alterations to the amount or timing of filling and drawdown of groundwater within the wetland OR The groundwater is generally artificially lowered below the root zone for most of the AA due to pervasive artificial groundwater extraction or artificial drainage or diversions.

Metric 3: Hydrologic Connectivity

Definition: Hydrologic Connectivity describes the ability of water to flow into or out of the wetland, and for the wetland to slow the movement of water, and slowly release that water downstream. For Slope Wetlands, Hydrologic Connectivity describes the ability of the wetland to slow the movement of surface runoff and shallow groundwater. This metric assesses the degree to which the inflows of groundwater or surface runoff are likely to be retained and then released downstream in such ways that the outputs are filtered of particulate matter (although it might be enriched with nutrients), downstream peak flows are reduced, and base flows in receiving channels are increased, extended downstream, and longer lasting.

This metric is scored differently for Channeled Wet Meadows versus all other Slope Wetlands. Channeled Wet Meadows (Method 1) are scored using two sub-metrics. Sub-metric A considers the degree of entrenchment of the fluvial channel, and Sub-metric B assesses the percentage of meadow surface affected by the incised channel to determine the degree of dewatering. For all other Slope Wetlands (Method 2), the metric considers the degree of dewatering of the wetland by assessing dissection of the wetland by developing channels. Some Non-Channeled Slope wetlands may be highly dissected by numerous channels; use the initial designation of Channeled or Non-Channeled to determine which rating table to use.

Method 1: Procedure to Assess this Metric for Channeled Wet Meadows

For Channeled meadows, this metric assesses the potential for rising waters in the channel to reach the meadow surface and spill out of the channel banks. It also looks at the dewatering impacts to the meadow by assessing the percentage of the meadow dewatered due to the presence of incised channels. This metric is split into two sub-metrics, the Bank Height Ratio Sub-metric and the Percent Dewatered Sub-Metric. The Hydrologic Connectivity: Bank Height Ratio Sub-metric is scored by assessing the degree to which the lateral movement of floodwaters is restricted from flowing out onto the meadow surface due to incision of the channel. The sub-metric is assessed based on a portion of the Bank Erosion Hazard Index (BEHI) (Rosgen 2001). Although the BEHI method contains multiple measurements to assess bank stability, only the bank height to bankfull depth ratio is used here. This ratio is a field measurement calculated by making two in-channel measurements at three representative locations in the AA (upstream, middle, downstream). Bank height is measured as the maximum height between the thalweg (the deepest point along the channel bed) and the top of the channel bank (the break in slope between the near vertical channel bank and the near horizontal meadow surface). The meadow surface is measured at the level of the primary horizontal meadow surface, and not at the height of a small inset floodplain that may be forming in an entrenched or incising system. Bankfull depth is measured as the height between the thalweg and the projected water surface at the level of bankfull flow. For assessments in large Channeled Wet Meadows that only include one half of the channel in the AA, the bankfull width and depth are still measured across the entire channel. A stadia rod and tape measure is recommended for making these measurements.

Submetric A: Bank Height Ratio

Channeled Wet Meadow Wetland Bank Height Calculation Worksheet

The following 4 steps should be conducted for each of 3 cross-sections located in the AA at the approximate midpoints along straight riffles or glides, away from deep pools or meander bends. An attempt should be made to place them at the top, middle, and bottom of the AA.				
Steps	**Replicate Cross-sections** ⟶	**TOP**	**MID**	**BOT**
1 Estimate bankfull width.	This is a critical step requiring familiarity with field indicators of the bankfull contour. Measure the distance between the right and left bankfull contours.			
2: Estimate max. bankfull depth.	Imagine a level line between the right and left bankfull contours; measure the height of the line above the thalweg (the deepest part of the channel).			
3: Estimate max. bank height	Identify the location of the top of bank. Measure the height between the thalweg and the top of bank location.			
4: Calculate bank height ratio.	Divide the bank height (Step 3) by the bankfull depth (Step 2).			
5: Calculate average bank height ratio.	Calculate the average results for Step 4 for all 3 replicate cross-sections. Enter the average result here and use it in Table 14.			

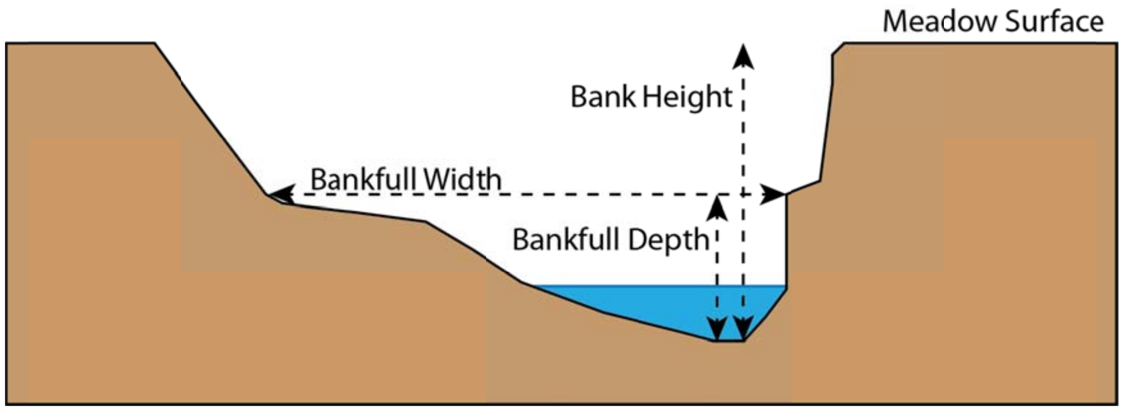


Figure 12: Diagram of bank height measurements. Bank height ratio is measured as maximum bank height divided by bankfull depth.

Special Notes:

**Definitions:*

- *Bankfull: stage when water just begins to leave the channel and flow over the floodplain or meadow surface*
  - *Although numerous studies suggest that bankfull flow has a frequency of about 1.5 to 3 years, the definition of bankfull is not dependent upon flow frequency. Supplemental indicators of bankfull:*
    - *Break in slope of bank from vertical to horizontal depositional surface making up the edge of the channel*

- *Lower limit of perennial species*
- *In some cases, the presence and height of certain depositional features-especially point bars can define lowest possible level for bankfull stage. However, point bar surfaces are usually below the bankfull height and are not reliable indicators of bankfull stage.*

- *Floodplain: relatively flat depositional surface adjacent to the river/stream that is formed by the river/stream under current climatic and hydrologic conditions. The floodplain is inundated on average every, or every other year by flood waters. In some instances, the floodplain may be the meadow surface.*

**It may be necessary to conduct a short test on how uncertainty about the location of the bankfull contour affects the metric score. To conduct the sensitivity analysis, assume two alternative bankfull contours, one 10% above the original estimate and one 10% below the original estimate. Re-measure the bankfull width and flood-prone width using the alternative bankfull contours. Re-calculate the metric based on these alternative bankfull heights. If either alternative changes the metric score, then add three additional cross-sections to finalize the estimates of bankfull height.*

** In altered systems (e.g. urban systems affected by hydromodification, or reaches downstream from dams) the physical indicators of bankfull are often obscured.*

**For a video describing bankfull, please go to the tips page of the CRAM website to see "A Guide for Field Identification of Bankfull Stage in the Western United States"*

Table 14: Sub-metric A: Rating of Hydrologic Connectivity Bank Height Ratio for Channeled Wet Meadows.

Rating	Alternative States (based on the bank height calculation worksheet above)
A	Bank height to bankfull depth is ≤ 1.19
B	Bank height to bankfull depth is 1.2 to 1.5
C	Bank height to bankfull depth is 1.6 to 2.0
D	Bank height to bankfull depth is ≥ 2.1

Submetric B: Percent Dewatered

In Channeled Wet Meadows, the condition of the channel discharging the majority of the surface water is indicative of hydrologic alterations. Channels that are in or near equilibrium allow overbank flow and groundwater recharge when water flows across the meadow surface, whereas channels that are incised do not allow these functions, and contribute to increased dewatering of the meadow. Dewatering is defined as when the zone of saturation in the wetland drops below its previous elevation, so that the soils become drier and the plants become stressed due to reduced extent and duration of soil saturation. Indicators of channel incision include, but are not limited to: low entrenchment ratios, largely undercut banks with block failures, hanging or exposed roots, channel scoured to bedrock or dense clay, presence of active knickpoints, and active gully erosion or headcutting. Indicators of meadow dewatering that are found outside of the channel include, but are not limited to: stress or mortality of plants adjacent to the channel, presence of xeric/upland species in a zone adjacent to the channel, development of rills and gullies on the meadow surface, large areas of bare soil on the meadow surface, and soil cracking of the meadow surface adjacent to the channel. The root zone is the upper-most soil stratum (30 to 40 cm) where most of the biomass (80 to 90% by weight) of the herbaceous meadow plant roots are exists.

To determine the percentage of the meadow that is affected by incision and dewatering, consider the percentage of the larger wetland that contains the AA. In other words, do not limit this metric only to the AA. Use aerial imagery and field observations to best estimate the percentage of the Slope Wetland that is dewatered. For very large wetlands, only consider the wetland area that is within 500 m of the AA boundary.

Table 15: Sub-metric B: Rating of Hydrologic Connectivity Percent Dewatered for Channeled Wet Meadows.

Rating	Alternative States
A	The wet meadow functions as variable source area for downstream surface flows, discharging water through springs, seeps, or a fluvial channel that is not incised. OR The wet meadow lacks any apparent surface discharge of water, although groundwater flow from the wet meadow is likely.
B	The wet meadow functions as variable source area for downstream surface flows, discharging water through springs, seeps, or a fluvial channel (natural or artificial) that is somewhat incised and is tending to dewater the root zone for less than 25% of the wet meadow.
C	The wet meadow functions as variable source area for downstream surface flows, discharging water through springs, seeps, or a fluvial channel (natural or artificial) that is significantly incised and is tending to dewater the root zone for 25 to 50% of the wet meadow.
D	The wet meadow functions as variable source area for downstream surface flows, discharging water through springs, seeps, or a fluvial channel (natural or artificial) that is severely incised and is tending to dewater the root zone for more than 50% of the wet meadow.

Method 2: Procedure to assess this metric for all other Slope Wetlands (except Channeled Wet Meadows)

For Non-channeled meadows, Forested slope wetlands, and Seeps and Springs the development of rills or channels in a wetland that previously did not have these features represents concentration of surface or groundwater flows. These flows can concentrate and speed flows that previously moved more slowly across the wetland. The concentration of flow can also be erosive, incising a channel into the wetland surface, and further dewatering the wetland.

Indicators of wetland dewatering include, but are not limited to: stress or mortality of plants, presence of xeric/upland species, development of rills and gullies on the meadow surface, large areas of bare soil on the meadow surface, and soil cracking of the meadow surface. The root zone is the upper-most soil stratum (30 to 40 cm) where most of the biomass (80 to 90% by weight) of the herbaceous meadow plant roots are exists.

To determine the percentage of the meadow that is affected by incision and dewatering, consider the percentage of the larger wetland that contains the AA. In other words, do not limit this metric only to the AA. Use aerial imagery and field observations to best estimate the percentage of the Slope Wetland that is dewatered. For very large wetlands, only consider the wetland area that is within 500 m of the AA boundary.

Table 16: Rating of Hydrologic Connectivity for all other Slope Wetlands.

Rating	Alternative States
A	The AA receives water from natural springs, seeps, flooding, or entirely as groundwater, and discharges through springs, seeps, or fluvial channel heads. In essence, the AA functions as a variable source area for downstream surface flows, and is not dissected by channels that convey the wetland discharges. OR The AA lacks any apparent surface discharge of water, although groundwater flow from the wetland is likely.
B	The AA receives water from natural springs, seeps, flooding, or entirely as groundwater, and discharges through springs, seeps, or fluvial channel heads, but the wetland surface is beginning to develop natural or artificial channels that are actively eroding into the wetland, that tend to dewater the root zone for less than 25% of the AA, regardless of channel depth. Channels that occur outside the AA can also impact the AA by dewatering it.
C	The AA receives water from natural springs, seeps, or fluvial channels, or from artificial sources or modified sources and processes, but the wetland surface is slightly dissected by natural or artificial channels that tend to dewater the root zone for 25% to 50% of the AA, regardless of channel depth. Channels that occur outside the AA can also impact the AA by dewatering it.
D	The wetland receives water from natural springs, seeps, or fluvial channels, or from artificial sources or modified sources and processes, but the wetland surface is severely dissected by natural or artificial channels that tend to dewater the root zone for more than 50% of the wetland, regardless of channel depth. Channels that occur outside the AA can also impact the AA by dewatering it.

Attribute 3: Physical Structure

Physical structure is defined as the spatial organization of living and non-living surfaces that provide habitat for biota (Maddock 1999). For example, the distribution and abundance of organisms in riverine systems are largely controlled by physical processes and the resulting physical characteristics of habitats (e.g., Frissell *et al.* 1986). Metrics of the Physical Structure attribute in CRAM therefore focus on physical conditions that are indicative of the capacity of a wetland to support characteristic flora and fauna. CRAM assumes that wetlands with greater physical complexity will support greater diversity and levels of ecological services. While some of the features in these metrics are sometimes associated with drying of slope wetlands or other negative impacts, the metrics aim to capture the overall amount of physical complexity within an AA, and thus the ability of the AA to support a diverse assemblage of flora and fauna.

Metric 1: Structural Patch Richness

Definition: Patch richness is the number of different obvious types of physical surfaces or features that may provide habitat for aquatic, wetland, or riparian species. This metric is different from topographic complexity in that it addresses the number of different patch types, whereas topographic complexity evaluates the spatial arrangement and interspersion of the types. Physical patches can be natural or unnatural. The minimum size for most patches to be counted is 3 m^2.

The richness of physical, structural surfaces, and features in a wetland reflects the diversity of physical processes, such as energy dissipation, water storage, and groundwater exchange, which strongly affect the potential ecological complexity of the wetland. The basic assumption is that natural physical complexity promotes natural ecological complexity, which in turn generally increases ecological functions, beneficial uses, and the overall condition of a wetland. We acknowledge that, particularly in large meadows, the physical complexity present within a single AA may or may not add significant ecological value to the entire meadow. Although some of the patch types may sometimes indicate processes occurring that are detrimental to the wetland, they still contribute to overall complexity and diversity of functions in the wetland. The natural physical complexity is assessed by noting the visible patches of physical structure that occur any place within the AA.

Procedure to Assess this Metric for Slope Wetlands

Using the Structural Patch Worksheet below, note the presence of each of the patch types found in the AA. For AAs in large Channeled Wet Meadows that only include one of the channel banks, include patches that occur anywhere within the entire channel. Table 17 contains guidance for scoring the Structural Patch Richness.

**Please refer to the CRAM Photo Dictionary at www.cramwetlands.org for photos of each of the following examples.*

Patch Type Definitions:

<u>*Abundant wrack, organic debris, or thatch in channel or across wetland plain.*</u> Wrack is an accumulation of natural or unnatural floating debris along the high water line of a wetland.

<u>*Active fluvial channel(s).*</u> A channel is a linear feature that conveys flowing surface water, and has defined bed and banks.

<u>*Animal mounds and burrows, or vole trails.*</u> Many vertebrates make mounds or holes as a consequence of their foraging, denning, predation, or other behaviors. The resulting soil disturbance helps to redistributes soil nutrients and influences plant species composition

and abundance. To be considered a patch type there should be evidence that a population of burrowing animals has occupied the Assessment Area. A single burrow or mound does not constitute a patch.

Bank slumps or undercut banks in channels or along shorelines. A bank slump is a portion of a fluvial channel bank that has broken free from the rest of the bank but has not eroded away. Undercuts are areas along the bank or shoreline of a wetland that have been excavated by waves or flowing water.

Beaver dams or lodges. Beavers create dams or lodges across fluvial channels using sticks, logs, mud, and stones. The dams provide protection for the beavers and ready access to food. Dams also cause a backwater pond upstream of the dam, causing deposition of sediment and allowing infiltration of water.

Boulders or bedrock outcrop. Boulders are rocks with a middle axis larger than 256mm. Bedrock outcrop can be various shapes and sizes, but represents exposed in-place bedrock.

Concentric or parallel high water marks. Repeated variation in water level in a wetland can cause concentric zones in soil moisture, topographic slope, and chemistry that translate into visible zones of different vegetation types, greatly increasing overall ecological diversity. The variation in water level might be natural (e.g., seasonal) or anthropogenic.

Cutoff channels or oxbows. Cutoff channels or oxbows are inactive parts of old channels that have been bypassed by the continued meandering of the current fluvial channel. These channels have bed and banks, but do not convey surface flow. They often pond surface water or upwelling ground water, and provide important habitat and refugia for many species.

Filamentous macroalgae and algal mats. Macroalgae occurs on benthic sediments and on the water surface. Macroalgae are important primary producers, representing the base of the food web in some wetlands. Algal mats can provide abundant habitat for macro-invertebrates, amphibians, and small fishes.

Gravel or cobble. Gravel and cobble are rocks of different size categories. The middle axis of gravel ranges between 2mm and 64mm, whereas cobble ranges between 64 and 256mm. Submerged gravel and cobbles provide abundant habitat to aquatic macroinvertebrates. Exposed gravel and cobble can provide shelter for amphibians, contribute to the patterns of shade and light and air movement near the ground surface that affect local soil moisture gradients, deposition of seeds and debris, and overall substrate complexity.

Large woody debris. Large woody debris (LWD) in ponds or on floodplain provides important services and is an indicator of dynamic hydrology and ecology. LWD is any woody fragment greater than 10 cm diameter and 0.5 meters long. It provides basking habitat for turtles, which use wood perches preferentially over rock substrates. LWD can be a source of food for invertebrates, and it increases overall topographic heterogeneity. It can provide structure to create scour pools or eddies with dynamic hydrology. It can be a refuge to hide from predators in a low-relief landscape.

Moss. Bryophytes such as sphagnum moss or other mosses can form the base of the substrate in some wetlands, and this substrate is necessary for peat formation.

Non-vegetated flats (sandflats, mudflats) or bare ground. A flat is a non-vegetated area of silt, clay, or sand that adjoins the wetland foreshore and is a potential resting and feeding area for birds or other species. For example, in meadows, these can be alkaline areas, zones of recent siltation, or animal foraging areas.

Pannes or pools. A panne is a shallow topographic basin lacking vegetation but existing on a well-vegetated wetland plain. Pannes fill with water at least seasonally due to overland flow. They commonly serve as foraging sites for birds and as breeding sites for amphibians.

Plant hummocks or tussocks. Hummocks are mounds created by plants along floodplains, terraces or springs, created by the collection of sediment and organic material around wetland plants, or by freeze-thaw processes. Hummocks are typically less than 1m high. Tussocks are grasses that grow in clumps, tufts, or bunches, rather than forming a sod or lawn.

Sediment mounds around the bases of trees or shrubs. Sediment mounds are similar to hummocks but lack plant cover. They are depositional features formed from repeated flood flows depositing sediment on the floodplain.

Sediment splays. Sediment splays are areas of coarse sediment (sand or larger) deposited across the wetland surface, typically during a flood event.

Soil cracks. Repeated wetting and drying of fine grain soil that typifies some wetlands can cause the soil to crack and form deep fissures that increase the mobility of heavy metals, promote oxidation and subsidence, while also providing habitat for amphibians and macroinvertebrates. Cracks must be a minimum of 1 inch deep to qualify.

Springs or upwelling groundwater. Springs are areas where ground water intersects the land surface and emerges. Springs typically occur at breaks in slope (e.g. at the base of a slope) or along the banks of a fluvial channel, but they may also occur anywhere across the wetland surface where upwelling occurs.

Standing snags. Tall, woody vegetation, such as trees and tall shrubs, can take many years to fall to the ground after dying. These standing "snags" they provide habitat for many species of birds and small mammals. Any standing, dead woody vegetation that is at least 3 m tall with at least a 10 cm diameter is considered a snag.

Submerged vegetation. Submerged vegetation consists of aquatic macrophytes such as *Elodea canadensis* (common elodea), that are rooted in the sub-aqueous substrate but do not usually grow high enough in the overlying water column to intercept the water surface. Submerged vegetation can strongly influence nutrient cycling while providing food and shelter for fish and other organisms.

Swales. Swales are broad, elongated, vegetated, shallow depressions that can sometimes help to convey flood flows to and from vegetated marsh plains or floodplains. But, they lack obvious banks, regularly spaced deeps and shallows, or other characteristics of channels. Swales can entrap water after flood flows recede. They can act as localized recharge zones and they can sometimes receive emergent groundwater.

Variegated or crenulated upland edge. As viewed from above, the upland edge of a wetland can be mostly straight, broadly curving (i.e., arcuate), or variegated (e.g., meandering). In plan view, a variegated upland edge resembles a meandering pathway. Variegated edges provide greater contact between the upland and the wetland.

Structural Patch Type Worksheet for Slope Wetlands

Check each type of patch that is observed in the AA and use the total number of observed patches in Table 17 below.

STRUCTURAL PATCH TYPE (circle for presence)	**Slope Wetland**
Minimum Patch Size	**3 m^2**
Abundant wrack, organic debris, or thatch in channel, or across wetland plain	
Active fluvial channel(s)	
Animal mounds and burrows, or vole trails	
Bank slumps or undercut banks in channels	
Beaver dams or lodges	
Boulders or bedrock outcrop	
Concentric or parallel high water marks	
Cutoff channels or oxbows	
Filamentous macroalgae or algal mats	
Gravel or cobble	
Large woody debris	
Moss	
Non-vegetated flats or bare ground (scars, scalds, etc.)	
Pannes or pools on wetland surface	
Plant hummocks and/or tussocks	
Sediment mounds around the bases of shrubs or trees	
Sediment splays	
Soil cracks	
Springs or upwelling groundwater	
Standing snags (at least 3 m tall)	
Submerged vegetation (in channels or open water)	
Swales	
Variegated, convoluted, or crenulated upland edge (not broadly arcuate or mostly straight)	
Total Possible	**23**
No. Observed Patch Types (enter here and use in Table 17 below)	

Table 17: Rating of Structural Patch Richness.

Rating	Number of Patch Types Observed in the AA
A	≥ 12
B	9 – 11
C	6 – 8
D	≤ 5

Metric 2: Topographic Complexity

Definition: Topographic complexity refers to the variety of elevations within a wetland due to physical and biological materials and processes occurring within the AA.

Topographic complexity promotes variable hydroperiods and associated moisture gradients that, in turn, promote ecological complexity by increasing the spatial and temporal variability in energy dissipation, surface water storage, groundwater recharge, particulate matter detention, cycling of elements and compounds, and habitat dynamics. Areas that are aerated due to water movements through and across complex surfaces may promote volatilization of compounds, or re-suspension and export of water-borne material.

Procedure to Assess this Metric for Slope Wetlands

Topographic complexity is assessed by noting the overall variability in topographic features, physical patches, and vegetation roughness (Table 18 and Figure 13). For Slope wetlands, topographic complexity can be evaluated by observing the amount of macro- and micro-topographic relief and physical plant structure that affect moisture gradients or that influence the path of water movements along a transect across the AA. Note that in Slope wetlands, the macro- and micro-topographic features may be on the order of ≤ 1 m relief. Topographic gradients may be indicated by plant assemblages with different inundation/saturation or salinity tolerances. Table 18 provides narratives for rating Topographic Complexity for Slope wetlands.

Table 18: Typical indicators of Topographic Complexity.

Wetland Type	Examples of Topographic Features
Non-channeled Wet Meadows, Forested Slopes	Swales, oxbows, plant hummocks, tree fall locations (i.e. tip up mound and cavity), large woody debris, cobbles or boulders, bedrock outcrops, pannes/pools on wetland surface, irregular upland edge, a wide variety of surfaces and slopes
Channeled Wet Meadows	Fluvial channels large and small, secondary channels, swales, oxbows, natural levees, plant hummocks, tree fall locations (i.e. tip up mound and cavity), large woody debris, cobbles or boulders, bedrock outcrops, pannes/pools on meadow surface, irregular upland edge, a wide variety of surfaces and slopes
Seeps and Springs	Swales, rivulets and outflow pathways, plant hummocks, tree fall locations (i.e. tip up mound and cavity), large woody debris, cobbles or boulders, bedrock outcrops, irregular upland edge, a wide variety of surfaces and slopes

To complete this metric, walk through the AA perpendicular to (i.e., across) the overall wetland topographic slope (from upland edge to topographic low, or to the opposite upland edge if the AA extends to that edge). As you walk, sketch the topographic profile of the AA along the way, indicating the locations of any macro and micro-topographic relief, and noting vegetation roughness (worksheet below). Once the sketch is complete, compare it to the template of common cross-section profiles (Figure 13). Based on the comparison between the worksheet sketch and Figure 13, plus the rating table (Table 19), score the AA.

Worksheet for AA Topographic Complexity

Complete a field sketch of the topographic profile of the AA along a cross section perpendicular to the overall slope of wetland within the AA. Draw the section to include both AA boundaries. Note AA boundaries, important topographic features, and vegetation roughness.

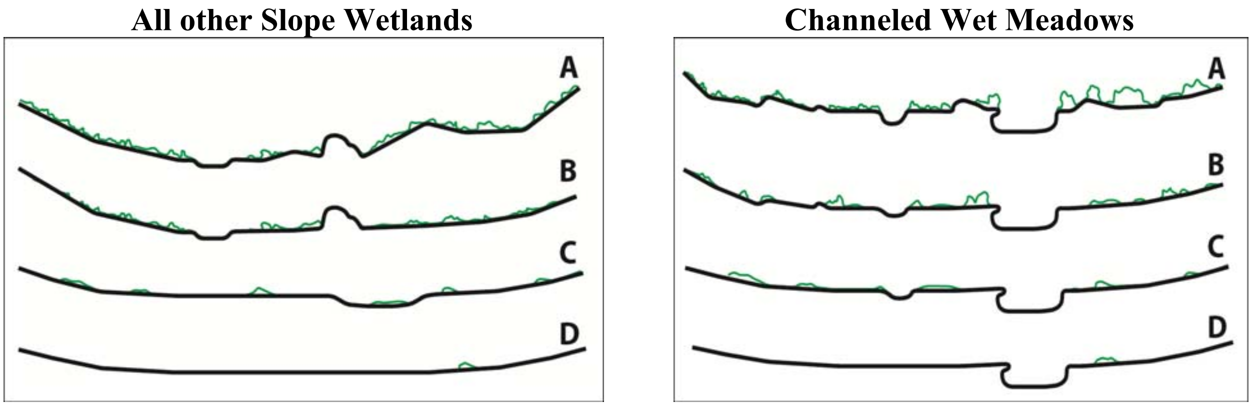


Figure 13: Topographic cross sectional profile templates for an AA perpendicular to its overall slope. These diagrams are exaggerated wetland cross sections, with ground surface shown as the heavy black line, and vegetation roughness as the thin green line. Note that these diagrams are conceptual representations of the morphology of a wetland, and any particular wetland may have a steeper or shallower slope than these models.

Table 19: Rating of Topographic Complexity for Slope Wetlands.

Rating	Alternative States (based on diagrams in Figure 13 above)
A	Cross-sectional profile of AA contains abundant macro and micro topographic features such as swales, oxbows, pannes/pools, or a wide variety of slopes AND abundant vegetation roughness. The profile is at least as complex as the line labeled "A" in Figure 13.
B	Cross-sectional profile of AA contains moderate macro and micro topographic features such as swales, oxbows, pannes/pools, or a wide variety of slopes, AND/OR moderate vegetation roughness. The profile resembles the line labeled "B" in Figure 13.
C	Cross-sectional profile of AA contains minor macro and micro topographic features such as swales, oxbows, pannes/pools, or a wide variety of slopes, AND/OR minor vegetation roughness. The profile resembles the line labeled "C" in Figure 13.
D	Cross-sectional profile of AA lacks macro and micro topographic features such as swales, oxbows, pannes/pools, or a wide variety of slopes, AND lacks any vegetation roughness. The profile resembles the line labeled "D" in Figure 13.

Attribute 4: Biotic Structure

This attribute is assessed differently depending on the type of Slope wetland that is being assessed. Wet meadows with fluvial channels (Channeled Wet Meadows), Forested slope wetlands, and Seeps and Springs often have woody riparian vegetation that is usually not present in Non-Channeled Wet Meadows, so the biotic structure is separated into different methods for some of the metrics.

Metric 1: Plant Community Metric for Channeled Wet Meadows, Forested Slope Wetlands, and Seeps and Springs

The Plant Community Metric for Channeled Meadows, Forested Slope wetlands, and Seeps and Springs is composed of four submetrics: Number of Plant Layers, Number of Co-dominant Plant Species, Percent Invasive Species, and Number of Upland Encroachment Species.

Submetric A: Number of Plant Layers

A "plant" is defined as an individual of any vascular macrophyte species of tree, shrub, herb/forb, or fern, whether submerged, floating, emergent, prostrate, decumbent, or erect, including non-native (exotic) plant species. Algae and bryophytes (including mosses and liverworts) are not included among the species identified in the assessment of the plant community. For the purposes of CRAM, a plant "layer" is a stratum of vegetation indicated by a discreet canopy at a specified height that comprises at least 5% of the area of the AA *where the layer is expected* (e.g. floating layer is expected only in areas that have a water column; no species are expected in areas of bedrock outcrop).

Layer definitions:

Floating Layer. This layer includes rooted aquatic macrophytes such as *Ruppia cirrhosa* (ditchgrass), *Ranunculus aquatilis* (water buttercup), and *Potamogeton foliosus* (leafy pondweed) that create floating or buoyant canopies at or near the water surface that shade the water column. This layer also includes non-rooted aquatic plants such as *Lemna* spp. (duckweed) and *Eichhornia crassipes* (water hyacinth) that form floating canopies.

Short Vegetation. This layer is never taller than 30 cm. It includes small emergent vegetation and plants. It can include young forms of species that grow taller. Vegetation that is naturally short in its mature stage includes *Polygonum bistortoides* (bistort), *Solidago canadensis* (goldenrod*), Mimulus primuloides* (primrose monkeyflower), *Eleocharis ssp.* (spikerush) and *Menyanthes trifoliata* (bog bean).

Medium Vegetation. This layer ranges from 30 cm to 1.0 m in height. It commonly includes rushes (*Juncus* spp.), sedges (*Carex* ssp.), *Deschampsia cespitosa* (tufted hairgrass), *Scirpus microcarpus* (bulrush), *Rubus ursinus* (blackberry), *Lupinus ssp.* (Lupin), and *Vaccinium uliginosum* (bog blueberry).

Tall Vegetation. This layer ranges from 1.0 m to 3.0 m in height. It usually includes the tallest emergent vegetation, larger shrubs, and small trees. Examples include *Typha latifolia* (broad-leaved cattail), *Glyceria elata* (mannagrass), *Veratrum californicum* (corn lily), *Baccharis pilularis* (coyote brush) and *Salix exigua* (narrow-leaf willow).

Very Tall Vegetation. This layer includes shrubs, vines, and trees that are greater than 3.0 m in height. Examples may include *Sambucus mexicanus* (blue elderberry), *Salix lemmonii* (Lemmon's willow), *Salix lasiolepis* (arroyo willow), and *Pinus contorta* (lodgepole pine).

Figure 14: Flow Chart to Determine Plant Dominance

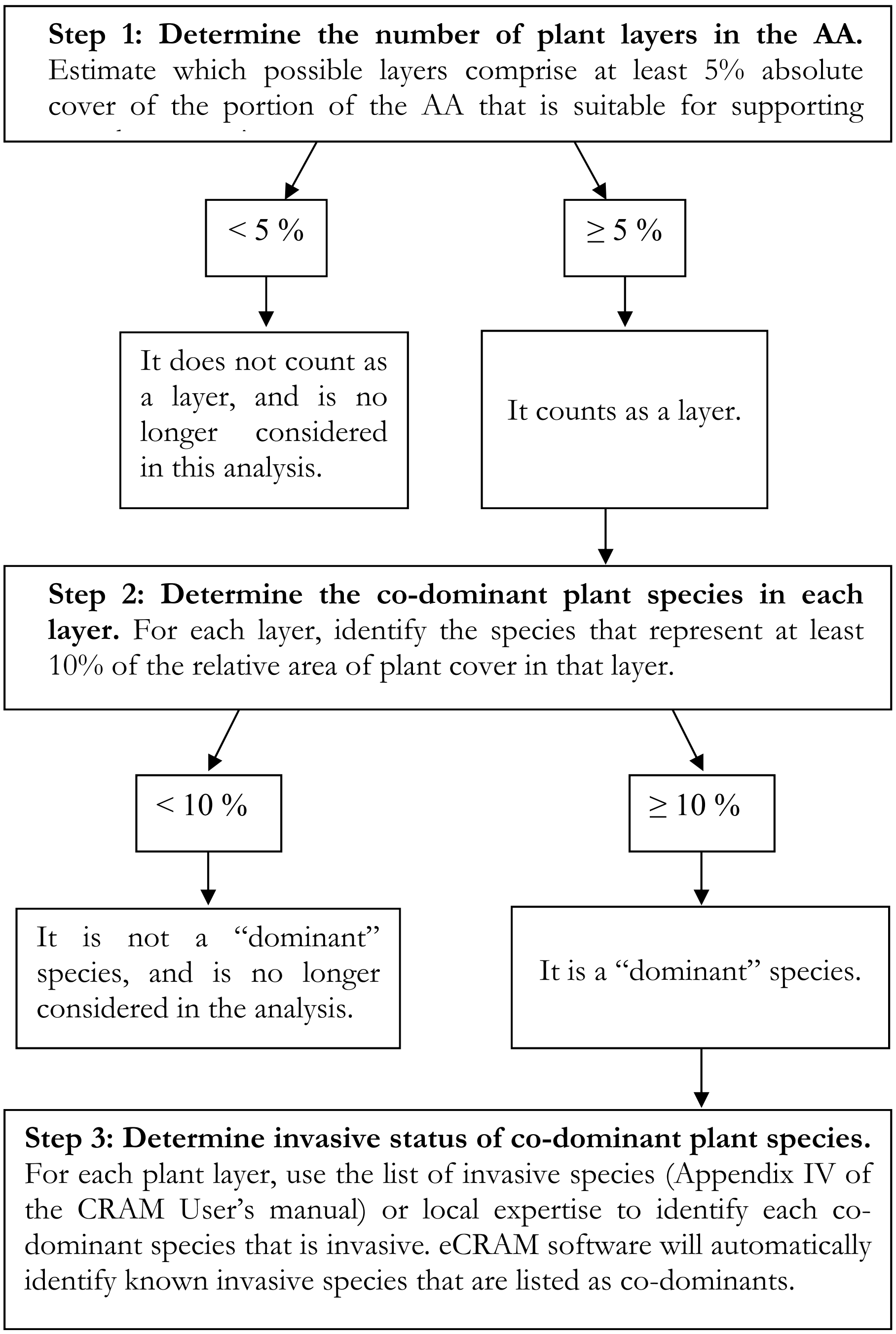


Table 20. Plant Layer Height Classes for Channeled Wet Meadow, Forested Slope Wetlands, and Seeps and Springs.

Height Class	Floating	Short	Medium	Tall	Very Tall
	On water surface	<0.3 m	0.3 – 1.0 m	1.0 - 3.0 m	> 3.0 m

Special Note:

**Standing (upright) dead or senescent vegetation from the previous growing season can be used in addition to live vegetation to assess the number of plant layers present. However, the lengths of prostrate stems or shoots are disregarded. In other words, fallen vegetation should not be "held up" to determine the plant layer to which it belongs. The number of plant layers must be determined based on the way the vegetation presents itself in the field.*

Submetric B: Number of Co-dominant Species

For each plant layer in the AA, every species represented by living vegetation that comprises at least 10% relative cover within the layer is considered to be dominant in that layer, and should be recorded in the appropriate part of the Plant Community Metric Worksheet. Only living vegetation in growth position is considered in this metric. Dead or senescent vegetation is disregarded. When identifying the total number of dominant species in an AA, count each species only once; do not count a species multiple times if it is found in more than one layer.

Special Notes:

**If there are unknown plant species that are considered dominant in the AA, take a close-up photograph and a voucher specimen sample back to your office for identification (provided you have permission to remove samples from the landowner or managing agency). Make sure to collect any flowers, fruit, or seeds that are present to help in the identification process.*

**Please refer to the CRAM Photo Dictionary at www.cramwetlands.org for a list of plant identification websites.*

Plant Community Metric Worksheet: Co-dominant species richness for Channeled Wet Meadow, Forested Slope wetlands, and Seeps and Springs
(A dominant species represents ≥10% *relative* cover)

Special Note:

** Combine the counts of co-dominant species from all layers to identify the total species count. Each plant species is only counted once when calculating the Number of Co-dominant Species and Percent Invasion submetric scores, regardless of the numbers of layers in which it occurs.*

Floating or Canopy-forming	**Invasive?**	**Short (<0.3 m)**	**Invasive?**
Medium (0.3-1.0 m)	**Invasive?**	**Tall (1.0-3.0 m)**	**Invasive?**
Very Tall (>3.0 m)	**Invasive?**	**Total number of co-dominant species for all layers combined (enter here and use in Table 23)**	
		Percent Invasion (enter here and use in Table 23)	

Submetric C: Percent Invasive Species

A list of invasive species is provided as Appendix IV of the User's Manual. Any species not on this list is not considered to be invasive, although it might be non-native, unless there is a strong rationale from local experts to designate a particular plant as invasive for a region. Expertise is required to assure that species are correctly identified as native, non-native, or invasive.

Submetric D: Number of Upland Encroachment Groups

The presence of specific species groups within the AA indicates the degree of encroachment of upland vegetation (i.e. primarily UPL or FACU rating in the Army Corps National Wetland Plant List) into the wetland. CRAM assumes that encroachment of a wetland by non-wetland species degrades the condition of the wetland. While encroachment of the wetland indicates succession into a drier regime, the practitioner may or may not be able to discern the causes (natural or not natural). However, this metric simply aims to capture the reduced wetland functions provided by the wetland due to encroachment, regardless of the causes. The number of the indicator species groups present, and comprising at least 5% relative cover of the AA, are considered for this submetric. Examples of each group are listed in the following Table; this is not an exhaustive list.

Table 21: Example Species for Number of Upland Encroachment Groups.

Group	Example Species
Conifers	Lodgepole Pine*, Juniper, Sitka Spruce, Douglas Fir
Deciduous Trees	Tan Oak, Live Oak
Upland Shrubs	Sagebrush, Rabbitbrush, Bitterbrush, Scotch Broom, French Broom**
Vines	Himalayan Blackberry**
Upland Grasses	Ripgut Brome, Oat Grass**

**Note- Lodgepole Pine (Pinus contorta) is facultative (FAC) in the wetland plant indicator status for California. It is equally likely to occur in wetlands or in non-wetlands. Lodgepole encroachment may be in the natural range of variability for a wetland between successive fire events. Both drier conditions due to dewatering and also fire suppression may lead to greater encroachment by conifers.*
***Many of the examples listed above also happen to be considered invasive by Cal-IPC, however, this metric is considering encroachment into the wetland by non-wetland species, not measuring invasion. This table is just illustrating a few example species, and could include many other species that encroach into wetlands, yet are not considered invasive.*
****The term "upland" is used here for shrubs and grasses; the intent is to capture the group of species encroaching into the wetland that typically are present in upland settings, rather than wetland settings, for each region of the state.*

Table 22: Worksheet for Number of Upland Encroachment Groups.
Note: Each group must comprise at least 5% relative cover of the AA

Group	Present?
Conifers	
Deciduous Trees	
Upland Shrubs	
Vines	
Upland Grasses	
Total	

Table 23: Ratings for Plant Community Sub-metrics for Channeled Wet Meadows, Forested Slope Wetlands, and Seeps and Springs.

Rating	Submetric A: Number of Plant Layers Present	Submetric B: Number of Co-dominant Species	Submetric C: Percent Invasion	Submetric D: Number of Upland Encroachment Groups
Channeled Wet Meadows, Forested Slope Wetlands, and Seeps and Springs				
A	4-5	≥ 11	0 – 10%	0
B	3	8 – 10	11 – 20%	1
C	2	5 – 7	21 – 30%	2
D	0-1	0 – 4	31 – 100%	≥3

Metric 1: Plant Community for Non-Channeled Meadows

The Plant Community Metric for Non-Channeled Meadows is composed of three submetrics (submetrics B – D): Number of Co-dominant Species, Percent Invasive Species, and Number of Upland Encroachment Species. Submetric A: Number of Plant Layers Present is not applicable.

A “plant” is defined as an individual of any vascular macrophyte species of tree, shrub, herb/forb, or fern, whether submerged, floating, emergent, prostrate, decumbent, or erect, including non-native (exotic) plant species. Algae and bryophytes (including mosses and liverworts) are not included among the species identified in the assessment of the plant community.

Non-native species owe their occurrence in California to the actions of people since the time of Euroamerican contact. Many non-native species are now *naturalized* in California, and may be widespread in occurrence, but are not considered invasive. “Invasive” species are non-native species that “(1) are not native to, yet can spread into, wildland ecosystems, and that also (2) displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes” (CalIPC 2012). CRAM uses the California Invasive Plant Council (CalIPC) list to determine the invasive status of plants, *with augmentation by regional experts*.

Submetric B: Number of Co-dominant Species

All plant species that comprise at least 10% relative cover of the AA are considered to be dominant. Only living vegetation is considered in this metric. Dead or senescent vegetation is disregarded. Bare areas and areas of open water areas are also disregarded.

Figure 15: Steps to Determine Number of Co-dominants

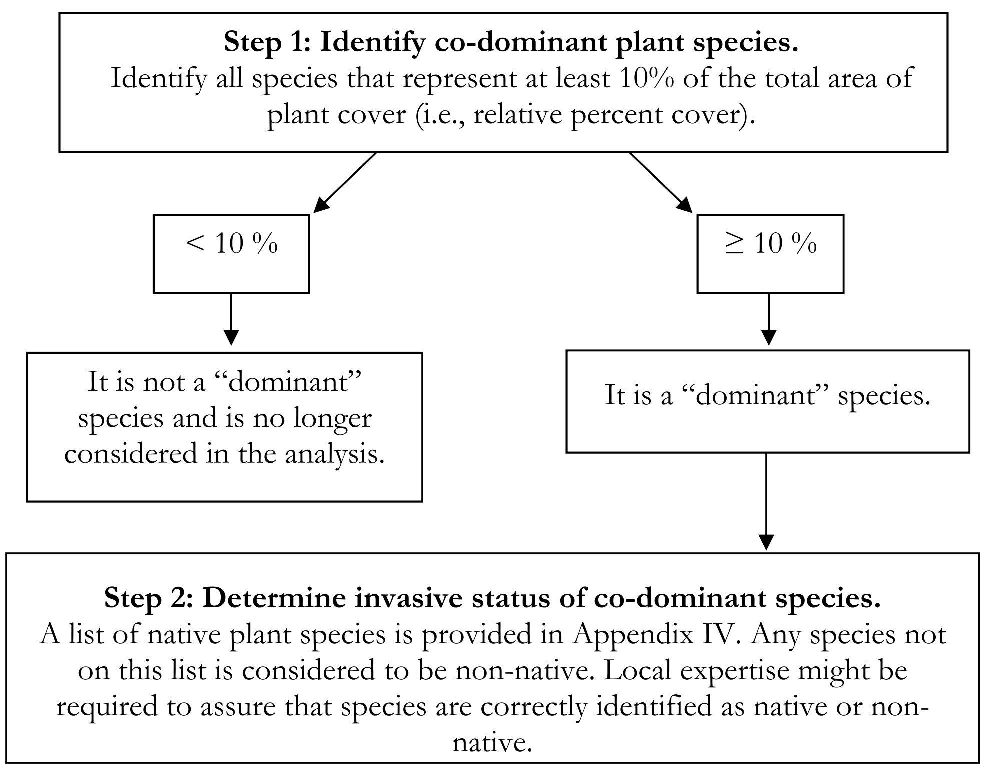


Table 25: Worksheet for Co-dominant Plant Species.

Note: A dominant species represents ≥10% *relative* cover. Count species only once when calculating any Plant Community sub-metric. Invasive species are listed in Appendix IV of the User's Manual.

Co-dominant Species	Check if Invasive
Total Number of Co-dominants	
Total Number of Invasive Co-dominant species	
Percent Invasive Species (round to nearest integer)	

Submetric C: Percent Invasive Species

A list of invasive species is provided as Appendix IV of the User's Manual. Any species not on this list is not considered to be invasive, although it might be non-native, unless there is a strong rationale from local experts to designate a particular plant as invasive for a region. Expertise is required to assure that species are correctly identified as native, non-native, or invasive.

Submetric D: Number of Upland Encroachment Groups

The presence of specific species groups within the AA indicates the degree of encroachment of upland vegetation (i.e. primarily UPL or FACU rating in the Army Corps National Wetland Plant List) into the wetland. CRAM assumes that encroachment of a wetland by non-wetland species degrades the condition of the wetland. While encroachment of the wetland indicates succession into a drier regime, the practitioner may or may not be able to discern the causes (natural or not natural). However, this metric simply aims to capture the reduced wetland functions provided by the wetland due to encroachment, regardless of the causes. The number of the indicator species groups present, and comprising at least 5% relative cover of the AA, are considered for this submetric. Examples of each group are listed in the following Table; this is not an exhaustive list.

Table 24: Example Species for Number of Upland Encroachment Groups.

Group	Example Species
Conifers	Lodgepole Pine*, Juniper, Sitka Spruce, Douglas Fir
Deciduous Trees	Tan Oak, Live Oak
Upland Shrubs	Sagebrush, Rabbitbrush, Bitterbrush, Scotch Broom, French Broom**
Vines	Himalayan Blackberry**
Upland Grasses	Ripgut Brome, Oat Grass

**Note- Lodgepole Pine (Pinus contorta) is facultative (FAC) in the wetland plant indicator status for California. It is equally likely to occur in wetlands or in non-wetlands. Lodgepole encroachment may be in the natural range of variability for a wetland between successive fire events. Both drier conditions due to dewatering and also fire suppression may lead to greater encroachment by conifers.*

***Many of the examples listed above also happen to be considered invasive by Cal-IPC, however, this metric is considering encroachment into the wetland by non-wetland species, not measuring invasion. This table is just illustrating a few example species, and could include many other species that encroach into wetlands, yet are not considered invasive.*

****The term "upland" is used here for shrubs and grasses; the intent is to capture the group of species encroaching into the wetland that typically are present in upland settings, rather than wetland settings, for each region of the state.*

Table 26: Worksheet for Number of Upland Encroachment Groups.
Note: Each group must comprise at least 5% relative cover of the AA

Group	Present?
Conifers	
Deciduous Trees	
Upland Shrubs	
Vines	
Upland Grasses	
Total	

Table 27: Ratings for Plant Community Submetrics for Non-Channeled Wet Meadows.

Rating	Submetric A: Number of Plant Layers Present	Submetric B: Number of Co-dominant Species	Submetric C: Percent Invasion	Submetric D: Number of Upland Encroachment Groups
Non-Channeled Wet Meadows				
A	n/a	≥ 9	0 – 10%	0
B	n/a	7-8	11 – 20%	1
C	n/a	5 – 6	21 – 30%	2
D	n/a	0 – 4	31 – 100%	≥3

Metric 2: Horizontal Interspersion

Horizontal Interspersion refers to the variety and interspersion of plant “zones,” or patches of monocultures or obvious multi-species association that are arrayed along gradients of elevation, moisture, or other environmental factors that seem to affect the plant community organization in a two-dimensional plan view. Interspersion is essentially a measure of the number of distinct plant zones or patches AND the amount of edge between them. Each zone must comprise 5% or more of the AA. It is important to note that the number of zones can be surprisingly high in some areas, and this metric cannot be scored by simply “counting” the number of zones. An "A" condition means BOTH more zones AND a greater degree of interspersion, and the departure from the "A" condition is proportional to BOTH the reduction in the numbers of zones AND their interspersion.

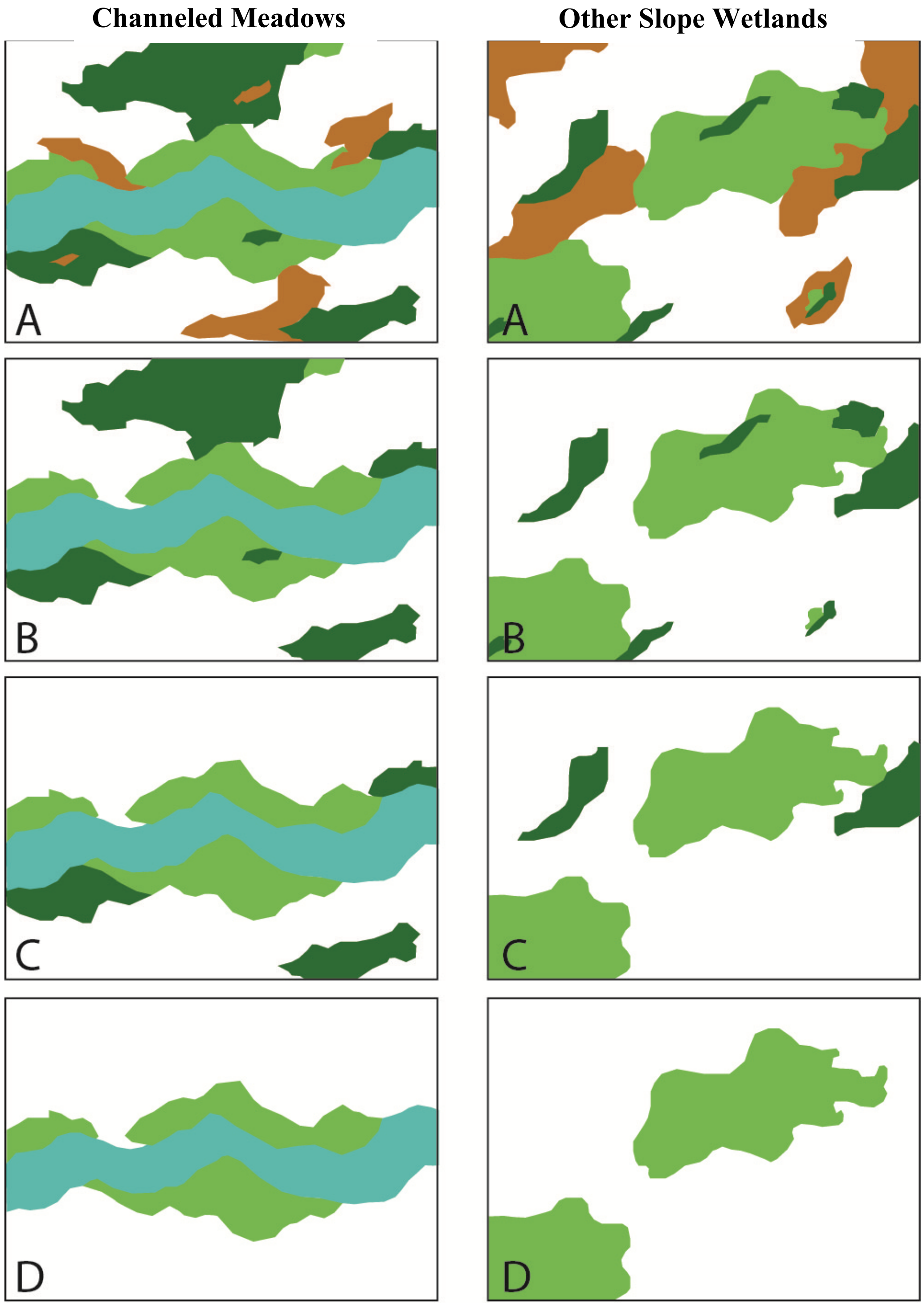
Examples may include multi-layered “riparian forest” composed of alders and pines above a willow understory; a shrub thicket dominated solely by arroyo willow; “meadow plain” composed of a consistent mix of three Carex and two Juncus species; or a “grass zone” with a widely varying composition of numerous Eurasian and/or native grasses. In all cases, the plant “zones” are defined by a relatively unvarying combination of physiognomy and species composition. Think of each plant zone as a vegetation complex of relatively non-varying composition extending from the top of the tallest trees down through all of the vegetation to ground level. A zone may include groups of species of multiple heights, and this metric is not based on the layers established in the Plant Community Submetric A.

Horizontal Interspersion Worksheet

Use the spaces below to make a quick sketch of the AA in plan view, outlining the major plant zones (this should take no longer than 10 minutes). Assign the zones names and record them on the right. Based on the sketch, choose a single profile from Figure 16 that best represents the AA overall.

	Assigned zones: **1)** **2)** **3)** **4)** **5)** **6)**

Figure 16: Illustration of alternative patch mosaics for Horizontal Interspersion. Each row represents a different degree of interspersion and zonation among the patches. The first column represents Channeled Wet Meadows, and the second column represents all other Slope wetlands. Colors represent obviously different plant zones. The white area within represents the matrix or background vegetation type.



Metric 3: Plant Life Forms

The Plant Life Forms metric captures the number of different plant structure types that are present within the AA. Each plant life form provides unique functions for animal habitat as well as influencing hydrologic and physical processes. Wetlands with multiple life forms provide a greater diversity and complexity of biotic structure, which in turn provides the complexity of habitat for birds, mammals, amphibians and insects. Each life form must be present over at least 5% relative cover of the AA to be counted.

Table 28. Vertical Structure Metric: Plant Life Forms.

Life Form	Present in > 5% of AA?
Herbs/Forbs	
Grasses	
Sedges/Rushes	
Shrubs	
Deciduous Trees	
Coniferous Trees	
Bryophytes (mosses, liverworts, hornworts)	
Lichens or Fungi	
Total Number of life forms	

Table 29: Ratings for Number of Life Forms Present.

Rating	Number of Co-dominant Life Forms
A	≥ 5
B	4
C	3
D	0 – 2

Guidelines to Complete the Stressor Checklists

A stressor, as defined for the purposes of the CRAM, is an anthropogenic perturbation within a wetland or its environmental setting that is likely to negatively impact the condition and function of the CRAM Assessment Area (AA). A disturbance is a natural phenomenon that affects the AA.

There are four underlying assumptions of the Stressor Checklist: (1) deviation from the best achievable condition can be explained by a single stressor or multiple stressors acting on the wetland; (2) increasing the number of stressors acting on the wetland causes a decline in its condition (there is no assumption as to whether this decline is additive (linear), multiplicative, or is best represented by some other non-linear mode); (3) increasing either the intensity or the proximity of the stressor results in a greater decline in condition; and (4) continuous or chronic stress increases the decline in condition.

The process to identify stressors is the same for all wetland types. For each CRAM attribute, a variety of possible stressors are listed. Their presence and likelihood of significantly affecting the AA are recorded in the Stressor Checklist Worksheet. For the Hydrology, Physical Structure, and Biotic Structure attributes, the focus is on stressors operating within the AA or within 50 m of the AA. For the Buffer and Landscape Context attribute, the focus is on stressors operating within 500 m of the AA. More distant stressors that have obvious, direct, controlling influences on the AA can also be noted.

Table 30: Wetland disturbances and conversions

Has a major disturbance occurred at this wetland?	Yes	No		
If yes, was it a flood, fire, landslide, or other?	flood	fire	landslide	other
If yes, then how severe is the disturbance?	likely to affect site next 5 or more years	likely to affect site next 3-5 years	likely to affect site next 1-2 years	
Has this wetland been converted from another type? If yes, then what was the previous type?	depressional	vernal pool	vernal pool system	
	non-confined riverine	confined riverine	seasonal estuarine	
	perennial saline estuarine	perennial non-saline estuarine	wet meadow	
	lacustrine	seep or spring	playa	

Worksheet: Stressor Checklist

HYDROLOGY ATTRIBUTE (WITHIN 50 M OF AA)	**Present**	**Present and likely to have significant negative effect on AA**
Point Source (PS) discharges (POTW, other non-stormwater discharge)		
Non-point Source (Non-PS) discharges (urban runoff, farm drainage)		
Flow diversions or unnatural inflows		
Dams (reservoirs, detention basins, recharge basins)		
Flow obstructions (culverts, paved stream crossings)		
Weir/drop structure, tide gates		
Dredged inlet/channel		
Engineered channel (riprap, armored channel bank, bed)		
Dike/levees		
Groundwater extraction		
Ditches (borrow, agricultural drainage, mosquito control, etc.)		
Actively managed hydrology		
Comments		

PHYSICAL STRUCTURE ATTRIBUTE (WITHIN 50 M OF AA)	**Present**	**Present and likely to have significant negative effect on AA**
Filling or dumping of sediment or soils **(N/A for restoration areas)**		
Grading/ compaction **(N/A for restoration areas)**		
Plowing/Discing **(N/A for restoration areas)**		
Resource extraction (sediment, gravel, oil and/or gas)		
Vegetation management		
Excessive sediment or organic debris from watershed		
Excessive runoff from watershed		
Nutrient impaired (PS or Non-PS pollution)		
Heavy metal impaired (PS or Non-PS pollution)		
Pesticides or trace organics impaired (PS or Non-PS pollution)		
Bacteria and pathogens impaired (PS or Non-PS pollution)		
Trash or refuse		
Comments		

BIOTIC STRUCTURE ATTRIBUTE (WITHIN 50 M OF AA)	Present	Present and Likely to Have Significant negative effect on AA
Mowing, grazing, excessive herbivory (within AA)		
Excessive human visitation		
Predation and habitat destruction by non-native vertebrates (e.g., *Virginia opossum* and domestic predators, such as feral pets)		
Tree cutting/sapling removal		
Removal of woody debris		
Treatment of non-native and nuisance plant species		
Pesticide application or vector control		
Biological resource extraction or stocking (fisheries, aquaculture)		
Excessive organic debris in matrix (for vernal pools)		
Lack of vegetation management to conserve natural resources		
Lack of treatment of invasive plants adjacent to AA or buffer		
Comments		

BUFFER AND LANDSCAPE CONTEXT ATTRIBUTE (WITHIN 500 M OF AA)	Present	Present and likely to have significant negative effect on AA
Urban residential		
Industrial/commercial		
Military training/Air traffic		
Dams (or other major flow regulation or disruption)		
Dryland farming		
Intensive row-crop agriculture		
Orchards/nurseries		
Commercial feedlots		
Dairies		
Ranching (enclosed livestock grazing or horse paddock or feedlot)		
Transportation corridor		
Rangeland (livestock rangeland also managed for native vegetation)		
Sports fields and urban parklands (golf courses, soccer fields, etc.)		
Passive recreation (bird-watching, hiking, etc.)		
Active recreation (off-road vehicles, mountain biking, hunting, fishing)		
Physical resource extraction (rock, sediment, oil/gas)		
Biological resource extraction (aquaculture, commercial fisheries)		
Comments		

CRAM Score Guidelines

Table 31: Steps to calculate attribute scores and AA scores.

Step 1: Calculate Metric Score	For each Metric, convert the letter score into the corresponding numeric score: A=12, B=9, C=6 and D=3.
Step 2: Calculate raw Attribute Score	For each Attribute, calculate the Raw Attribute Score as the sum of the numeric scores of the component Metrics, except in the following cases: • For Attribute 1 (Buffer and Landscape Context), the submetric scores relating to buffer are combined into an overall buffer score that is added to the score for the Aquatic Area Abundance metric, using the following formula: $\left(\text{Buffer Condition} \times \left(\text{\% AA with Buffer} \times \text{Average Buffer Width} \right)^{1/2} \right)^{1/2} + \text{Aquatic Area Abundance}$ • For Attribute 2, the Hydrologic Connectivity metric is split into two sub-metrics for Channeled Wet Meadows. Prior to calculating the Raw Attribute Score, average the 2 sub-metrics. Then sum the result with the other two Hydrology metrics. For all other Slope wetlands, simply sum the three Hydrology metrics. • For Attribute 4 (Biotic Structure), prior to calculating the Raw Attribute Score, average the three or four Plant Community submetrics (A-D for Channeled Wet Meadows, Forested Slopes and Seeps and Springs, B-D for Non-Channeled Meadows). Then sum this result with the other two Biotic Structure metrics for the Raw Attribute Score. • **Do not** round the Raw Attribute scores to the nearest integer.
Step 3: Calculate final Attribute Score	For each Attribute, divide its Raw Attribute Score by its maximum possible score, which is 24 for Buffer and Landscape Context, 36 for Hydrology, 24 for Physical Structure, and 36 for Biotic Structure. **Do not** round the final Attribute scores to the nearest integer before calculating the AA Index Score. You may round the final Attribute score to the nearest integer for reporting purposes.
Step 4: Calculate the AA Index Score	Calculate the AA Index score by averaging the Final Attribute Scores (with all significant figures: not rounded). Round this average to the nearest integer to get the AA Index Score (0.5 or greater rounds up, less than 0.5 rounds down).

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