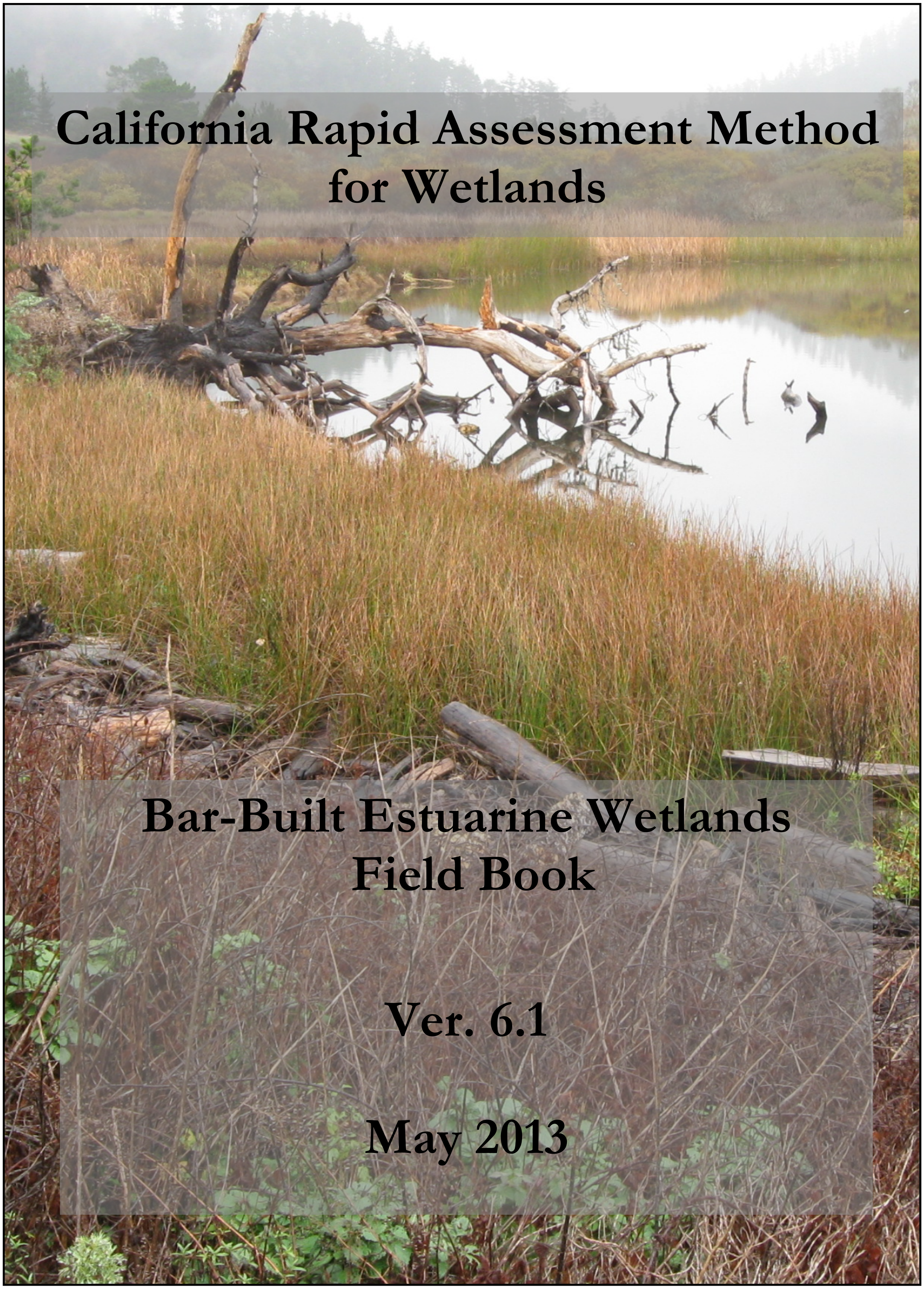


California Rapid Assessment Method for Wetlands

Bar-Built Estuarine Wetlands Field Book

Ver. 6.1

May 2013

Basic Information Sheet: Bar-built Estuarine Wetlands

Assessment Area Name:	
Project Name:	
Assessment Area ID #:	
Project Site ID #:	**Date:**
Assessment Team Members for This AA	
AA Location: **Latitude:** **Longitude:** **Datum:**	
AA Category: ☐ Restoration ☐ Mitigation ☐ Impacted ☐ Ambient ☐ Reference ☐ Training ☐ Other:	
AA Encompasses: ☐ entire wetland ☐ portion of the wetland	
What best describes the tidal stage over the course of the time spent in the field? Note: It is recommended that the assessment be conducted during low tide. ☐ high tide ☐ low tide	
What best describes the condition of the mouth of the estuary over the course of the time spent in the field? ☐ fully open to tidal inputs ☐ partially open to tidal inputs or overwash of waves ☐ closed to tidal inputs	
Please indicate of your aerial image the location of the mouth if it is not correctly depicted.	

Photo Identification Numbers and Description:

	Photo ID No.	Description	Latitude	Longitude	Datum
1		North			
2		South			
3		East			
4		West			
5					
6					
7					
8					
9					
10					

Site Location Description:

Comments:

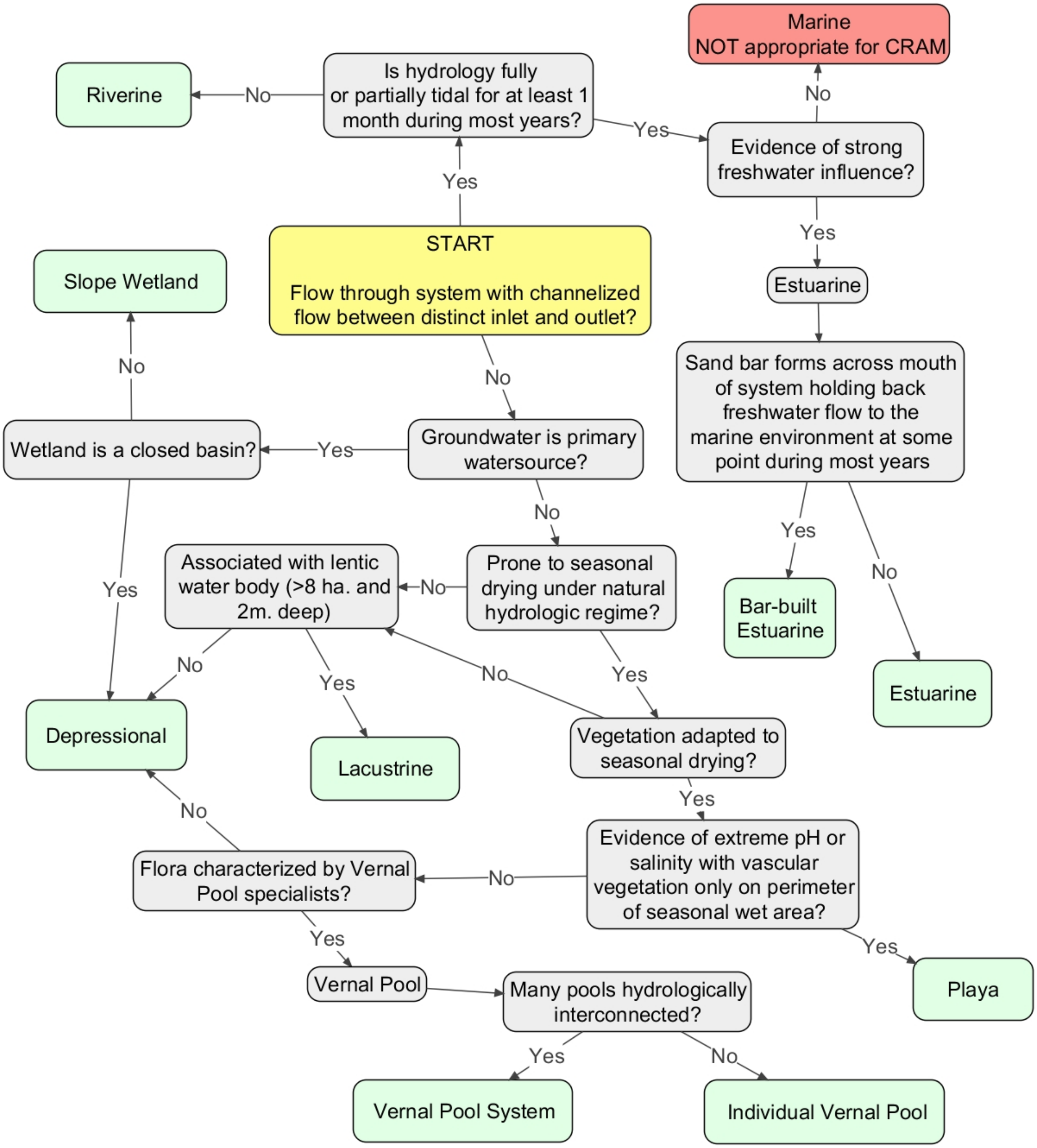
Scoring Sheet: Bar-built Estuarine Wetlands

AA Name:				**Date:**
Attributes and Metrics			**Scores**	**Comments**
Attribute 1: Buffer and Landscape Context (pp. 8-18)				
	Alpha	*Numeric*		
Aquatic Area Abundance Submetric 1: Stream Corridor Continuity				
Aquatic Area Abundance Submetric 2: Adjacent Aquatic Area				
Aquatic Area Abundance Submetric 3: Marine Connectivity				
Buffer submetric A: Percent of AA with Buffer				
Buffer submetric B: Average Buffer Width				
Buffer submetric C: Buffer Condition				
Raw Attribute Score= $((1+2+3)/3)+[\,C \text{ x } (A \text{ x } B)^{1/2}]^{1/2}$				**Final Attribute Score** = (Raw Score/24)100
Attribute 2: Hydrology (pp. 19-22)				
			Alpha / *Numeric*	
Water Source				
Hydroperiod				
Hydrologic Connectivity				
Raw Attribute Score= sum of numeric scores				**Final Attribute Score** = (Raw Score/36)100
Attribute 3: Physical Structure (pp. 23-30)				
			Alpha / *Numeric*	
Structural Patch Richness				
Topographic Complexity				
Raw Attribute Score= sum of numeric scores				**Final Attribute Score** = (Raw Score/24)100
Attribute 4: Biotic Structure (pp. 31-41)				
	Alpha	*Numeric*		
Plant Community submetric A: Number of Plant Layers				
Plant Community submetric B: Number of Co-dominant species				
Plant Community submetric C: Percent Invasion				
Plant Community Metric (*average of submetrics A-C*)				
Horizontal Interspersion				
Vertical Biotic Structure				
Raw Attribute Score= sum of numeric scores				**Final Attribute Score** =(Raw Score/36)100

Overall AA Score= Average of four final Attribute Scores	

Identify Wetland Type

Figure 1: Flowchart to determine CRAM wetland type.



Bar-built Estuary Wetland Sub-type

Bar-built estuaries treated by this CRAM module are the reaches of coastal rivers and streams that are ecologically influenced by seasonal closures of their tidal inlets. The frequency and duration of inlet closure can be natural or managed. The tidal regime can be muted or not (i.e., the tidal range can be the same or less than that of the adjacent marine or estuarine system when the tidal inlet is open). The salinity regime of a bar-built estuary can be highly variable. It can be fresh throughout very wet years or hypersaline during extended droughts. Bar-built estuaries covered by this module are often referred to as "lagoons;" geomorphologically this term refers to any coastal water feature behind a bay-mouth bar.

This module is not used for large coastal lagoons, such as Big Lagoon and Stone Lagoon in Humboldt County and Lake Earl/Tolowa in Del Norte County, even though these lagoons are intermittently tidal. These lagoons are not associated with significant fluvial sediment sources from streams or rivers, and their hydrodynamics differ from the bar-built estuaries covered by this module. These large lagoons are covered, in part, by the Lacustrine Module, and additional development work in appropriate elements of other modules is in progress.

It should be noted that tidal influences on streamflow dynamics may extend many meters above the upstream limit of estuarine mixing when estuaries are open to full tidal exchanges, but this module does not apply to tidal but non-estuarine reaches of rivers or streams. Additionally, if a system has been altered such that hardened structures at its mouth prevent the formation of a sand bar that would close off the system to marine influence, this is considered a type change to a perennially saline estuary and is not covered by this module.

Establish the Assessment Area (AA)

Often it is difficult to establish the upstream limit of bar-built estuaries and as a result, the upstream extent will be determined by the 10-foot contour combined with visual indicators, including a change in wetland type or a significant hydrologic break, such as the presence of tide gates.

Indicators up upstream extent of which AA should not extend past:

- riffle (or rapid) transitions from a riverine wetland into an estuarine wetland
- upstream extent of ponding influence of mouth closure, which can be indicated by the transition from cobble substrate to sand/silt substrate, indicating a shift to a depositional environment
- indicators of head of tide such as bare areas along the edge of the bank indicating water level changes of wetland from opening and closing of mouth to ocean influence
- obvious changes in vegetation type from salt tolerant to non-salt tolerant, or from emergent marsh to willow/riparian
- Prominent wrackline indicating maximum high water height

Frequently bar-built estuaries are small and the AA may encompass the entire wetland. In either case, the AA should include the vegetation near the mouth of the estuary (where cover exceeds 10%) and extend inland to the limits describe above. The main channel and any side channels will be included, and the AA will extend to the top of the banks of these features where a break in slope is observed. The AA can extend across the marsh plain between these features as well.

The AA should not extend above the backshore, as indicated by wrack lines, and transitions from tidal to upland vegetation. However, the backshore (landward boundary) of the AA will include any adjacent riparian vegetation that directly overhangs the wetland, including the entire footprint of individual trees or plants that overhang the wetland. If riparian vegetation does not overhang the wetland, include an area 2 meters wide extending landward from the backshore as part of the AA.

The AA should not extend into any hyrologically isolated (at high water) wetlands on the marsh plain (i.e. perched fresh water ponds). Additionally, the AA should not cross across any channel that is wider than 50 m or that cannot be safely crossed at low tide. The boundary of the AA can extend along the midline of such channels but not across them.

Figure 2. Example wetland area and Assessment Area in a Bar-built Estuary.

Table 1: Examples of features that *should* be used to delineate AA boundaries.

- diversion ditches
- end-of-pipe large discharges
- grade control or water height-control structures
- major channel confluences
- open water areas more than 30 m wide on average or broader than the wetland
- transitions between wetland types, such as riverine to estuarine at the inward extent of the estuarine wetland
- foreshores, backshores and uplands at least 5 m wide
- weirs, culverts, dams, levees, and other flow control structures

Table 2: Examples of features that *should not* be used to delineate any AAs.

- 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
- spatial changes in land cover or land use along the wetland border
- state and federal jurisdictional boundaries

Table 3: Recommended maximum and minimum AA size

Bar-built Estuaries	Maximum size is 2.25 ha (about 150 m x 150 m, but shape can vary); minimum size is 0.1 ha (about 30m x 30m).

Special Note:

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

Attribute 1: Buffer and Landscape Context

Metric 1: Aquatic Area Abundance

Definition: The Aquatic Connectivity Attribute in BBE CRAM is an index of the degree to which an Assessment Area is able to provide ecological connectivity among aquatic features in its landscape setting. It is assessed in terms of its spatial association with other areas of aquatic features. This Attribute considers all aquatic features, including those common to bar-built estuaries such as beaches, dune swale wetlands, palustrine back-water habitats, historic channels, riverine and side inputs. Ecological data indicate that systems which retain this wetland complexity provide a variety of wetland functions and provide habitat for a variety of species. Additionally, multiple wetland types in close proximity have a greater potential to interact ecologically and hydrologically, and such interactions are generally beneficial.

The aquatic connectivity metric is composed of **three submetrics** which take into account the influence of the riverine, adjacent wetland habitats, and the link to the marine environment. The submetrics contribute equally to the metric score, which is computed as the average of the three submetric scores.

Submetric 1: Stream Corridor Continuity

For bar-built estuaries, aquatic connectivity with the riverine system is assessed as the continuity of the stream corridor over a distance of 500 m upstream of the wetland that contains the AA. Of special concern is the ability of wildlife to enter the riparian area from outside of it at any place within 500 m of the AA, and to move easily through adequate cover along the stream corridor through the AA from upstream. The stream corridor continuity of bar-built estuaries is assessed as the total amount of non-buffer land cover (as defined in Table 8) that interrupts the average width of the stream corridor at the transition from estuarine habitat to riverine habitat within 500 m upstream of the bar-built estuary that contains the AA. Areas of non-buffer land cover that extend for less than 10 m along the transect are disregarded in this metric. Both sides of the stream are considered.

Note that, for stream corridor continuity, this metric considers areas of open water to provide connectivity and is therefore considered part of the stream corridor. This acknowledges the role the stream corridors have in linking together aquatic habitats and in providing habitat for anadromous fish and other wildlife.

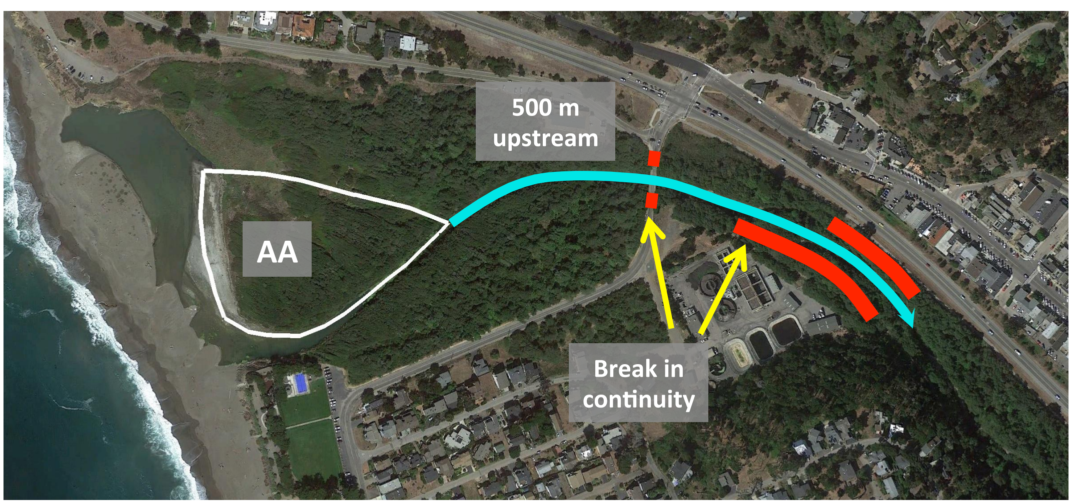


Figure 3. Diagram of method to assess Stream Corridor Continuity of BBE wetlands. This example shows 4 locations (red bars) where width of stream corridor is decreased within 500 m upstream (blue line with arrow) of the wetland that contains the AA. The first two are due to the bridge crossing and are 10 m long. The third, which is about 160 m long, is on the south side due to the wastewater treatment facility. The fourth, which is about 100 m long, is on the north side due to the encroachment of the road. The total length of "non-buffer" segments is about 280 m.

Table 4: Steps to assess Submetric 1 of Aquatic Area Abundance for Bar-built Estuarine wetlands

Step 1	Extend a line 500 m upstream from the transition from estuarine to riverine wetland, regardless of the land cover types that are encountered.
Step 2	Using the site imagery, identify all the places where non-buffer land covers (see Table 8) at least 10 m long interrupt the width of the stream corridor on at least one side of the channel in the 500 m of riverine wetland. Disregard interruptions of the stream corridor that are less than 10 m long. Do not consider open water as an interruption.
Step 3	Estimate the length of each non-buffer segment identified in Step 2, and enter the estimates in the worksheet for this metric.

Worksheet for Submetric 1 of Aquatic Area Abundance Metric for Bar-built Estuarine wetlands

Lengths of Non-buffer Segments For Distance of 500 m Upstream of AA	
Segment No.	Length (m)
1	
2	
3	
4	
5	
Upstream Total Length	

Special Notes:

**Assume the riparian width is the same upstream and downstream as it is for the AA, unless a substantial change in width is obvious for a distance of at least 100 m.*

**To be a concern, a "non-buffer" segment must cross the riparian area on at least one side of the AA.*

For the purpose of assessing aquatic connectivity for riverine wetlands, open water* ***is* *considered part of the riparian corridor. This acknowledges the role the riparian corridors have in linking together aquatic habitats and in providing habitat for anadromous fish and other wildlife. However, for the purpose of assessing buffers, open water is considered a non-buffer land cover.*

**A bridge crossing the stream that is at least 10 m wide will interrupt the riparian corridor on both sides of the stream so is counted twice, once for right bank amd once for left bank.*

Table 5: Rating for Submetric 1 of Aquatic Area Abundance for Bar-built Estuarine wetlands

Rating	For Distance of 500 m Upstream of AA:
A	The combined total length of all non-buffer segments is less than 100 m.
B	The combined total length of all non-buffer segments is between 100 m and 150 m.
C	The combined total length of all non-buffer segments is between 150 m and 200 m.
D	The combined total length of non-buffer segments is greater than 200 m.

Submetric 2: Adjacent Aquatic Area

On digital or hardcopy site imagery, draw 4 straight lines (2 on each side) extending 500 m from the AA boundary going out, aligned perpendicular to the main flow direction of the wetland. If the AA is located adjacent to the beach, draw the lines parallel to the shoreline so the score in not inflated by having the lines pass over the ocean. Along each transect line, estimate the percentage of the segment that passes through wetland habitat of any kind, including wetlands, other aquatic features, and open water. Use the worksheet below to record these estimates.

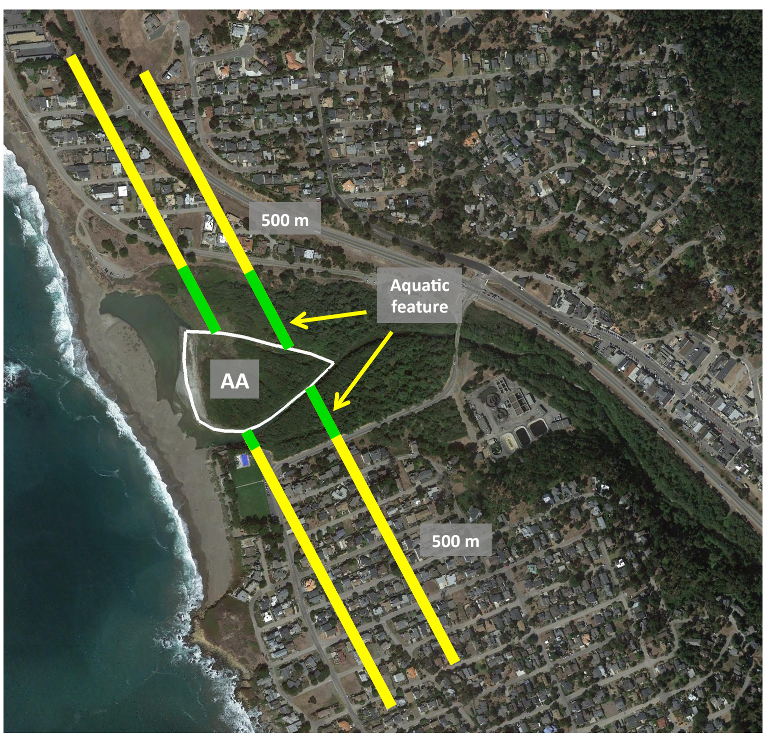


Figure 4. Diagram illustrating the method to assess the Adjacent Aquatic Area of BBE wetlands. The green portions of the 500 m yellow bars indicate portions of the line that pass through wetland or aquatic habitat. The example shows that an average of 20% of the four 500 m long transects cross an aquatic feature of any kind.

Worksheet for Submetric 2 of Aquatic Area Abundance for Bar-built Estuarine wetlands

Percentage of Transect Lines that Contains an Aquatic Feature of Any Kind	
Segment Direction	Percentage of transect length that is an Aquatic Feature
Line 1	
Line 2	
Line 3	
Line 4	
Average Percentage of Transect Length that is an Aquatic Feature ***Round to the nearest integer***	

Table 6: Rating for Submetric 2 of Aquatic Area Abundance for Bar-built Estuarine wetlands

Rating	Alternative States
A	An average of ≥61% of the transects pass through an aquatic feature of any kind.
B	An average of ≥31 -60 % of the transects pass through an aquatic feature of any kind.
C	An average of ≥11 - 30 % of the transects pass through an aquatic feature of any kind.
D	An average ≤10% of the transects pass through an aquatic feature of any kind.

Submetric 3: Marine Connectivity

Go 500 m up-coast and down-coast of the midpoint of the lagoon system and measure indicators of altered sediment supply or marine nutrient supply or connectivity. The center point is measured directly out from the center of the main stream channel (rather than where the lagoon is breached at any particular point in time).

Alterations to sediment supply include barriers to sand migration such as jetties, seawalls/riprap, piers, bridges, and dunes stabilized by invasive species. Indicators of altered marine connectivity include groomed beaches, or evidence of intense human visitation (for example: high density trashcans, volleyball courts, or tire tracks). Look at the entire width of the beach and look at indicators on the beach or the back edge of the beach.

A combination of field recognizance and aerial image interpretation should be used to assess this submetric.

Figure 5. Diagram illustrating the method to assess the Marine Connectivity of BBE wetlands. The orange dot represents the center of the main stream channel, with 500 m yellow transects extending north and south along the coastline. The red bar represents the portion of the coastline with an alteration to sediment supply and transport. This portion of the shoreline is armored with rip-rap.

Table 7: Rating for Submetric 3 of Aquatic Area Abundance for Bar-built Estuarine wetlands

Rating	Alternative States
A	There are no signs of altered sediment supply or marine connectivity on the beach up-coast and down-coast 500 m.
B	Less than 500m up-coast and down-coast has evidence of altered sediment supply AND/OR marine connectivity
C	500-900m of the transect up-coast and down-coast has evidence of altered sediment supply OR marine connectivity
D	More than 500 meters of the transect up-coast and down-coast has evidence of altered sediment supply AND marine connectivity OR more than 900 meters up-coast and down-coast has evidence of altered sediment supply OR marine connectivity

Metric 2: Buffer

Definition: The buffer is the 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 forays into the AA by people and non-native predators, or otherwise protect the AA from stress and disturbance.

To be considered as buffer, a suitable land cover type must be at least 5 m wide starting at the edge of your AA extending perpendicular to the channel and extend along the perimeter of the AA (measured parallel to the channel) 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 Note:

**Any area of open water at least 30 m wide that is adjoining the AA, such as a lake, large river, or large slough, is not considered in the assessment of the buffer. 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.*

Submetric A: Percent of AA with Buffer

Definition: This submetric is based on the relationship between the extent of buffer and the functions provided 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 that is surrounded by at least 5 meters of buffer land cover (Figure 3). The upstream and downstream edges of the AA are not included in this metric, only the edges parallel to the stream.

In the example below (Figure 3), most of the area around the AA (outlined in white) consists of non-buffer land cover types. The AA adjoins a major roadway, parking lot, and other development that is a non-buffer land cover type. There is a nearby wetland but it is separated from the AA by a major roadway and is not considered buffer. The open water area is neutral and not considered in the estimation of the percentage of the AA perimeter that has buffer. In this example, the only areas that would be considered buffer is the area labeled "Upland Buffer".

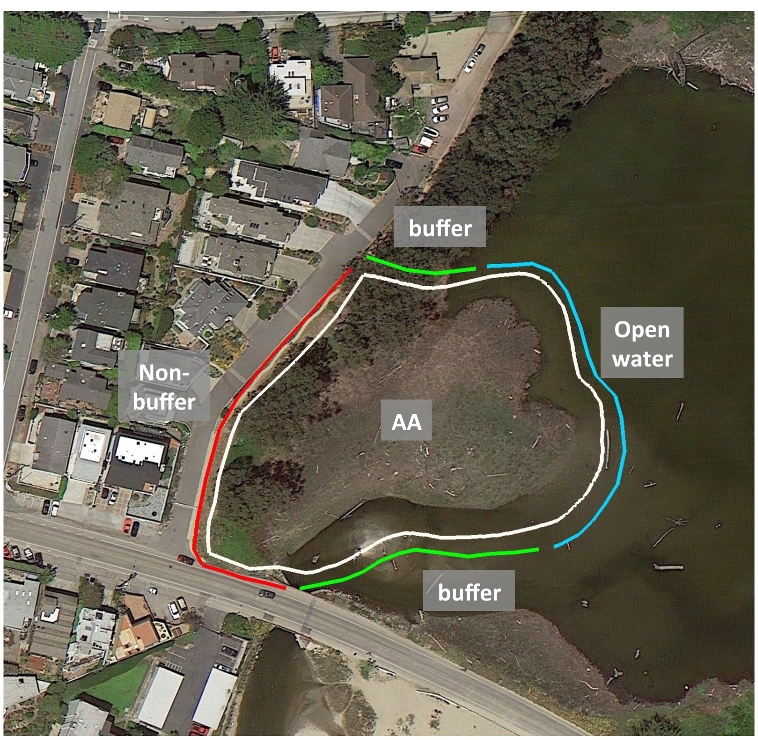


Figure 6: Diagram of buffer (green) and non-buffer (red) land cover types for a BBE assessment area (white polygon). The open water area (blue) adjoining the AA is neutral in the calculation of percent with buffer. Of the remaining perimeter of the AA, about 45% has buffer adjoining the AA that is at least 5 m wide. The non-buffer landcover types include roads and urban landscape.

Table 8: Guidelines for identifying wetland buffers and breaks in buffers.

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) • lawns • active railroads (more than 2 trains per day) • 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)

Percent of AA with Buffer Worksheet.
In the space provided below 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.

Percent of AA with Buffer: ____________ %

Table 9: Rating for Percent of AA with Buffer.

Rating	Alternative States (not including 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 around the AA from its perimeter outward to the nearest non-buffer land cover or 250 m, which ever 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 8 above for more guidance regarding the identification of AA buffers.

Table 10: Steps to estimate Buffer Width.

Step 1	Identify areas in which open water is directly adjacent to the AA, with <5 m between the edge of the AA and the open water. **These areas are excluded from buffer calculations.**
Step 2	From the previous sub-metric, identify the areas that have buffer adjacent to the AA.
Step 3	For the area that has been identified as having buffer, draw eight straight lines 250 m in length perpendicular to the AA at regularly spaced intervals starting at the AA boundary (see Figure 4 below).
Step 4	Estimate the buffer width of each of the lines as they extend away from the AA. Record these lengths on the worksheet below.
Step 5	Calculate the average buffer width. Record this width on the worksheet below.

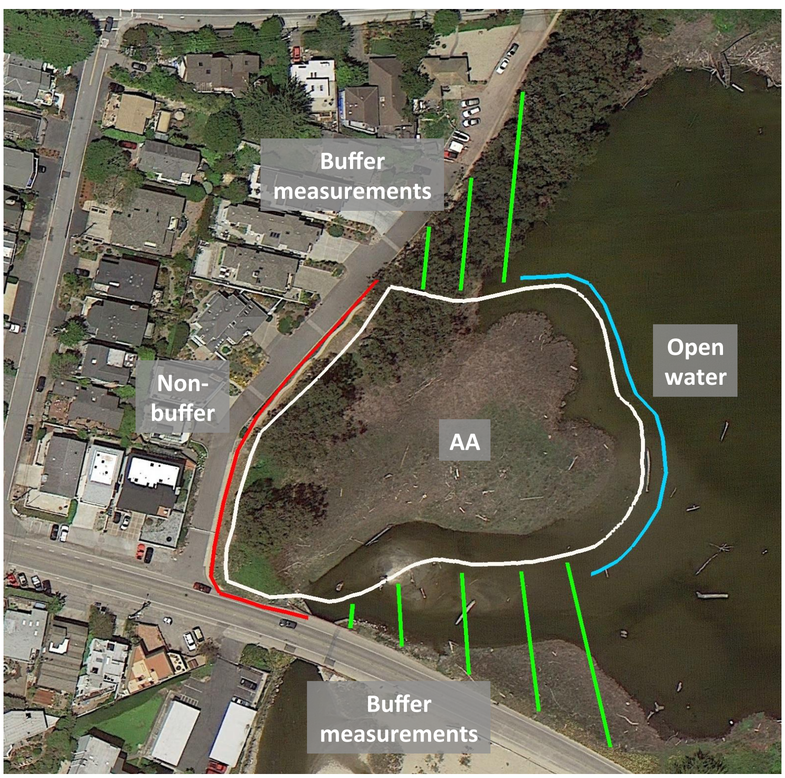


Figure 7: Examples of the method used to estimate Buffer Width. The average width is based on the lengths of eight lines that extend at regular intervals out from the edge of the AA (white polygon). Buffer lines (green) are drawn where buffer is present (determined in the previous submetric), excluding non-buffer areas (red) and the open water area (blue) that directly adjoins the AA.

Worksheet for calculating average buffer width of AA

Line	Buffer Width (m)
A	
B	
C	
D	
E	
F	
G	
H	
Average Buffer Width ***Round to the nearest integer***	

Table 11: Rating for average buffer width.

Rating	Alternative States
A	Average buffer width is >190 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 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 4). 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. If there is no buffer, assign a score of D.

Figure 8. Example of buffer areas outside of the AA (white polygon) to be considered for assessment in the buffer condition metric for BBE wetlands (green shaded areas). Portions of the area directly adjacent to the AA that are open water (blue) and non-buffer landcover types (red) are not assessed.

Table 12: Rating for Buffer Condition.

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

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	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 low impact human visitation.
	OR
	Buffer for AA is dominated by native vegetation, but shows some soil disturbance and is apparently subject to 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

Metric 1: Water Source

Definition: Water sources directly affect the extent, duration, and frequency of the hydrological dynamics 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 are considered a 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 hydrologic regime of the AA. Inputs of water affecting conditions during the dry season are especially important because they strongly influence the structure and composition of wetland plant and animal communities. The Water Source metric therefore focuses on conditions that affect dry season hydrology.

Natural sources of water for estuarine wetlands include by definition a combination of marine (i.e., tidal) and riverine (i.e., fluvial) sources. This metric is focused on the non-tidal water sources that account for the conditions during the growing season, regardless of the time of year when these sources exist. Examples of unnatural sources include stormdrains that empty into the AA or into the watershed upstream, or irrigation runoff from agriculture. 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 hydrologic 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 rainy season storm events and reduces infiltration that supports base flow discharges during the drier seasons later in the year. Although flows that are influenced by hydromodification usually happen during the wet season, the change in hydrologic dynamics strongly affects conditions in the stream during the dry season.

To assess water source, the plant species composition of the wetland should be compared to what is expected, in terms of the position of the wetland along the salinity gradient of the estuary, as adjusted for the overall wetness of the water year. In general, altered sources are indicated by vegetation that is either more tolerant of saline conditions or less tolerant than would be expected. If the plant community is unexpectedly salt-tolerant, then an unnatural decrease in freshwater supply is indicated. Conversely, if the community is less salt-tolerant than expected, than an unnatural increase in freshwater is indicated.

To score this metric use site aerial imagery and any other information collected about the region or watershed surrounding the AA to assess the water sources within an area about 2 km upstream of the AA. If there are features more than 2km upstream that directly affect the quantity and quality of water entering the estuary from the riverine system these can be considered. For example, if there is a publicly owned treatment works (POTW) 3km upstream that supplies the majority of the water to the stream during the dry season, this should not be ignored. Or if there are large withdrawals in the upper reaches of a small watershed that substantially affect the water supply to the estuary these should be considered.

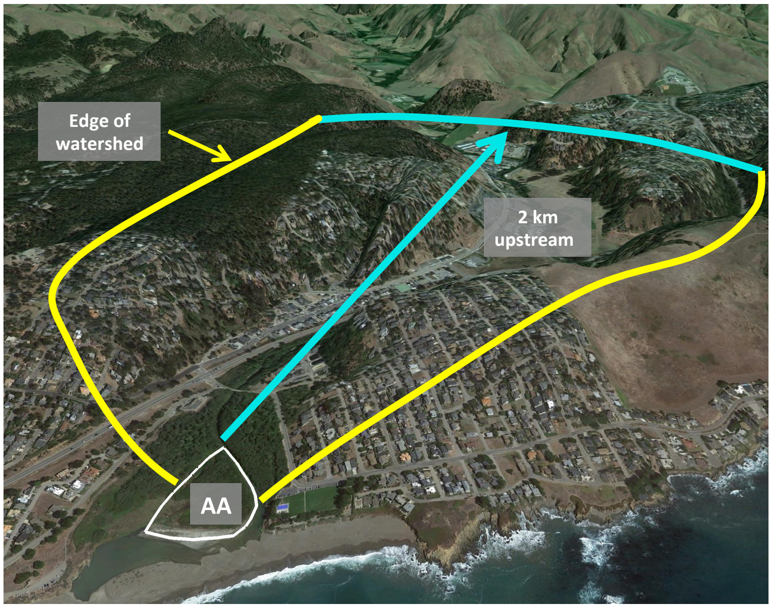


Figure 9. Diagram of approach to assess water sources affecting an AA showing an oblique view of the watershed. After identifying the portion of the aerial imagery that constitutes the area of the watershed directly contributing to the AA (yellow lines), assess the freshwater sources in a 2 km region (blue line) upstream of the AA (white polygon).

Table 13: Rating for Water Source.

Rating	Alternative States
A	Freshwater sources that affect the dry season condition of the AA, such as its flow characteristics, hydroperiod, or salinity regime, are precipitation, groundwater, and/or 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 water sources.
B	Freshwater sources that affect the dry season condition of the AA are mostly natural, but also obviously include occasional or small effects of modified hydrology. Indications of such anthropogenic inputs include developed land or irrigated agricultural land that 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. No large point sources or dams control the overall hydrology of the AA.
C	Freshwater sources that affect the dry season conditions of the AA are primarily urban runoff, direct irrigation, pumped water, artificially impounded water, water remaining after diversions, regulated releases of water through a dam, or other artificial hydrology. Indications of substantial artificial 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 presence of major point source discharges that obviously control the hydrology of the AA. OR Freshwater sources that affect the dry season conditions of the AA are **substantially controlled** by known diversions of water or other withdrawals directly from the AA, its encompassing wetland, or from its drainage basin.
D	Natural, freshwater sources that affect the dry season conditions of the AA have **been eliminated** based on the following indicators: impoundment of all possible wet season inflows, diversion of all dry-season inflow, predominance of xeric vegetation, etc.

Metric 2: Hydroperiod

Definition: Hydroperiod is the characteristic frequency and duration of inundation or saturation of a wetland during a typical year. The natural hydroperiod for bar-built estuarine wetlands can be highly variable seasonally due to intra-annual variations in freshwater inputs and breaching of the tidal barrier. Additionally, bar-built estuaries typically have daily variations in water height that are governed by diurnal increases in evapotranspiration and beach over-wash from the marine environment.

Hydroperiod alteration can be inferred from atypical wetting and drying patterns along the shoreline. Dikes, levees, ponds, ditches, tide-control structures, and physical lagoon mouth management are indicators of an altered hydroperiod resulting from management for flood control, salt production, waterfowl hunting, mosquito control, boating, etc. Additional indicators include plants exhibiting salt stress (increase in breaching relative to natural conditions) and changes in the distribution of salt tolerant vs. non-tolerant plants. The presence of SAV in the main channel may indicate that there is very **little** active breaching of the system. Table 14 provides narratives for rating Hydroperiod for bar-built estuarine wetlands.

The Hydroperiod metric is scored by assessing the nature of mouth management or anthropogenic breaching and the presence of barriers to mouth migration. In bar-built estuaries breaching occurs naturally one or more times per year, but in some cases artificial breaching can be a major stressor to species that use these systems. Therefore the level of artificial breaching is a factor in scoring this metric. Barriers to mouth migration can also be a major stressor to these systems as they prevent natural dynamics and sediment movement. A bridge spanning the entire mouth would not constitute a barrier if it allows for free movement of the lagoon mouth location up or down coast between headlands. However, an earthen bridge crossing more than a third of the valley would constitute a barrier. Other barriers to mouth migration could be roadfill, jetties, breakwater, or levees.

Table 14: Rating of Hydroperiod for Bar-built Estuarine wetlands.

Rating	Alternative States
A	AA is subject to natural intra-annual tidal fluctuations (range may be severely muted or vary seasonally), and episodically has tidal inputs by natural breaching due to either fluvial flooding or wave overtopping **and** there **are no** anthropogenic barriers to mouth migration.
B	AA is subject to natural interannual tidal fluctuations (range may be severely muted or vary seasonally), and episodically has tidal inputs by natural breaching due to either fluvial flooding or storm surge **and** there **are** anthropogenic barriers to mouth migration (such as road fill, jetties, breakwaters, levees). **OR** AA is subject to tidal inputs more often than would be expected under natural circumstances, because of artificial breaching of the tidal inlet, but the inlet is allowed to close through natural formation of a sandbar, **and** there are no anthropogenic barriers to mouth migration.
C	AA is subject to tidal inputs more often than would be expected under natural circumstances, because of artificial breaching of the tidal inlet, but the inlet is allowed to close through natural formation of a sandbar **and** there **are** anthropogenic barriers to mouth migration.
D	AA is subject to both increased and decreased tidal inputs during different times of the year due to management of the inlet to prevent its opening and because of artificial breaching of the tidal inlet. Natural fluvial processes still sometimes act on the system, but are subject to modifications by human management **and** there **are** anthropogenic barriers to mouth migration.

Metric 3: Hydrologic Connectivity

Definition: Hydrologic Connectivity describes the ability of water to flow into or out of the wetland, to inundate its adjacent upland transition zones, allowing the system to accommodate rising flood waters without dramatic changes in water level, which can result in stress to wetland plants and animals. Additionally, the presence of this transition zone between the wetland and the upland provides varied saturation zones and their associated habitats and increases complexity.

This metric is scored by assessing the degree to which the lateral movements of rising waters are restricted by features such as very steep banks, levees, concrete walls, rip-rap, or road grades in the AA, **its encompassing wetland** and the associated upland transition zone. In smaller estuarine systems the entire wetland will be assessed, however, in larger systems this metric should be assessed only for the part of the wetland within about 500 meters of the AA.

For estuarine wetlands, this metric should be scored by considering anthropogenic restrictions on the tidal or fluvial hydrology. **The percentage of restriction should be calculated only in consideration of those features (levees, dikes, seawalls, transportation infrastructure, or other fills) that restrict flood tides.**

Indicate on your aerial imagery where restrictions to the lateral movement of flood waters exist.

Table 15: Rating of Hydrologic Connectivity for Bar-built Estuarine wetlands

Rating	Alternative States
A	Rising water in the wetland that contains the AA has unrestricted access to adjacent areas, without levees, dikes or other obstructions to the lateral movement of flood waters.
B	There are unnatural features such as levees, dikes or road grades that limit the amount of adjacent transition zone or the lateral movement of flood waters, relative to what is expected for the setting. But, the limitations exist for **less than 50%** of the boundary of wetland that contains the AA. Restrictions may be intermittent along margins of the wetland, or they may occur only along one bank or shore of the wetland.
C	The amount of adjacent transition zone or the lateral movement of flood waters is limited, relative to what is expected for the setting, by unnatural features, such as levees, dikes or road grades, for **50-90%** of the wetland that contains the AA.
D	The amount of adjacent transition zone or the lateral movement of flood waters is limited, relative to what is expected for the setting, by unnatural features, such as levees, dikes or road grades, for **more than 90%** of the wetland that contains the AA.

Attribute 3: Physical Structure

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.

Special Note:

**Physical patches can be natural or unnatural.*

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

Patch Type Definitions:

Abundant wrackline or organic debris in channel or on floodplain. Wrack is an accumulation of natural or unnatural floating debris along the high water line of a wetland. The organic debris must be free of its original growth position. Senesced plant material that is still attached to the parent plant does not count (for example, last year's cattail or bulrush growth)

Animal mounds and burrows. 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.

Backwater habitats. These habitats, which are of shoots of a main channel, a hydrologically linked depression off the channel, or tributary channels that originate in the wetland and that only convey flow between the wetland and the primary channel. For example, short tributaries that are entirely contained within the CRAM Assessment Area (AA) are regarded as backwater habitats. They provide flood refuge during high flow events to salmonids, tide water gobies, and invertebrates.

Bank slumps or undercut banks in channels or along shorelines. A bank slump is a portion of a depressional, estuarine, or lacustrine 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.

Cobble and boulders. Cobble and boulders are rocks of different size categories. The long axis of cobble ranges from about 6 cm to about 25 cm. A boulder is any rock having a long axis greater than 25 cm. Submerged cobbles and boulders provide abundant habitat for aquatic macroinvertebrates and small fish. Exposed cobbles and boulders provide roosting habitat for birds and shelter for amphibians. They contribute to 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.

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.

Debris jams. A debris jam is an accumulation of driftwood and other flotage across a channel that partially or completely obstructs surface water flow and sediment transport, causing a change in the course of flow.

Filamantous Macroalgae and algal mats. Macroalgae occurs on benthic sediments and on the water surface of all types of wetlands. 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.

Plant hummocks or sediment mounds. Hummocks are mounds created by plants along the banks and floodplains of tidal systems created by the collection of sediment and biotic material around wetland plants. Hummocks are typically less than 1m high. Sediment mounds are similar to hummocks but lack plant cover. They are depositional features formed from repeated flood flows depositing sediment on the floodplain.

Large woody debris in channel exposed above high water. Large woody debris and logs in the channel and embayment of the estuary, but exposed above high water, provide essential basking and resting habitat for turtles and birds that use these systems. Large woody debris or logs should be more than 3 m long and greater than 30 cm diameter.

Large woody debris on marsh plain. Large woody debris and logs on the marsh plain provide important habitat for amphibians and invertebrates. Large woody debris or logs should be more than 3 m long and greater than 30 cm diameter.

Non-vegetated flats (sandflats, mudflats, gravel flats, etc.). A flat is a non-vegetated area of silt, clay, sand, shell hash, gravel, or cobble at least 10 m wide and at least 30 m long that adjoins the wetland foreshore and is a potential resting and feeding area for fishes, shorebirds, wading birds, and other waterbirds. Flats can be similar to large bars (see definitions of point bars and in-channel bars below), except that they lack the convex profile of bars and their compositional material is not as obviously sorted by size or texture.

Pannes or pools on floodplain/off-channel habitats. 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, forming a pool. These are also know as off channel habitats in bar-built estuaries. They commonly serve as foraging sites for waterbirds and as breeding sites for amphibians.

Point bars and in-channel bars. Bars are sedimentary features within intertidal and fluvial channels. They are patches of transient bedload sediment that form along the inside of meander bends or in the middle of straight channel reaches. They sometimes support vegetation. They are convex in profile and their surface material varies in size from small on top to larger along their lower margins. They can consist of any mixture of silt, sand, gravel, cobble, and boulders.

Pools in channels/ residual embayment when bar is open. Pools are areas along tidal and fluvial channels that are much deeper than the average depths of their channels and that tend to retain water longer than other areas of the channel during periods of low or no surface flow. These are essential in a fully functioning bar-built estuary as they provide areas for spring feeding and salinity adjustment for salmonids. Additionally, they can serve as a refuge for benthic invertebrates when water levels get low. When the bar then closes and the estuary fills, the invertebrates can recolonize the embayment, providing food for a suite of other species that use these systems.

Riffles or rapids. Riffles and rapids are areas of relatively rapid flow and standing waves in tidal or fluvial channels. Riffles and rapids add oxygen to flowing water and provide habitat for many fish and aquatic invertebrates. In bar-built estuaries riffles are found in the fluvial outflow at the lower end of the system when the mouth is open. The riverine channel should be excluded from the AA, so riffles in the upstream stream channel are not counted as a patch type.

Secondary channels on floodplains or along shorelines. Channels confine and consist of a bed and its opposing banks, plus its floodplain. Estuarine and riverine wetlands can have a primary channel that conveys most flow, and one or more secondary channels of varying sizes that convey flood flows. The systems of diverging and converging channels that characterize braided and anastomosing fluvial systems usually consist of one or more main channels plus secondary channels.

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.

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 is considered a snag.

Submerged vegetation. Submerged vegetation consists of aquatic macrophytes such as *Elodea canadensis* (common elodea), and *Zostera marina* (eelgrass) 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 on floodplain or along shoreline. 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.

Upland habitat safe from flooding. Intact upland habitat safe from winter flooding, including terrace riparian vegetation, seasonally flooded isolated wetlands, sparse grassland and brushland, can provide overwintering and nesting habitat for frogs, turtles and snakes.

Variegated or crenulated foreshore. As viewed from above, the foreshore of a wetland can be mostly straight, broadly curving (i.e., arcuate), or variegated (e.g., meandering). In plan view, a variegated shoreline resembles a meandering pathway. Variegated shorelines provide greater contact between water and land. The term "foreshore" in this case refers to the strip of land at the margin of the water, but not specifically to a tidal height or location although it is sometimes defined this way by coastal geomorphologists.

Vegetated Islands (exposed at high-water stage). An island is an area of land above the usual high water level and, at least at times, surrounded by water in a riverine, lacustrine, estuarine, or playa system. Islands differ from hummocks and other mounds by being large enough to support trees or large shrubs.

Structural Patch Type Worksheet for Bar-built Estuarine wetlands

Check each type of patch that is observed in the AA and enter the total number of observed patches in Table 16 below. Each patch should occupy in aggregate at least 3 m^2 of area in the AA.

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

STRUCTURAL PATCH TYPE (check for presence)	Bar-built Estuarine
Minimum Patch Size	**3 m^2**
Abundant wrackline or organic debris in channel, on floodplain, or across depressional wetland plain	
Animal mounds and burrows	
Backwater habitats	
Bank slumps or undercut banks in channels or along shoreline	
Cobble and/or Boulders	
Debris jams	
Filamentous macroalgae or algal mats	
Large woody debris in channel exposed above high water	
Large woody debris on marsh plain	
Non-vegetated flats or bare ground (sandflats, mudflats, gravel flats, etc.)	
Pannes or pools on floodplain/off channel habitats	
Plant Hummocks/Sediment mounds	
Point bars and in-channel bars	
Pools in channels/ residual embayment	
Riffles or rapids (wet channel) or planar bed (dry channel)	
Submerged aquatic vegetation	
Secondary channels on floodplains or along shorelines	
Soil cracks	
Standing snags (at least 3 m tall)	
Swales on floodplain or along shoreline	
Variegated, convoluted, or crenulated foreshore (instead of broadly arcuate or mostly straight)	
Vegetated islands (mostly above high-water)	
The following can be located in the AA or wetland and upland outside the AA within 250m:	
Concentric or parallel high water marks	
Upland habitat safe from flooding	
Total Possible	**24**
No. Observed Patch Types (enter here and use in Table 16)	

Table 16: Rating of Structural Patch Richness (based on results from worksheet).

Rating	Number of Patches Observed
A	≥ 13
B	11 – 12
C	9– 10
D	≤ 8

Metric 2: Topographic Complexity

Definition: Topographic complexity refers to the variety of elevations within a wetland due to physical, abiotic features and elevations gradients.

Definition: Topographic complexity refers to the micro- and macro-topographic relief and variety of elevations within a wetland due to physical and abiotic features and elevation gradients that affect moisture gradients or that influence the path of flowing water. Table 17 indicates the range of topographic features that occur in bar-built estuarine wetlands.

This metric is assessed by noting the overall variability in physical patches and topographic features (Table 17 and Figure 11). Care must be taken to distinguish indicators of topographic complexity or habitat features within a wetland. Topographic complexity can be evaluated by observing the number of elevational features that affect moisture gradients along a transect across the AA, and the amount of micro-topographic relief along the transect. Moisture gradients at various elevational features may be indicated by plant assemblages with different inundation/saturation tolerances.

Table 17: Typical indicators of Macro- and Micro-topographic Complexity for Bar-built Estuarine wetlands

Examples of Topographic Features
channels large and small, bars, pannes, potholes, natural levees, slump blocks, soil cracks, partially buried debris, high rugosity of marsh plain, variegated shorelines, large woody debris, backwater pools, water at multiple heights throughout the wetland (perched ponds), multiple horizontal plains at varying levels

Worksheet for AA Topographic Complexity
At two locations in the AA, make a sketch of the profile from the AA boundary to AA boundary. Try to capture the major channels, slopes and intervening micro-topographic relief. Based on these sketches and the profiles in Figure 11, choose a description in Table 18 that best describes the overall topographic complexity of the AA.

Profile 1
Profile 2

Figure 10: Scale-independent schematic profiles of Topographic Complexity.

Each profile A-D represents one-half of a characteristic cross-section through an AA. The right end of each profile represents the edge of the AA. The left end represents the middle of the main channel. **All or a portion of each of the examples may be used to rate the topographic complexity of the AA.** For example, if the AA is entirely located up on the marsh plain, then use only the right portion of the figure. If the AA includes all or part of the main channel then use the entire figure.

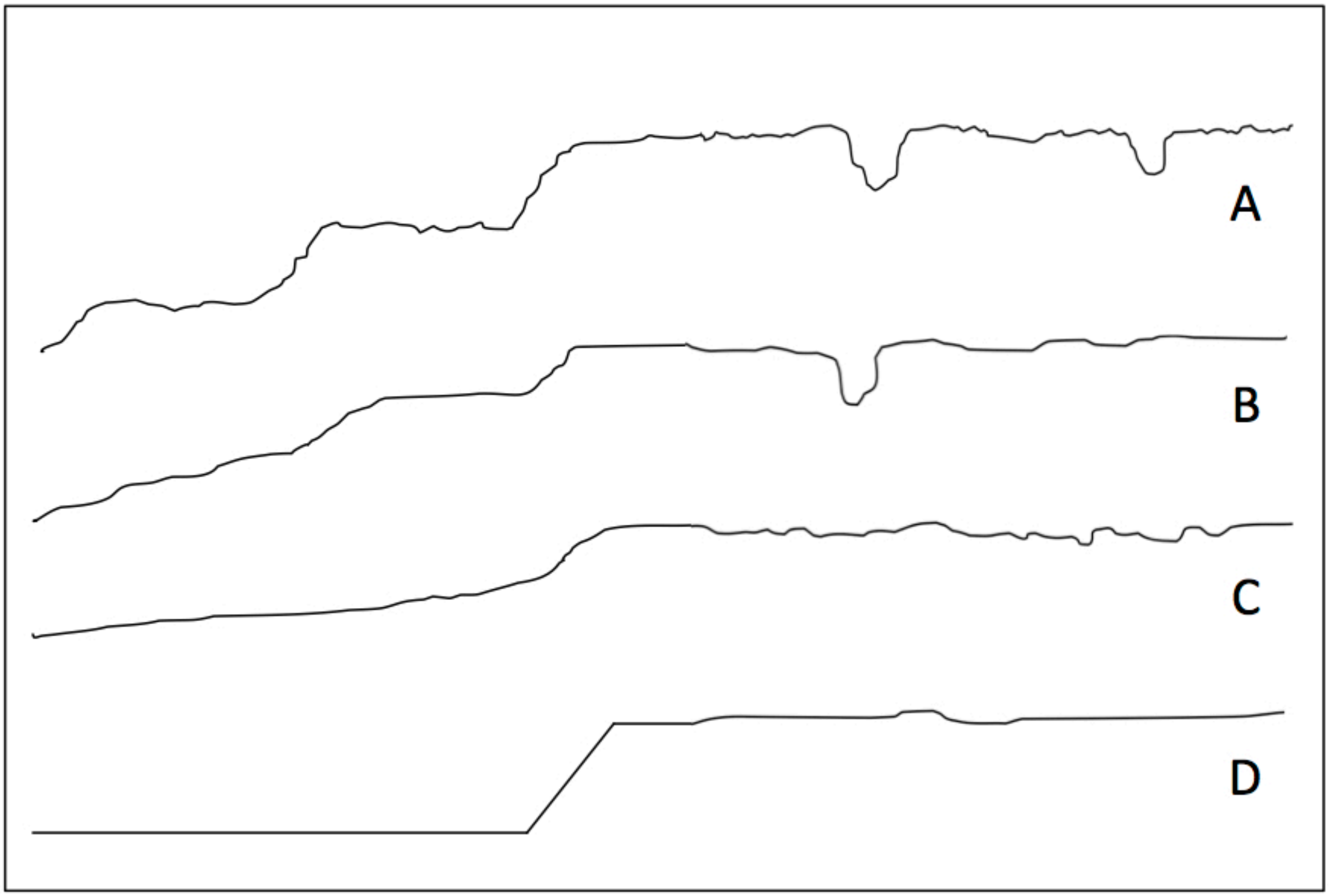


Table 18: Rating of Topographic Complexity for Bar-built Estuarine wetlands

Rating	Alternative States (based on diagrams in Figure 5 above)
A	The vegetated plain and main channel of the AA in cross-section have a variety of macro-topographic and micro-topographic features created by breaks in slope, plants, animal tracks, cracks, partially buried debris, retrogressing channels (filling-in with sediment and plants), natural levees along channels, pannes and pools on the floodplain that together comprise a complex array of ups and downs resembling diagram A in Figure 11.
B	The vegetated plain of the AA has a variety of macro-topographic and micro-topographic features as described above for "A" but they are less abundant and/or they comprise less variability in elevation overall, as illustrated in diagram B of Figure 11.
C	The vegetated plain of the AA has a variety of micro-topographic features as described above for "A" but lacks well-formed secondary channels or backwater habitats that retain water during ebb tide or when the mouth is open and lacks pannes or pools on the floodplain. If channels exist they are filling-in with sediment, preventing them from retaining water for longer periods of time. The plain overall resembles diagram C of Figure 11.
D	The vegetated plain of the AA has little or no micro-topographic relief, its banks may be hardened with cement or riprap, and has few or no well-formed channels or pools on the floodplain. The plain resembles diagram D of Figure 11.

Attribute 4: Biotic Structure

Metric 1: Plant Community

Definition: The Plant Community Metric is composed of three submetrics: Number of Plant Layers, Number of Co-dominant Plant Species, and Percent Invasion. A thorough reconnaissance of an AA is required to assess its condition using these submetrics. The assessment for each submetric is guided by a set of Plant Community Worksheets. The Plant Community metric is calculated based on these worksheets.

A "plant" is defined as an individual of any vacular macrophyte species of tree, shrub, herb/forb, or fern, whether submerged, floating, emergent, prostrate, decumbent, or erect, including non-native (exotic) plant species. Mosses and algae are not included among the species identified in the CRAM Manual's Appendix. 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.

Non-native species owe their occurrence in California to the actions of people since shortly before Euroamerican contact. Many non-native species are now naturalized in California, and may be widespread in occurrence. "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 A: Number of Plant Layers Present

To be counted in CRAM, a layer must cover at least 5% of *the portion of the AA that is suitable for the layer*. This would be the littoral zone of estuarine wetlands for the one aquatic layer, called "floating." The "short," "medium," and "tall" layers might be found throughout the non-aquatic areas of each wetland class, except in areas of exposed bedrock, mudflat, beaches, active point bars, etc. The "very tall" layer is usually expected to occur along the backshore.

It is essential that the layers be identified by the actual plant heights (i.e., the approximate maximum heights) of plant species in the AA, regardless of the growth potential of the species. For example, a young gumplant less than 0.3 m tall would belong to the "short" layer, even though in the future the same individual gumplant might belong to the "medium or tall" layer. Some species might belong to multiple plant layers. For example, areas of pickleweed of all different heights might collectively represent two non-aquatic layers in an estuarine AA.

It should be noted that widespread species may occupy different layers in different parts of California, and the identification of dominant species must be based on an identification of the actual species present in the AA.

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 has a maximum height of 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 *Rorippa nasturtium-aquaticum* (watercress)*, Distichlis spicata* (saltgrass), *Jaumea carnosa* (jaumea), and *Potentilla anserine* (Silverweed).

Medium Vegetation. This layer ranges from 30 cm to 1 m in height. It commonly includes emergent vegetation such *Salicornia virginica* (pickleweed), *Atriplex* spp. (saltbush), rushes (*Juncus* spp.), *Rubus ursinus* (California blackberry), and *Rumex crispus* (curly dock).

Tall Vegetation. This layer ranges between 1 m and 3 m in height. It usually includes the tallest emergent vegetation and the larger shrubs. Examples include *Typha latifolia* (broad-leaved cattail), *Scirpus californicus* (bulrush), *Sparganium* (burweeds), and *Baccharis piluaris* (coyote brush).

Very Tall Vegetation. This layer is reserved for shrubs, vines, and trees that are taller than 3 m. Examples include *Plantanus racemosa* (western sycamore), *Populus fremontii* (Fremont cottonwood), *Alnus rubra* (red alder), *Salix lasiolepis* (Arroyo willow).

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.*

**If the AA supports less that 5% plant cover and/or no plant layers are present (e.g. some concrete channels), automatically assign a score of "D" to the plant community metric*

Figure 11: Flow Chart to Determine Plant Dominance

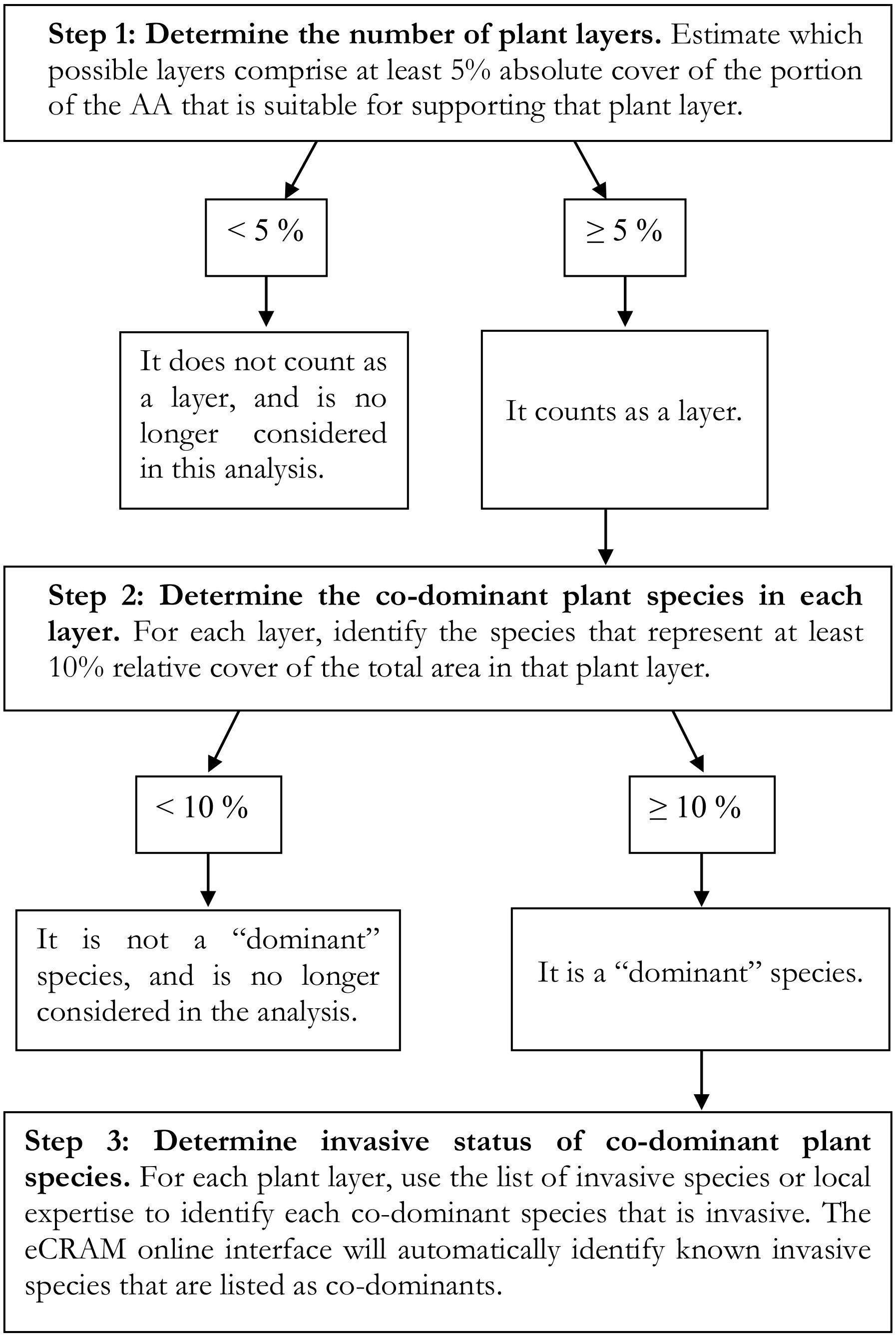


Table 19: Summary of Plant layer heights for Bar-built Estuarine wetlands

Wetland Type	Plant Layers				
	Aquatic	Semi-aquatic and Riparian			
	Submerged or floating	Short	Medium	Tall	Very Tall
Bar-built Estuarine	Benthic or surface	<0.3 m	0.3 – 1 m	1 – 3 m	>3 m

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.*

Submetric C: Percent Invasion

The number of invasive co-dominant species for all plant layers combined is assessed as a percentage of the total number of co-dominants, based on the results of the Number of Co-dominant Species sub-metric. The invasive status for California wetland and riparian plant species is based on the Cal-IPC list. However, the best professional judgment of local experts may be used in addition to the Cal-IPC list to determine whether or not a co-dominant species is invasive in a very localized context.

Plant Community Metric Worksheet: Co-dominant species richness
(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	Invasive?	Short (<0.3 m)	Invasive?
Medium (0.3-1 m)	**Invasive?**	**Tall (1-3 m)**	**Invasive?**
Very Tall (>3 m)	**Invasive?**		
		Total number of co-dominant species for all layers combined (enter here and use in Table 20)	
		Percent Invasion *Round to the nearest integer* (enter here and use in Table 20)	

Table 20: Ratings for submetrics of Plant Community Metric.

Rating	Number of Plant Layers Present	Number of Co-dominant Species	Percent Invasion
Bar-built Estuarine Wetlands			
A	≥4	≥ 10	0 – 10%
B	3	7 – 9	11 – 20%
C	1 – 2	5 – 6	21 – 30%
D	0	0 – 4	31 – 100%

Metric 2: Horizontal Interspersion

Definition: Horizontal interspersion refers to the variety and interspersion of plant "zones." Plant zones are obvious multi-species associations (in some cases zones may be plant monocultures; for instance pickleweed) that remain relatively constant in makeup throughout the AA and which 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. Examples may include "marsh channel edge" composed of cordgrass and pickleweed, or "levee" composed of gumplant and frankenia. In all cases, the plant "zones" are defined by a relatively unvarying combination of physiognomy and species composition. Think of each plant zone as extending from the top of the tallest plants 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.

Marsh plant communities are seldom completely uniform over large expanses. The dynamics of marsh plant associations can be subtle and lead to variations in the abundances of common species within different areas of an AA. The differences in relative dominance among plant species across an AA may reflect ecological differences supporting an identification of different "plant zones." For example, a marsh plant zone that is dominated by *Sarcocornia pacifica* with some included *Jaumea carnosa* and *Distichlis spicata* may be ecologically differentiable from a similar zone dominated by *Distichlis*. The possible ecological significance of micro-scale variation in plant dominance should be considered carefully in scoring this metric.

Interspersion is essentially a measure of the number of distinct zones and the amount of edge between them. It is important to base the assessment of this metric on a combination of aerial image interpretation and field reconnaissance. The user should focus on the major zones that are visible in plan view (birds eye view). 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.

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, and the diagrams in Figure 7, choose a description in Table 21 that best describes the overall interspersion of plant zones in the AA.

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

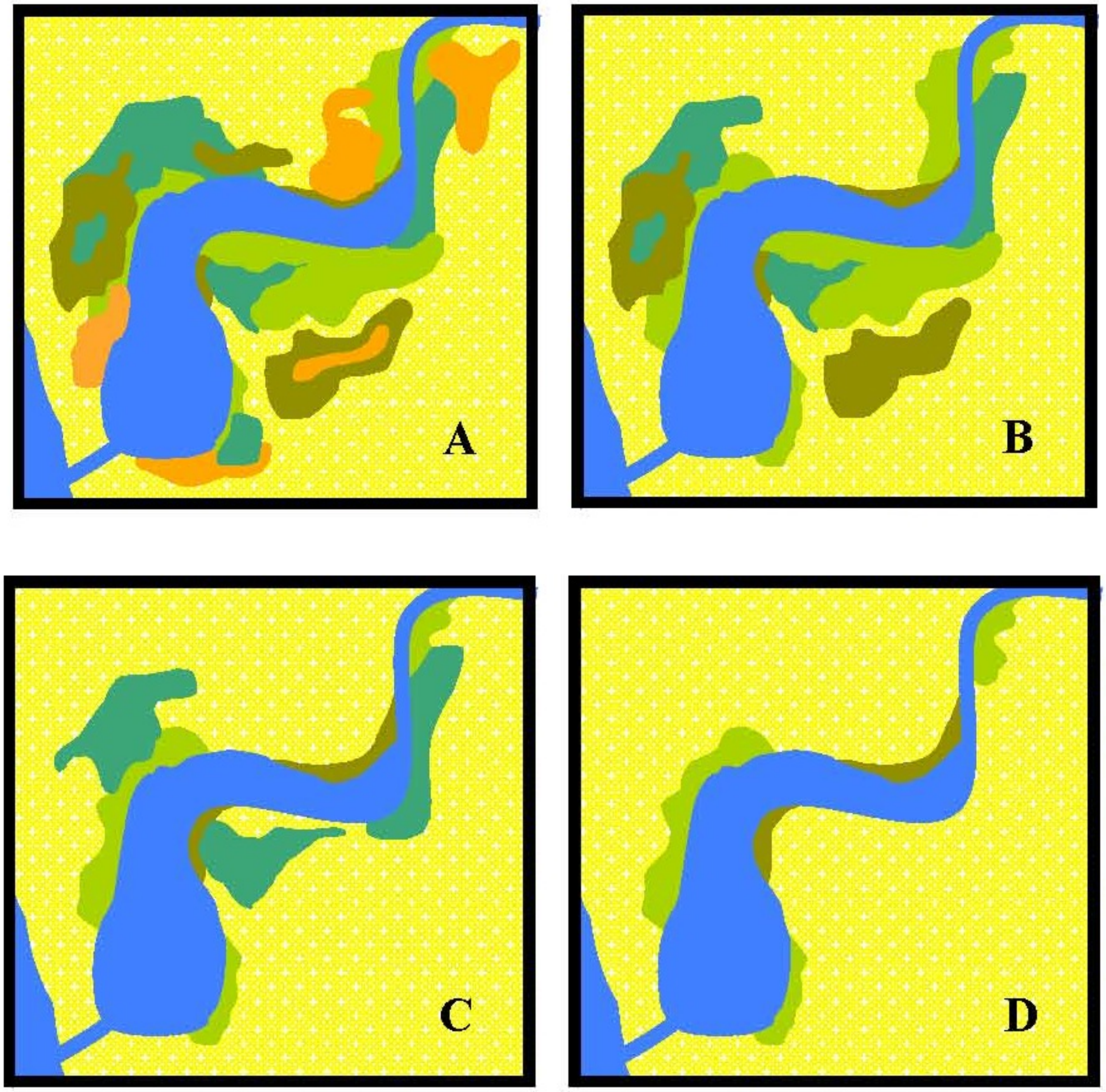


Figure 12: Schematic diagrams of varying degrees of interspersion of plant zones and patches for Bar-built Estuarine wetlands organized around a tidal channel with an open mouth to tidal influence. In these diagrams, each plant zone or patch type has a unique color and comprises at least 5% of the AA. There is one example for each condition A-D. These diagrams represent the entire wetland, not necessarily just the AA. The yellow background represents uplands and dune habitat.

Table 21: Rating of Horizontal Interspersion

Rating	Alternative States
A	AA has a high degree of plan-view interspersion.
B	AA has a moderate degree of plan-view interspersion.
C	AA has a low degree of plan-view interspersion.
D	AA has minimal plan-view interspersion.

Metric 3: Vertical Biotic Structure

Definition: The vertical structure component of the biotic structure attribute assesses the vertical complexity of the bar-built estuarine wetland, commonly recognized as the overall number of plant layers, their spatial extent, and their vertical overlap relative to the expected conditions.

Vertical structure must be assessed in the field, using one of two methods based on the type of vegetation structure of the bar-built estuarine wetland being assessed:

Method 1: For wetlands with large marsh plain areas, small or patchy zones of open water, and typically lacking substantial woody vegetation around the wetland perimeter, the entrainment method is used (Table 22). In many bar-built estuarine wetlands, the detritus of above-ground growth of low and medium layers of herbaceous plants and emergent monocots tends to get entrained within the layers as an internal canopy below the maximum height of the upper plant layer. These "entrained canopies" serve as cover for many wildlife species. Over time, these entrained canopies can gain enough density and thickness to provide important shelter for many species of birds and small mammals. Birds that nest in estuarine wetlands may choose to nest below an entrained canopy because it protects them from avian predators, including owls and harriers. Dense canopies can best provide these services. A sparse canopy still has some utility but the patchy cover may allow for predation.

Method 2: For wetlands with woody vegetation, the vertical overlap of plant layers is assessed (Table 23). These may be wetlands with central channel of open water surrounded by fringing vegetation, or they may have woody vegetation occupying large portions of the wetland. In these situations, the entrained canopy may be a less important structural element in the wetland than the structure of overlapping plant layers. The same plant layers used to assess the Plant Community Composition metrics are used to assess Vertical Biotic Structure. To be counted in CRAM, a layer must cover at least 5% of the portion of the AA that is suitable for the layer.

Special Note:

**If it is not clear which method to use on a particular Assessment Area, use both methodologies and choose the one with the higher score.*

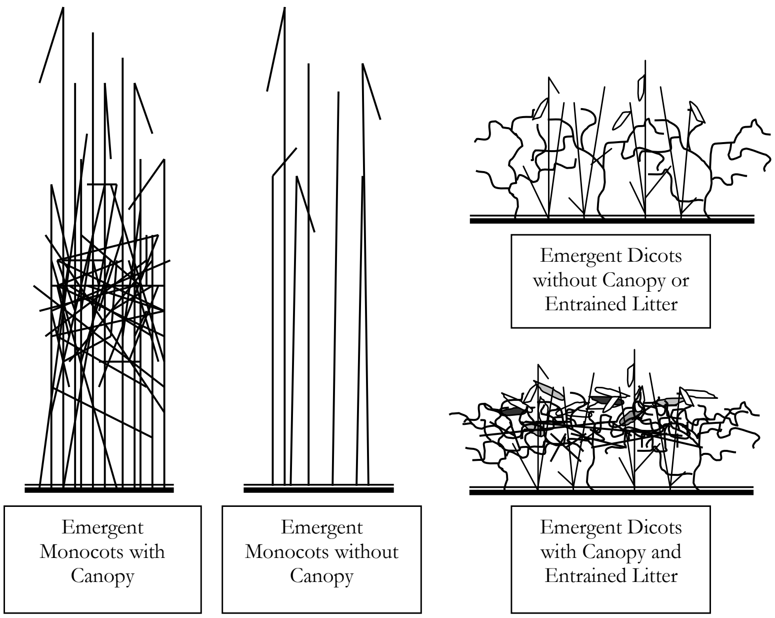


Figure 13: Schematic diagrams of plant canopies and entrained litter used to assess Vertical Biotic Structure in Bar-built Estuarine wetlands (Method 1).

Table 22. Rating of Vertical Biotic Structure for Bar-Built Estuarine wetlands dominated by emergent vegetation (Method 1)

Rating	Alternative States (Method 1)
A	Most of the vegetated plain of the AA has a dense canopy of living vegetation or entrained litter or detritus forming a "ceiling" of cover above the wetland surface that shades the surface and can provide abundant cover for wildlife.
B	Less than half (25-50%) of the vegetated plain of the AA has a dense canopy of vegetation or entrained litter or detritus as described in "A" above; OR Most of the vegetated plain has a sparse canopy of vegetation or entrained litter or detritus .
C	25-50% of the vegetated plain of the AA has a sparse canopy of vegetation or entrained litter or detritus.
D	Most of the AA (>75%) lacks a canopy of living vegetation or entrained litter or detritus.

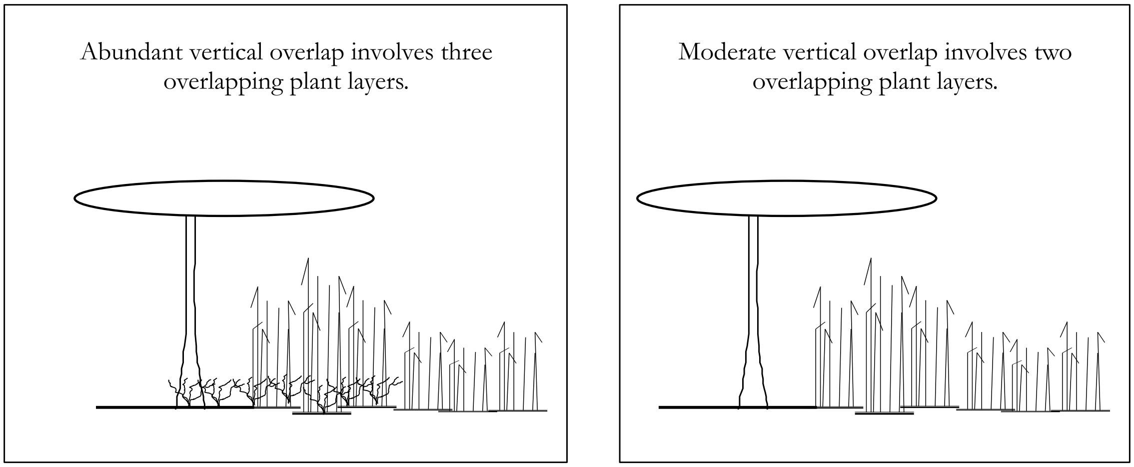


Figure 14: Schematic diagrams of plant canopies and entrained litter used to assess Vertical Biotic Structure in Bar-built Estuarine wetlands dominated by overlap of multiple plant layers (Method 2).

Table 23: Rating of Vertical Biotic Structure for Bar-built Estuarine AAs dominated by overlap of multiple plant layers (Method 2)

Rating	Alternative States (Method 2)
A	More than 50% of the fringing marsh supports abundant overlap of plant layers
B	More than 50% of the fringing marsh supports at least moderate overlap of plant layers
C	25–50% of the fringing marsh supports at least moderate overlap of plant layers.
D	Less than 25% of the of the fringing marsh supports moderate overlap of plant layers, **or** AA is sparsely vegetated overall.

Guidelines to Complete the Stressor Checklists

Definition: 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.

Worksheet for Wetland disturbances and conversions.

<table>
<tr><td>Has a major disturbance occurred at this wetland?</td><td>Yes</td><td colspan="2">No</td><td colspan="2"></td><td></td></tr>
<tr><td>If yes, was it a flood, fire, landslide, or other?</td><td>flood</td><td colspan="2">fire</td><td colspan="2">landslide</td><td>other</td></tr>
<tr><td>If yes, then how severe is the disturbance?</td><td colspan="2">likely to affect site next 5 or more years</td><td colspan="2">likely to affect site next 3-5 years</td><td colspan="2">likely to affect site next 1-2 years</td></tr>
<tr><td rowspan="4">Has this wetland been converted from another type? If yes, then what was the previous type?</td><td colspan="2">depressional</td><td colspan="2">vernal pool</td><td colspan="2">vernal pool system</td></tr>
<tr><td colspan="2">non-confined riverine</td><td colspan="2">confined riverine</td><td colspan="2">bar-built estuarine</td></tr>
<tr><td colspan="2">perennial saline estuarine</td><td colspan="2">perennial non-saline estuarine</td><td colspan="2">wet meadow</td></tr>
<tr><td colspan="2">lacustrine</td><td colspan="2">seep or spring</td><td colspan="2">playa</td></tr>
</table>

Stressor Checklist Worksheet

HYDROLOGY ATTRIBUTE (WITHIN 50 M OF AA)	Present	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	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	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)		
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	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

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 Aquatic Area Abundance and the submetric scores relating to buffer are combined independently into an overall Aquatic Area Abundance score and overall Buffer score. These are then added to eachother. Please see the formula on the scoring sheet. • For Attribute 4 (Biotic Structure) Prior to calculating the Raw Attribute Score, average the three Plant Community sub-metrics. Then sum this result with the other two Biotic Structure metrics. • **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. Round this average to the nearest whole number (integer) to get the AA Index Score (0.5 or greater rounds up, less than 0.5 rounds down).