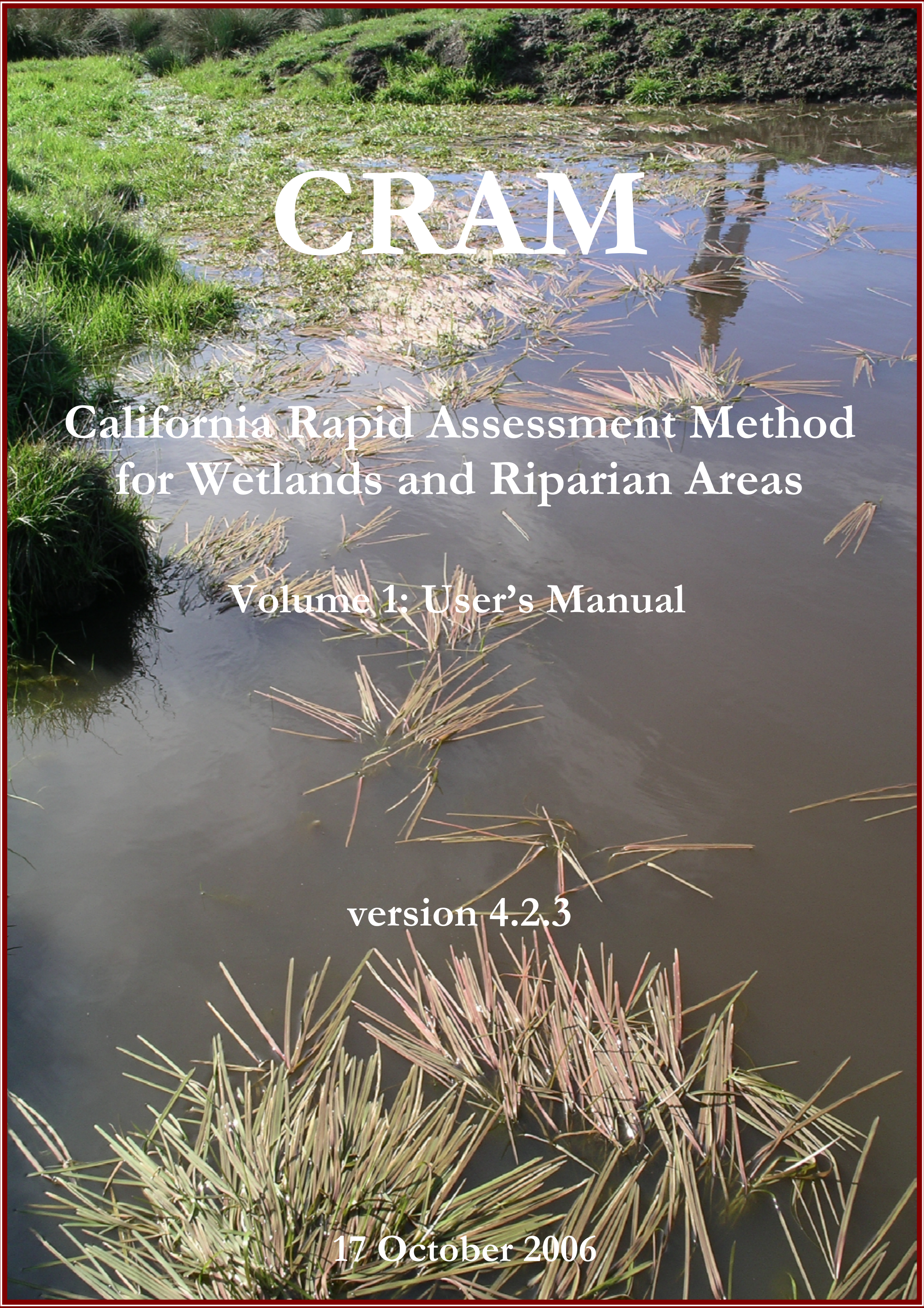

CRAM

California Rapid Assessment Method for Wetlands and Riparian Areas

Volume 1: User's Manual

version 4.2.3

17 October 2006

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California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas

Volume 1: User's Manual

version 4.2.3

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CRAM Software 1.0.0, an electronic version of CRAM 4.2.3,
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Core Team and Regional Team members during verification and calibration exercises.

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EXECUTIVE SUMMARY

Large amounts of public funds and human resources are being invested in the protection, restoration, creation, and enhancement of wetlands and riparian habitats in California. The State needs to be able to track the extent and condition of these habitats to evaluate the investments in them now and into the future. The community of wetland scientists, managers, and regulators needs to be able to answer the questions: where are the wetlands and riparian habitats and how are they doing?

The California Rapid Assessment Method (CRAM) is part of a comprehensive program plan to meet this need. The plan is based on the three-level framework recommended by the USEPA in its guidance to the State (USEPA 2006): Level 1 is the statewide wetland inventory as mandated by California Assembly Bill 2286. Level 2 is CRAM, a rapid assessment method designed to assess and report on the status and trends of wetlands and related projects under the U.S. Clean Water Act and California Environmental Quality Act. Level 3 consists of standardized protocols for intensive-quantitative habitat assessment to explore the processes that account for the observed conditions and to validate and augment CRAM as needed. All three levels are to be supported by a data management system that enables the State to compile local and regional Level 1-3 data into summary reports on the extent and condition of wetlands and riparian habitats, including restoration or mitigation projects. CRAM is supported by an open-source, web-based database designed to provide Level 1-3 data to state and federal information systems.

CRAM was developed as a rapid, scientifically defensible, and repeatable assessment methodology that can be used routinely to assess and monitor the conditions of wetlands and riparian habitats. CRAM is applicable throughout the state of California. The general framework of CRAM is consistent across wetland types and regions, yet allows for customization to address special characteristics of different regions and wetland classes.

CRAM was developed through collaborations among the San Francisco Estuary Institute (SFEI), the Southern California Coastal Water Research Project (SCCWRP), the Central Coast District of the California Coastal Commission (CCC), and the Moss Landing Marine Laboratory (MLML). Funding was provided mainly by US EPA through US Clean Water Act Section 104b(3) grants administered by USEPA Region 9.

Although CRAM development has centered on coastal watersheds and wetlands, a special effort was made to involve environmental scientists and managers who are familiar with inland arid and montane environments. A statewide Core Team and Regional Teams with representatives from natural resource management and regulatory agencies, the private sector, and academia provided the breadth and depth of technical and administrative experience necessary to guide CRAM development and implementation.

CRAM development has incorporated aspects of other approaches to habitat assessment in California and elsewhere, including the Washington State Wetland Rating System (WADOE, 1993), MRAM (Burglund, 1999), and ORAM (Mack, 2001). CRAM also draws on concepts from stream bio-assessment and wildlife assessment procedures of the California Department of Fish and Game, the different wetland compliance assessment methods of the

San Francisco Bay Regional Water Quality Control Board and the Los Angeles Regional Water Quality Control Board, the Releve Method of the California Native Plant Society, and various HGM guidebooks that have been developed in California.

CRAM is a diagnostic tool that two or more trained practitioners can use to assess the condition of a wetland or riparian site over a half-day period using visual indicators in the field. In practice, the practitioners use the indicators to choose the best-fit narrative description of habitat condition among a standardized set of mutually exclusive descriptions for a variety of metrics of four universal attributes: landscape context and buffer, hydrology, physical structure, and biotic structure. CRAM scores can be used to compare sites within a wetland class, but not between classes. Each narrative description has a fixed numerical value. The score for an attribute is calculated as the sum of the values for the chosen narratives of the attribute's component metrics, and the attribute scores are tallied into an overall site score. The attribute and site scores are then calculated as percentages of the maximum possible scores. A site score therefore represents the condition of a site relative to its best possible condition. This means that each site is scored relative to a conceptual model of what the ideal site would look like. Verification and calibration exercises have indicated that the population of sites within each region of the state spans the full range of condition including the ideal. By scoring sites relative to an ideal best condition, all sites within a wetland class are held to the same standard, and any site can be compared over time and to any other sites of the same wetland class. Regional and statewide networks of sites that together illustrate the full range of condition for each metric will continue to be developed as CRAM is used. CRAM also provides guidelines for identifying the stressors that might account for any low scores.

CRAM is supported by a web site (www.cramwetlands.org) that provides access to an electronic version of this manual, training materials, CRAM software (the downloadable open-source software that eliminates the need for taking a hardcopy version of CRAM into the field), and the secure CRAM database. CRAM results can be uploaded to the database, viewed, and retrieved via the CRAM web site. CRAM, CRAM software, and the supporting web sites are open source developments without branding or copyrights.

CRAM and CRAM Software are designed to cost-effectively assess individual wetlands and riparian areas (i.e., restoration projects, mitigation projects, refuges and reserves) and ambient conditions at any scale, from groups of sites to watersheds, regions within the state, and to the state as a whole. The use of CRAM for ambient monitoring will, over time, help wetland managers and scientists quantify the relative influence of anthropogenic stress, management actions, and natural disturbance on the spatial and temporal variability in the condition of wetlands and riparian habitats. This information can then be used in the design, management, and assessment of wetland projects.

Additional, specific applications of CRAM include: (1) assessments of impacted wetlands to help determine appropriate mitigation measures; (2) preliminary assessments of wetland conditions and stressors to determine the need for intensive monitoring; (3) evaluation of wetland project performance under the Coastal Zone Management Act, Section 1600 of the California State Fish and Game Code, Sections 401 and 404 of the Clean Water Act, and local government wetland regulations; and (4) assessment of restoration or mitigation progress relative to ambient conditions, reference conditions, and expected endpoints.

CHAPTER 1:
NEED, GOAL, STRATEGIC CONTEXT, INTENDED USES, AND GEOGRAPHIC SCOPE

1.0 Introduction

This document is intended to serve as a User's Manual for the California Rapid Assessment Method (CRAM) for wetlands and riparian habitats. CRAM is designed to assess all types of wetlands in California, including riparian habitats associated with streams, lakes, or depressional wetlands. Chapter 1 covers the perceived need, goal, strategic context, intended uses, and geographic scope of CRAM. Chapter 2 covers key terms, the conceptual framework for CRAM and its development process. Chapter 3 covers the steps for implementing CRAM to assess conditions in the field. Chapter 4 contains detailed guidelines for assessing wetlands and riparian habitats using CRAM.

1.1 Statement of Need

As this document is being released, large amounts of public and private funds are being invested in policies, programs, and projects to protect, restore, and manage wetlands in California. Most of these investments cannot be evaluated, however, because the ambient conditions of wetlands are not being monitored, the methods to monitor individual wetland sites are inconsistent, and there is little assurance of data quality. Furthermore, the results of monitoring are not readily available to analysts and decision makers. CRAM is a new approach that promises to provide consistent, scientifically defensible, affordable information about wetland conditions throughout California.

1.2 Justification for Rapid Assessment

The three most significant obstacles to developing adequate information about the conditions of California wetlands are (1) the lack of regional or statewide inventories of wetlands and related projects; (2) the cost of conventional assessment methods; and (3) the lack of an information management system to support regional or statewide wetland assessments. CRAM is part of a three-level approach that can minimize these obstacles to adequate wetland assessment (USEPA 2006).

Level 1 consists of inventories and landscape profiles of wetlands and riparian areas in a Geographic Information System (GIS). Inventories are basic component of a comprehensive wetlands assessment program. They are essential for identifying the spatial distribution and abundance of wetlands. While there are various efforts to map wetlands on regional, county, and local levels, the California State Wetland Inventory as mandated by Assembly Bill 2286 is the primary wetland inventory for the State. It is used to update the National Wetlands Inventory (NWI) of the USFWS and the National Hydrography Dataset (NHD) of the USGS, while also meeting many of the needs of the regional wetland scientists, managers, and regulators. In addition to mapping all the wetlands, the State Wetland Inventory uses hydro-geomorphic modifiers to characterize the landscape context of wetlands and their water sources. Its products will include regional and statewide reports on the status and trends in the distribution and abundance of each wetland class. The State Wetland Inventory will aid wetland conservation planning by showing each wetland in the context of all others. It will also serve as a sample frame for objective, probabilistic surveys of ambient wetland condition within watersheds, regions, and statewide.

Level 2 consists of rapid assessment of habitat conditions. It relies on field observations that correlate to quantitative measures of wetland function, condition, or beneficial use that vary predictably along gradients of environmental stress. The stressors, such as habitat conversion, biological invasion, hydro-modification, and pollution are anthropogenic causes of changes in wetland function. Rapid assessment methods must be calibrated with Level 3 data that quantify relationships between stress, function, and condition. Once calibrated, the rapid methods can be used where intensive data are lacking or too expensive to collect. Rapid assessment can thus lessen the amount and kinds of data needed to monitor wetlands across a region or over time. It can also be used to augment monitoring where the resources may be focused on one particular aspect (i.e., water quality), but an assessment of overall habitat condition is also needed. CRAM can meet the need for Level 2 data and thus greatly reduce the dependency on the much more expensive quantitative data that comprise Level 3.

Level 3 consists of intensive, quantitative data. They are needed to develop indicators, to develop techniques of data collection and analysis, to calibrate and validate Level 1 and 2 methods, to explain mechanisms that account for observed conditions, and to assess conditions if Level 2 data are inadequate. The calibration and validation procedures can, in turn, yield standard methods for Level 3 assessment and monitoring.

CRAM is based on a growing body of scientific literature and practical experience in the rapid assessment of habitat. Several authors have reviewed methods of wetland assessment (Margules and Usher, 1981, Westman, 1985, Lonard and Clairain, 1986, Jain *et al.*, 1993, Stein and Ambrose, 1998, Bartoldus, 1999, Fennessy *et al.*, 2004). Most methods differ more in the details of data collection than in overall approach. In general, the most useful approaches to assess condition focus on the visible, physical and/or biological structure of wetlands, and they rank or categorize wetlands along one or more stressor gradients (Stevenson and Hauer, 2002). The indicators of condition are derived from intensive studies that show relationships between the indicators, high-priority functions or beneficial uses of wetlands, and anthropomorphic stress, such that the indicators can be used to assess the effects of management actions on wetland condition.

Existing methods have been used to assess wetlands at a variety of spatial scales, from habitat patches within local project sites, to landscapes, regions within states, and regions of the U.S. Methods that are designed to assess large areas, such as the Synoptic Approach (Leibowitz *et al.*, 1992), typically produce coarser and more general results than site-specific methods, such as either the Hydrogeomorphic Method (HGM; Smith *et al.*, 1995, Smith 2000) or the Index of Biotic Integrity (IBI; Karr, 1981). Each scale of assessment provides different information about the extent and condition of wetlands. Furthermore, assessments at different scales can be used for cross-validation, thereby increasing confidence in the approach. A set of methods to assess wetlands at different scales can be useful for a comprehensive monitoring program.

Existing methods also differ in the amount of effort and expertise they require. Methods such as the Wetland Rapid Assessment Procedure (WRAP; Miller and Gunsalus, 1997) and the Descriptive Approach (USACOE, 1995), are extremely rapid, whereas the Habitat Evaluation Procedure (HEP; USFWS, 1980), the New Jersey Watershed Method (Zampella *et al.*, 1994), and the Bay Area Watersheds Science Approach (WSA version 3.0, Collins *et al.*, 1998), are much more demanding of time and expertise.

None of the existing methods can be applied equally well to all kinds of wetlands in California. The HGM and the IBI are the most widely applied approaches in the U.S. While they are intended to be rapid, they require more time and resources than are usually available, and both have a somewhat limited range of applicability. For example, IBIs are developed separately for different ecological components of wetland ecosystems, such as vegetation and fish, and for different types of wetlands, such as wadeable streams. HGM guidebooks are similarly restricted to one type of habitat, such as vernal pools or riverine wetlands, and they are typically restricted to a narrowly defined bioregion. Some guidebooks are restricted to individual watersheds. Rapid assessment methods have been developed by other States. However, trial applications of both the Florida WRAP and the Ohio Rapid Assessment Method (ORAM; Mack, 2001) in California coastal watersheds indicated that significant modifications of these methods would be required for their use in California, and lead to increased interest in developing a rapid method specifically for California wetlands.

1.3 Goal and Intended Use

The overall goal of CRAM is:

> *To provide a rapid, scientifically defensible, and repeatable assessment methodology that can be used routinely in wetland monitoring and assessment programs. CRAM should be applicable to wetlands and streams throughout the state of California. The general framework of CRAM should be consistent across wetland types and regions, yet allow for customization to address special characteristics of different regions and wetland classes.*

CRAM is intended to provide comparable rapid assessments of wetland condition across all regions and types of wetlands in California. CRAM should prove to be a valuable tool for "taking the pulse" of wetlands. Until now, the State has lacked this capability.

CRAM provides a consistent approach to local, regional, and statewide wetland assessment and monitoring, without neglecting characteristic differences in wetland form or function between regions or between types of wetlands.

CRAM is designed to cost-effectively assess the performance of wetland restoration projects, mitigation projects, and the status and trends of ambient wetland conditions within watersheds, regions of the State, and for the State as a whole. The use of CRAM for ambient monitoring will, over time, help wetland managers and scientists quantify the relative influence of anthropogenic stress, management actions, and natural disturbance on the spatial and temporal variability in reference conditions. This information can then be used in the design, management, and assessment of wetland projects.

Specific applications of CRAM could include: (1) a component of wetland ambient assessment; (2) assessments of impacted wetlands to help determine appropriate mitigation measures; (3) preliminary assessments of wetland conditions and stressors to determine the need for intensive monitoring; (4) evaluation of wetland project performance under the Coastal Zone Management Act, Section 1600 of the California State Fish and Game Code, Sections 401 and 404 of the Clean Water Act, and local government wetland regulations; and (5) assessment of restoration or mitigation progress relative to ambient conditions, reference conditions, and expected ecological trajectories.

1.4 Related Rapid Assessment Efforts in California and Other States

Development of the CRAM has incorporated concepts and methods from other wetland assessment programs in California and elsewhere, including the Washington State Wetland Rating System (WADOE, 1993), MRAM (Burglund, 1999), and ORAM (Mack, 2001). CRAM also draws on concepts from stream bio-assessment and wildlife assessment procedures of the California Department of Fish and Game, the different wetland compliance assessment methods of the San Francisco Bay Regional Water Quality Control Board and the Los Angeles Regional Water Quality Control Board, the Releve Method of the California Native Plant Society, and various HGM guidebooks that are being used in California.

1.5 Geographic Scope

CRAM is intended for application to all kinds if wetlands throughout California. Although centered on coastal watersheds, CRAM development involved scientists and managers from other regions to account for the variability in wetland type, form, and function that occurs with physiographic setting, latitude, altitude, and distance inland from the coast. Calibration efforts have indicated that CRAM is broadly applicable throughout most of the range of wetland condition commonly encountered. However, since CRAM emphases complexity, it may yield artificially low scores for naturally simply wetlands. CRAM should therefore be used with caution in extreme environments where wetlands naturally tend to be very simple in overall structure. This includes riverine wetlands in very arid watersheds and alpine wetlands above timberline. CRAM results will be used to adjust CRAM as needed to remove any systematic bias against these kinds of wetlands.

1.6 Organization and Coordination to Develop CRAM

An organization was created to foster collaboration and coordination among the regional efforts to develop CRAM. USEPA awarded Wetland Development Grants through Section 104b(3) of the US Clean Water Act to the Southern California Coastal Water Research Project (SCCWRP), to a partnership of the Association of Bay Area Governments (ABAG) and the San Francisco Estuary Institute (SFEI), to a partnership of the Central Coast District of the California Coastal Commission (CCC) and the Moss landing marine laboratories (MLML), and to the North Coast Region of the California Department of Fish and Game (CDFG) to develop and begin implementing Level 1-3 methods, with an emphasis on Level 2 (rapid assessment) and information management. The Principal Investigators (PIs) at these institutions worked with sponsoring agencies to form a statewide Core Team and Regional Teams that have provided the breadth and depth of technical and administrative experience necessary to develop and implement CRAM.

1.6.1 Core Team

The Core Team fostered collaboration and coordination among the regions to produce one integrated approach to rapid wetland assessment that is consistent across wetland types throughout California. The Core Team consists of the PIs plus technical experts in government agencies, non-governmental science organizations, and academia. Core Team members are listed in the acknowledgments at the front of this document. The Core Team set the direction for the PIs and the Regional Teams, reviewed their products, and promoted CRAM to potential user groups. The Core Team delegated internal roles and responsibilities by consensus, as needed.

1.6.2 Regional Teams

The Regional Teams advised and reviewed the work of the PIs to ensure that CRAM addressed regional differences in wetland form, structure, and function. The members of each Regional Team are listed in the acknowledgments at the front of this document. The Regional Teams assisted in the verification and calibration of CRAM, and provided feedback through the PIs to the Core Team about the utility of CRAM in the context of regional wetland regulation and management. Each Regional Team consisted of the PIs, local and regional wetland experts who have experience with assessment methodologies, Core Team members who work within the region, and technical representatives from selected agencies that are potential users of CRAM.

Blackberry flowers and Pacific tree frog among bulrushes in depressional wetland in Gualala River watershed.

CHAPTER 2: CRAM TERMS, CONCEPTUAL FRAMEWORK, AND DEVELOPMENT PROCESS

2.0 Key Terms and Conceptual Framework

CRAM uses standardized definitions for key terms, including "disturbance," "stress," and "condition." CRAM also embodies three sets of assumptions and principles about adaptive management; interactions between natural disturbance, anthropogenic stress, wetland functions or conditions; and spatial arrangements between wetland conditions and their anthropogenic causes. The following sections detail key terms, assumptions, and principals of CRAM.

2.1 Key Terms

- ***Stress*** is the consequence of natural or anthropogenic changes in forcing functions or controlling factors. ***Key stressors*** are events or actions that tend to modify the quantity and/or quality of habitat, sediment supplies and/or water supplies upon which the desired functions of the wetland depend. Gradients of stress result from spatial variations in the magnitude, intensity, or frequency of the stressors.
- The ***Condition*** of a wetland is defined as its status, in terms of its natural structural and biological complexity, relative to the best possible condition for wetlands of the same class, at the time of the assessment.
- The ***Ecological Services*** or ***Beneficial Uses*** of a wetland are what it does to sustain or improve the quality of life for populations of people and other organisms. ***Key ecological services*** for many types of wetlands include flood control, groundwater recharge, water filtration, conservation of cultural values, aesthetics, and the support of special-status species of plants, fish, and other wildlife.
- ***Attributes*** are the obvious, universal aspects of wetland condition. In concept, all wetlands everywhere share these attributes: buffer and landscape context, hydrology, physical structure, and biotic structure. Each of these attributes consists of a number of metrics.
- A ***Metric*** is a measurable component of an attribute. Each metric should be field-based (Fennessy *et al.*, 2004), ecologically meaningful, and have a dose-dependent response to stress that can be discriminated from natural variation across a stressor gradient (Barbour *et al.*, 1995). The full range of possible states for each metric is represented by a set of mutually exclusive narrative descriptions.
- The ***Narrative Descriptions*** of ***Alternative States*** for a metric represent the range of its possible condition.
- ***Indicators*** are field evidence of the state of a metric and are often used as visual cues to distinguish between narrative descriptions of alternative states.
- The ***Rating*** of a metric is the numerical value fixed to the narrative description that is chosen because it best-fits the state of the metric at the time of the assessment.

- An ***Attribute Score*** is calculated as the percent of the maximum possible sum of the metric ratings for the attribute.
- A ***CRAM Score*** is an indication of the overall condition of the wetland assessment area and is calculated as the percent of the maximum possible sum of the Attribute Scores for an Assessment Area.
- The ***Assessment Area (AA)*** is the portion of a wetland that is the subject of a CRAM assessment. Multiple AAs might be needed to assess extensive individual wetlands. Rules for determining the boundaries of an AA are in Section 3.5.

2.2 Conceptual Framework

CRAM was developed according to a set of underlying conceptual models and assumptions about the meaning and utility of rapid assessment, the framework for managing wetlands, the driving forces that account for wetland condition, and spatial arrangements among the driving forces. These models and assumptions are explicitly stated in this section to help guide the interpretation of CRAM scores.

2.2.1 Management Framework

The management framework for CRAM is the Pressure-State-Response model (PSR) of adaptive management (Holling, 1978, Bormann *et al.*, 1994). The PSR model states that human operations, such as agriculture, urbanization, recreation, and the commercial harvest of natural resources can be sources of stress or *pressure* affecting the overall functions of a wetland. This stress causes changes alter the *state*, or condition, of the wetland. The human *responses* to these changes include any organized behavior that aims to reduce, prevent or mitigate undesirable changes. Wetland protection depends on monitoring and assessment to understand the relationships between wetland stress, wetland state, and management responses. The managers' concerns and the targets that they set for wetland protection drive relevant monitoring efforts, and the results of the monitoring drive the managers' actions.

Assessment approaches vary in that they may evaluate indicators of any or all aspects of the pressure-state-response model. Pressure indicators describe the variables that directly cause (or may cause) environmental problems, such as discharges of fill or urban encroachment. State indicators evaluate the current condition of the environment, such as plant diversity or concentration of a particular contaminant in the water. Response indicators demonstrate the efforts of managers to address the environmental problem, such as presence of best management practices or conservation easements. The approach used by CRAM is to focus on indicators of wetland *condition* or *state*. A separate stressor checklist is then used to evaluate *pressure* affecting wetland condition. In practice, knowledge of pressure and state by managers can lead to an effective *response* to protect or restore a particular wetland.

2.2.2 Rapid Assessment

Rapid Assessment methods, in general, are based on the assumption that the ecological condition of wetlands will vary along a gradient of anthropogenic stress, and that the resultant condition can be evaluated based on a core set of observable field indicators. CRAM was created to meet three criteria characteristic of wetland rapid assessment methods (Fennessy *et al.*, 2004).

1. *The method measures* ***existing*** *condition* (see Section 2.1 above) of a wetland in terms of its maximum possible natural structural complexity and hence its potential to support the ecological services intrinsic to its wetland class. The method does not assess a wetland site, or an AA, relative to past conditions, or relative to planned or anticipated future conditions.
2. *The method is truly rapid.* A method is considered rapid if it requires two people no more than one half day of fieldwork plus one half day of subsequent data analysis to complete.
3. *The method is a site assessment* based on field conditions and not just inferred from Level 1 data, existing reports, opinions of site managers, etc.

2.2.3 Scientific Foundation for CRAM: Interactions Between Driving Forces, Stress, Wetland Structure, and Wetland Condition

The condition of a wetland reflects the suite of hydrologic, biologic (biotic), and physical processes that are occurring in and adjacent to the wetland. These processes are usually the result of the wetland's position in the landscape (i.e., its geomorphic setting), its source of water, and the dynamics of water movement through the wetland (Brinson, 1993). CRAM is based on four basic assumptions about the interactions between physical and biological processes. CRAM assumes that (1) the ecological services and beneficial uses provided by a wetland are mainly determined by the quantity and quality of water, mineral and organic material, and sediment that are either processed within the wetland or that are exchanged between the wetland and its environment; (2) the supplies of water and sediment are ultimately controlled by climate, geology, and land use; (3) geology and climate govern natural disturbance, whereas land use accounts for anthropogenic stress; and that (4) these controlling factors are significantly mediated by vegetation (Figure 2.1).

A fundamental assumption of CRAM is that, for any wetland class, the quality of a wetland increases with the diversity of its ecological services. It is also assumed that the diversity of ecological service increases with wetland structural complexity and size. CRAM therefore favors large structurally complex wetlands. The structural complexity of a wetland can be assessed in terms of the richness of its structural components and their interspersion along vertical and horizontal gradients.

In California, the key anthropogenic wetland stressors tend to be habitat conversion or loss, hydro-modification, chemical pollution, and biological invasions (USEPA, 1999). Important natural stressors include periodic floods and fires that are typical of western environments. CRAM is designed to separately assess condition and identify likely sources of stress. Stressors are assessed by surveying for signs of stress inside and outside of the wetland. This allows the assessors to identify the likely causes of the observed conditions, and thus to recommend management actions. If the causes are not readily apparent, then Level 3 studies might be recommended to determine the causes and to what extent they can be managed. If the causes are deemed natural, then management actions may not be warranted.

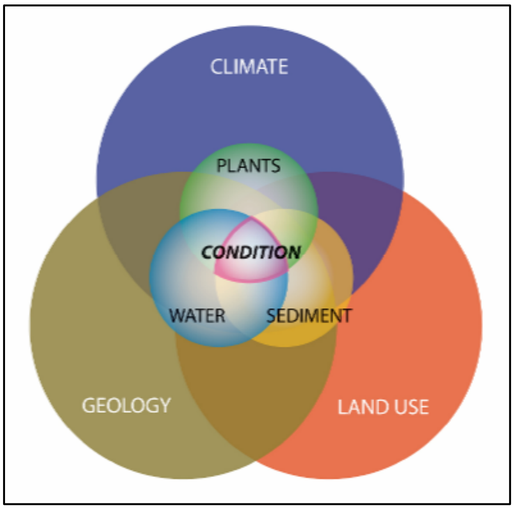

Figure 2.1: Spatial hierarchy of factors that control the condition of a wetland. Conditions are ultimately controlled by climate, geology, and land use.

The interactions of stressors, buffers, and condition can also be organized into a spatial hierarchy (Figure 2.2). Stress often originates outside the wetland, in the surrounding landscape or encompassing watershed. Buffers around the wetland can intercept and otherwise mediate stress that affects conditions within the wetland.

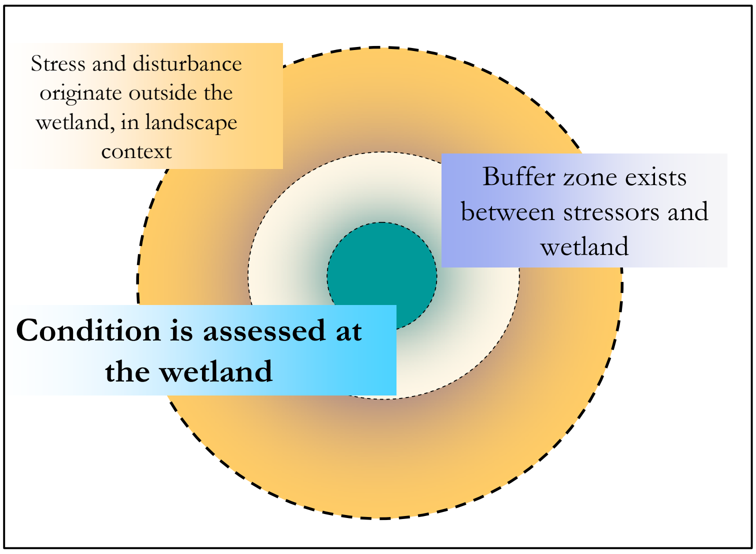

Figure 2.2: Spatial hierarchy of stressors, buffers, and wetland condition. Most stressors originate outside the wetland. The buffer exists between the wetland and the sources of stress, and serves to mediate the stress.

2.3 CRAM Developmental Framework

The three phases of method development, verification, and calibration are described below. Table 2.1 illustrates the component nine steps of CRAM development.

2.3.1 Method Development

Method development consists of defining key conceptual models and terms, identifying universal attributes of wetland condition, determining individual metrics that describe each attribute, and drafting the mutually exclusive narrative descriptions for each metric (Table 2.1). Method development was done primarily through discussions within the Core Team, with initial field-testing and feedback by Regional Teams. Version 2.0 of CRAM marked the completion of the *Method Development* Phase.

2.3.2 Verification

The overall goal of the verification phase was to determine if the draft wetland classification scheme, the attributes, and the metrics were (1) comprehensive and appropriate; (2) sensitive to obvious variations in wetland condition (i.e., able to distinguish high-condition wetlands from low-condition wetlands); (3) able to produce similar scores for wetlands that are under similar stress levels; and (4) tended to foster repeatable results among different practitioners. For each attribute, the Regional Teams selected wetlands clearly representing a broad range of condition. The metrics were evaluated according to their ability to discern wetlands with high condition/low stress from those with low condition/high stress. The verification phase involved iterative adjustments to the wetland classification scheme and the metrics. CRAM versions 2.5-3.5 resulted from the Verification Phase.

2.3.3 Calibration

The goals of the Calibration Phase were to assign numerical scores to the mutually exclusive narrative descriptions for each metric, determine the optimal system of weighting and combining the metric scores and attribute scores into CRAM scores, and to assess the overall performance of CRAM. Alternative rules for weighting and combining scores were developed based on the conceptual models of wetland form and function. The deciding criteria were the strength of correlations between draft scores and independent Level 3 data. The simplest combination rules without any weighting generally performed best and were therefore adopted. A full report of the Calibration Phase of CRAM development is available at www.cramwetlands.org. The calibration phase for riverine and estuarine classes was completed with version 4.0.

Table 2.1: Basic steps in CRAM development.

Core Team	Step 1	Develop conceptual models of wetland form and function
	Step 2	Identify universal Attributes of wetland condition
	Step 3	Nominate Metrics of the Attributes
	Step 4	Nominate narrative descriptions of mutually exclusives states for each Metric
Core and Regional Teams	Step 5	Verify the Attributes, Metrics, and narrative descriptions
	Step 6	Develop a checklist to identify stressors
	Step 7	Calibrate Metrics and Attributes using Level 3 data
	Step 8	Conduct independent peer review
	Step 9	Provide outreach and training

2.4 Universal Attributes, Metrics, and Stressors

The attributes and metrics developed for CRAM (Table 2.2) reflect the common, visible characteristics of all wetlands in all regions of California, based on the conceptual models of wetland form and function. Each metric is represented by a set of narrative descriptions of mutually exclusive alternative states. The sets of narrative descriptions for each metric reflect its full range of expected variability along one or more gradients of anthropogenic stress. Wetland stressors are identified using a stressor checklist. The stressor checklist enables wetland managers to identify which stressors, if any, are most likely to account for the observed conditions.

The metric scores and attribute scores for each wetland class are expected to have a positive correlation with one or more key wetland functions (Table 2.3). These correlations can be tested as the Level 2 and Level 3 datasets grow. The calibration exercises to date have focused on the correlations between CRAM scores and wildlife support functions, and generally affirm the predicted relationships. A report on the results is available at the CRAM web site.

Table 2.2: CRAM Site Attributes and Metrics.

Attributes		Metrics
Buffer and Landscape Context		Landscape Connectivity
		Percent of AA with Buffer
		Average Buffer Width
		Buffer Condition
Hydrology		Water Source
		Hydroperiod or Channel Stability
		Hydrologic Connectivity
Structure	Physical	Structural Patch Richness
		Topographic Complexity
	Biotic	Interspersion and Zonation
		Organic Matter Accumulation
		Vertical Biotic Structure
		Plant Community
		• Number of Plant Layers Present
		• Percent of Layers Dominated by Non-native Species
		• Number of Co-dominant Species
		• Percent of Co-dominant Species that are Non-native

Table 2.3: Relationship between CRAM Attributes, Metrics, and Key Wetland Functions.

KEY WETLAND FUNCTIONS	CRAM ATTRIBUTES AND METRICS/SUBMETRICS												
	Buffer and Landscape Context	**Hydrology**			**Physical Structure**		**Biotic Structure**						
	Buffer and Landscape Connectivity Metrics	Water Source	Hydroperiod or Channel Stability	Hydrologic Connectivity	Structural Patch Richness	Topographic Complexity	Organic Matter Accumulation	Number of Plant Layers Present	Percent of Layers Dominated by Non-native Species	Number of Co-dominant Species	Percent of Co-dominants that are Non-native	Interspersion and Zonation	Vertical Biotic Structure
Short- or long-term surface water storage	X		X	X	X	X						X	X
Subsurface water storage		X	X	X		X	X						
Moderation of groundwater flow or discharge	X	X											
Dissipation of energy					X	X	X	X				X	X
Cycling of nutrients	X		X	X	X	X	X	X	X	X	X		X
Removal of elements and compounds	X		X	X		X	X	X				X	
Retention of particulates			X	X	X	X	X	X		X		X	
Export of organic carbon			X	X			X	X	X		X	X	X
Maintenance of plant and animal communities	X		X	X	X	X		X	X	X	X	X	X

Historical stock pond as a depressional wetland, Marin County.

CHAPTER 3:
PROCEDURES FOR USING CRAM

3.0 Summary

The general procedure for using CRAM consists of nine (9) steps (Table 3.1).

Table 3.1: Steps for Using CRAM to Assess Wetland Condition.

Step 1	Assemble background information about the management and history of the wetland
Step 2	Classify the wetland using this manual (see section 3.2)
Step 3	Determine wetland size
Step 4	Verify the appropriate season and other timing aspects of field assessment
Step 5	Determine the boundary and estimate the size of the AA (if it is not the same as the wetland)
Step 6	Conduct the office assessment of stressors and on-site conditions of the AA
Step 7	Conduct the field assessment of stressors and on-site conditions of the AA
Step 8	Complete CRAM assessment scores and QA/QC Procedures
Step 9	Upload CRAM results into regional and statewide information systems

3.1 Step 1: Assemble Background Information

CRAM assessments are aided by background information about the management objectives, history, known or expected stressors, and general ecological character of the wetland to be assessed. Background materials include the following (Table 3.2).

Table 3.2: Example Background Materials.

- USGS quadrangles, National Wetland Inventory (NWI), State Wetlands Inventory, road maps, and other maps of geology, soils, vegetation, dams and canals, land uses, etc.
- Air photos and other imagery, preferably geo-rectified with a pixel resolution of 1-3 m
- California Natural Diversity Database (CNDDB) search results
- Relevant reports on geology, geotechnical conditions, hydrology, soils, environmental impacts, cultural history, land use, restoration and mitigation projects, management plans, etc., from water districts, flood control districts, open space districts, state and federal agencies, etc.

3.2 Step 2: Classify the Wetland

Classify the wetland according to the definition and proved in this section of this manual. A crosswalk exists between the CRAM classification system and the State Wetland Inventory, and the State inventory is attributed with the CRAM classes. It is essential to classify the site correctly because any of the metrics vary between classes.

3.2.1 Definition of Wetlands and Riparian Areas

There is no single, absolute ecological definition of "wetlands" or "riparian areas." Their boundaries in the field are not always obvious. The following general definitions of wetlands and riparian areas have been adopted from the State Wetland Inventory.

*"**Wetlands** are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is not a soil and is saturated with water or covered by shallow water at some time during the growing season of each year"(Cowardin et al., 1979).*

*"**Riparian Areas** are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes and biota. They are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems. Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes and estuarine-marine shorelines (National Research Council, 2001)."*

For the purpose of CRAM, riparian areas adjacent to lacustrine, depressional, non-saline estuarine, slope, and riverine wetlands are included in the CRAM wetland Assessment Areas (see Section 3.5 below). For each of these kinds of wetlands, the riparian area is defined as the area between the high water line of the wetland and the maximum distance landward from which the vegetation can directly contribute organic matter to the wetland, as leaf fall, limb fall, tree fall, etc. The width of the riparian area is therefore a function of the height of the vegetation, and is not a function of the plant species composition of the area.

3.2.2 Wetland Typology

In determining the most appropriate wetland typology for the CRAM, the Core Team considered the expected influences of landscape context and local geomorphic setting on wetland functions and stressors, as well as the practical problems in wetland classification. The Core Team also considered the need for consistency between the CRAM typology, the National Wetlands Inventory (NWI), and especially the State Wetland Inventory that serves as the Level 1 sample frame for ambient monitoring using CRAM. Any inconsistencies between the CRAM wetland typology and the Wetland Inventory will be corrected as the two initiatives are finalized. The corrections maybe accomplished by formulating crosswalks or correspondence tables between the State Wetland Inventory and CRAM.

The CRAM typology consists of seven major classes of wetlands, three of which have sub-classes (Table 3.3). Additional wetland subclasses may be added in future versions of CRAM based on additional data collection and a refined understanding of variability in wetland condition among wetland classes. It is designed to enable wetland scientists to classify wetlands using standard 1:24,000 scale topographic maps, geologic maps, soils maps, aerial imagery, local knowledge, and a minimum of ground-truthing. In the future, CRAM practitioners will be able to identify the CRAM wetland class using the State Wetland Inventory, which will classify wetlands by the standard USFWS system (Cowardin *et al*., 1979), as well as new HGM categories that are compatible with the CRAM typology.

Table 3.3: The CRAM Wetland Typology.

CRAM Wetland Classes	CRAM Sub-classes (these are recognized for some but not all metrics)
Riverine Wetlands	Confined Riverine Wetlands
	Unconfined Riverine Wetlands
Depressional Wetlands	Individual Vernal Pools
	Vernal Pool Systems
	Depressional Wetlands
Estuarine Wetlands	Saline Estuarine Wetlands
	Non-saline Estuarine Wetlands
Playas	no sub-classes
Coastal Lagoon Wetlands	no sub-classes
Slope Wetlands (Seeps and Springs)	no sub-classes
Lacustrine Wetlands	no sub-classes

Each wetland Assessment Area (AA) should consist of only one wetland type or class. Different classes of wetlands can be contiguous with each other, or even nested one within the other. Since the metrics vary between wetland classes, the class definitions (see below) must be carefully adhered to, or the CRAM results will be erroneous.

Some CRAM sites will have undergone a type conversion from one wetland class to another due to either natural or anthropogenic events. For example, a channel avulsion may capture a floodplain depression and convert it to a riverine system, or construction of a dam may impound a stream and convert it to a lacustrine system. In any case, the wetland should be evaluated according to its current class. Metric scores should be assigned using the ratings for the current state of the wetland, without regard for what the wetland might have been in the past, or what it might become in the future. However, for converted wetlands, the assessor should note the historical as well as the existing class. The stressor checklist enables the assessor to document if the wetland is stressed by the conversion (i.e., if the process of conversion is continuing or complete).

3.2.2.1 Riverine Class (Including Riparian Areas)

The riverine wetland class includes the channel and associated wetland areas below the bankfull contour or usual high water marks of rivers and streams, plus the adjoining area of the active floodplain, plus any riparian areas that are ecologically linked to the channel or its floodplain. Wetlands can occur along the channel bottoms of intermittent streams during the dry season. Wetland assessment in these systems during the dry season therefore includes the channel beds. However, the channel bed is excluded from the assessment when it contains non-wadeable flow. For the purpose of CRAM, an active floodplain is defined as the relatively level area with alluvial soils along a stream or river that is periodically flooded by stream water, as evidenced by deposits of fine sediment, scour, debris jams and wrack lines, flotage suspended in vegetation, scarring of vegetation by flood waters, zonation of plant communities, etc. The water level that corresponds to flooding and its periodicity can vary depending on flow regulation and whether the channel is in equilibrium with water supplies and sediment supplies. The active floodplain can include areas of relatively high ground among distributaries of deltas and braided channel systems. Under equilibrium conditions, the floodplain exists at about the elevation of bankfull flow, which has a recurrence interval of 1.5 to 2 years.

For the purposes of conducting a CRAM assessment there is a practical limitation to the applicability of the method in low order (i.e., headwaters) streams in arid environments. CRAM metrics are based on observable physical and biological features of the area being assessed. Low order streams in arid environments will, by their nature, often lack these features. For example, complex plant communities with horizontal and vertical structure may not occur. Similarly, topographic complexity may be inherently low. It is important that CRAM scores not appear to artificially "devalue" these systems based on their natural simplicity. Therefore, while CRAM assessments can be done in these systems, the results will be tracked carefully over the next year or more to ascertain if, and if so, how CRAM should be revised to apply as well to these systems as any others. To facilitate this analysis, practitioners are asked to note on the CRAM riverine site information sheet if the site is an ephemeral, headwater system.

Riverine wetlands are further classified as confined or unconfined, based on the conventional comparison between valley width and channel width (see Figure 3.1).

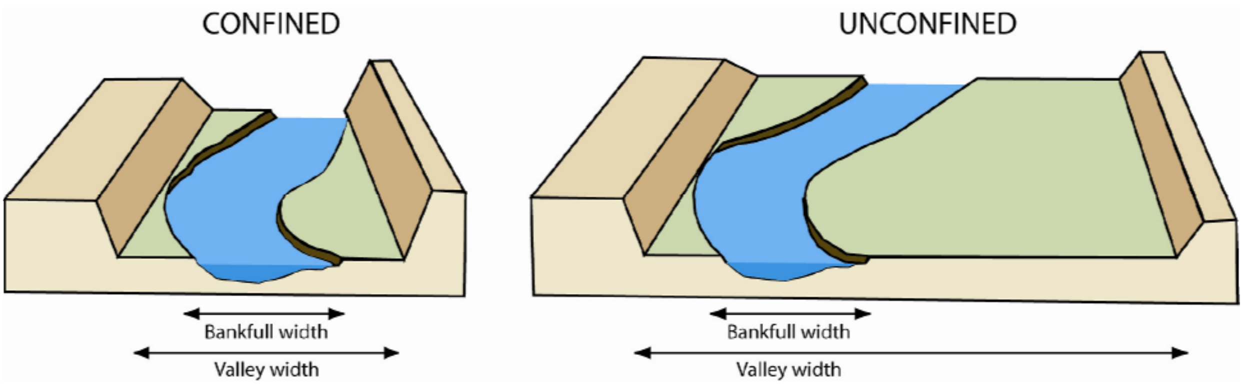

Figure 3.1: Illustrations for determining confined and unconfined riverine sub-class.

3.2.2.1.1 Unconfined Riverine Sub-class (Including Riparian Areas)

In unconfined riverine systems, the width of the valley across which the system can migrate without encountering a levee, hillside, terrace, or other feature that is likely to prevent further migration is at least twice the average bankfull width of the channel. The degree of confinement is unrelated to the degree of channel entrenchment. Naturally unconfined riverine systems typically occur on alluvial fans, deltas in lakes, and in the lower reaches of watersheds.

3.2.2.1.2 Confined Riverine Sub-class (Including Riparian Areas)

In confined riverine systems, the width of the valley across which the system can migrate without encountering a levee, hillside, terrace, or other feature that is likely to prevent further migration is less than twice the average bankfull width of the channel. The degree of confinement is unrelated to the degree of channel entrenchment. Naturally confined systems typically occur in very narrow canyons and in the upper reaches of watersheds. Unnaturally confined systems include rivers and streams that are bounded by flood control levees.

3.2.2.2 Depressional Wetlands (Including Riparian Areas)

Depressional wetlands exist in topographic lows or flats that do not usually have outgoing surface drainage except during extreme flood events or heavy rainfall. Precipitation is their main source of water. In this regard, they differ from springs, seeps, slope wetlands, and wet meadows, which depend mainly on groundwater discharge. They differ from lacustrine wetlands by lacking an adjacent perennial body of water at least 2 m deep and at least 8 ha in area. They differ from playas by lacking prominent areas of open water that do not support vascular vegetation.

Depressional wetlands can have distinct or indistinct boundaries. Many depressional wetlands are seasonal, and some lack surface ponding or saturated conditions during dry years. A complex of shallows and seasonally wet swales and depressions created by the slight topographic relief of a mountain meadow during spring is an example of an indistinct depressional wetland. The margins of distinct depressional wetlands are relatively easy to discern in aerial photos and in the field. Examples of distinct depressional wetlands include sag ponds, snowmelt ponds, kettle-holes in moraines, and cutoff ox-bows on floodplains or riverine terraces.

Depressional wetlands with large fluctuations in water level can have adjoining areas of riparian area. These areas are distinguished by one or more zones of vegetation that parallel the margin of the wetland and clearly depend on its seasonally high water levels. Slope wetlands that depend on ground water often attend the margins of depressional wetlands and should not be confused with riparian area that depends on wetland as its main source of water.

3.2.2.2.1 Vernal Pool Wetland Sub-class

Vernal pools are ephemeral wetlands that form in shallow depressions underlain by bedrock or by an impervious, near-surface soil horizon (Witham 2006). These depressions fill with rainwater and runoff from adjacent areas during the winter and may remain inundated until spring or early summer, sometimes filling and emptying repeatedly during the wet season (USFWS 1994).

Vernal pools annually undergo four distinct phases: (1) the wetting phase with the onset of the first rains; (2) the aquatic phase when the peak rainfall and inundation occurs; (3) the drying phase when many plants flower and produce seed and many animals disperse; and finally (4) the drought phase when the soil dries and cracks, and the plants succumbs to extreme dry conditions (Zedler 1987).

Vernal pools typically support a minimum of 30% relative cover of native vernal pool plant species during the aquatic or drying phase. Vernal pools in highly disturbed areas or subject to abnormal rainfall patterns might not meet this criterion due to invasion by non-native plants and the concomitant displacement of the native plant species (USFWS 1994). If the wetland is mostly characteristic of a vernal pool but also has characteristics of other kinds of wetlands, such that its classification as a vernal pool is not completely certain, then it should be considered a vernal pool.

3.2.2.2.2 Vernal Pool System Wetland Sub-class

Vernal pools often occur together and with vernal swales as vernal pool systems (Figure 3.4).These can have many pools of various sizes and shapes, floral and faunal composition, and hydroperiod (Witham 2006). Water can sometimes move between adjacent pools and swales through the thin soils above the underlying impervious substrate. The lack of surfaced flow between pools does not necessarily indicate that they are not hydrologically inter-connected.

3.2.2.2.3 Non-vernal Pool Depressional Sub-class (Including Riparian Areas)

These depressional wetlands may be seasonal or perennial, but their flora and fauna are mostly not characteristic of vernal pools (see 3.2.2.2.1 immediately above). They are smaller than lakes (i.e., les than 8 ha total area). Unlike playas, depressional wetlands usually support abundant vegetation within the associated water body.

3.2.2.3 Playa Wetland Class

The central feature of a playa is a shallow, seasonal water body with very fine-grain sediments of clays and silts. Unlike vernal pools, playas are either very sodic (i.e., strongly alkaline) or saline basins that support sparse peripheral populations of grasses and herbaceous plants tolerant of the soluble salts that accumulate along the edges of the playas as the water evaporates (Gustavson *et al.* 1994, Rocchio 2006). Playas also differ from vernal pools by having little or no vascular vegetation within the water body. Vernal pools are generally much smaller than playas. And unlike vernal pools, playas are more dependent on runoff than direct precipitation. The condition of a playa can be strongly influenced by the condition of its watershed (Keate 2005). Playas can be as large as lacustrine systems but they are shallower. Playas differ from lacustrine systems by having an average depth less than 2 m.

3.2.2.4 Estuarine Wetland Class

Estuarine wetlands are subjected to daily fluctuations in water height due to oceanic tides. The salinity of the water is variable due to inputs from marine (saline) and riverine or other freshwater sources. Typical freshwater sources include rivers, streams, groundwater, point discharges (e.g., effluent from sewage treatment facilities), and storm drains. Estuarine wetlands can occur along tidal sloughs, bays, and along the downstream tidal reaches of rivers and streams For the purpose of CRAM, saline estuarine wetlands are distinguished from non-saline estuarine wetlands by the species composition of emergent vegetation growing along the immediate shoreline and tidal creeks of the wetland.

3.2.2.4.1 Saline Estuarine Wetland Sub-class

In saline estuarine wetlands, the average dry season salinity of the tide water is equal to or greater than 15 ppt (parts per thousand). The vegetation closest to the waterline along the shore of the wetland or along the banks of the tidal creeks is dominated by cordgrass (*Spartina* spp), pickleweed (*Salicornia* spp), salt grass (*Distichlis* spp), or other halophytic or salt-tolerant plant species.

3.2.2.4.2 Non-saline Estuarine Wetland Sub-class (Including Riparian Area)

In non-saline wetlands (i.e., brackish or freshwater estuarine wetlands), the average dry season salinity of the tide water is less than 15 ppt (parts per thousand). The dominant vegetation closest to the waterline along the shore of the wetland or along the tidal creeks is either a rush (*Scirpus* spp, *Juncus* spp), cattails (*Typha* spp), or other plant species with moderate or slight tolerance for saline conditions.

Non-saline estuarine wetlands can include riparian areas and often adjoin riverine wetlands. Defining the AA for either of these wetland classes can involve distinguishing between them. Water salinity is not usually a good indicator of the boundary between riverine and non-saline estuarine wetlands because both tend to be fresh where they meet. The better indicator is the upstream limit of the tidal signal. For the purpose of CRAM, this signal is the daily or twice-daily rise or fall of the water surface as controlled by the celestial tidal forces. In practice, the boundary is most easily recognized as the usual upstream limit of slack high water, where the high tide causes the downstream surface flow to stop. The exact location of this boundary moves with each tidal cycle because of changes in river discharge and changes in the height of the high tide. An approximate location will suffice for CRAM.

3.2.2.5 Coastal Lagoon Wetland Class (Including Riparian Area)

A lagoon wetland fringes an impoundment that is subject to occasional or episodic tidal action, or regular tidal action that has a periodicity greater than one (>1) day. Lagoons include unnatural impoundments of tidewater behind control structures that prevent a daily ebb and flow of tidal water. Some lagoons have inputs of non-saline water through natural or man-made drainages or from groundwater. Tidewater inputs are mostly through natural or man-made channels or breeches, not as overland flow across tidal plains. Lagoon-like features of impounded water that are filled by tidewater flowing over vegetated tidal plains are called marsh pannes or ponds. They are habitat features of estuarine marshes, and they are not lagoons. The salinity of lagoon water may exceed marine salinity. Some lagoons are managed as estuaries by maintaining the tidal inlet permanently open (i.e., >80% of year). Wetlands in these systems should be scored estuarine wetlands (see 3.2.2.5 above).

Lagoon wetlands with large fluctuations in water level can have adjoining areas of riparian area. These areas are distinguished by one or more zones of vegetation that parallel the margin of the wetland and clearly depend on its high water levels. Slope wetlands that depend on ground water often attend the margins of lagoons and should not be confused with riparian area that depends on the lagoon as its main source of water.

3.2.2.6 Lacustrine Wetland Class (Including Riparian Area)

Lacustrine wetlands border perennial, lentic water bodies that exceed 8 hectares in total area and that usually have an average depth of at least 2 meters during the period of low water. Sources of water can be surface water flow, precipitation, and groundwater discharge. Lacustrine wetlands have a greater maximum depth and greater area of open water than depressional wetlands or vernal pools or playas, and they differ from lagoons by never being influenced by marine tides.

Lacustrine wetlands with large fluctuations in water level can have adjoining areas of riparian area. These areas are distinguished by one or more zones of vegetation that parallel the margin of the wetland and clearly depend on its high water levels. Slope wetlands that depend on ground water often attend the margins of lakes and should not be confused with riparian area that depends on wetland as its main source of water.

3.2.2.7 Slope Wetlands Class (Including Riparian Area)

Seeps, springs, and wet meadows (collectively referred to as slope wetlands) form due to seasonal or perennial groundwater emergence into the root zone or across the wetland surface. Their hydroperiods are mainly controlled by unidirectional subsurface flow. They can form on steep hillsides (e.g., hillslope seeps) or nearly level terrain (e.g., broad fens). Wet meadows, on gentle topographic gradients, that depend mainly on groundwater as the water source, and through which the ground water moves advectively, albeit slowly, in one dominant direction, are examples of slope wetlands. If the hydroperiod of a wet meadow mainly depends on precipitation, then it is a depressional wetland (see Section 3.2.2.4, above). Channels can lead into and from a slope wetland, but not all the way through it. If surface water moves through the wetland in a well-defined channel, then the wetland is riverine.

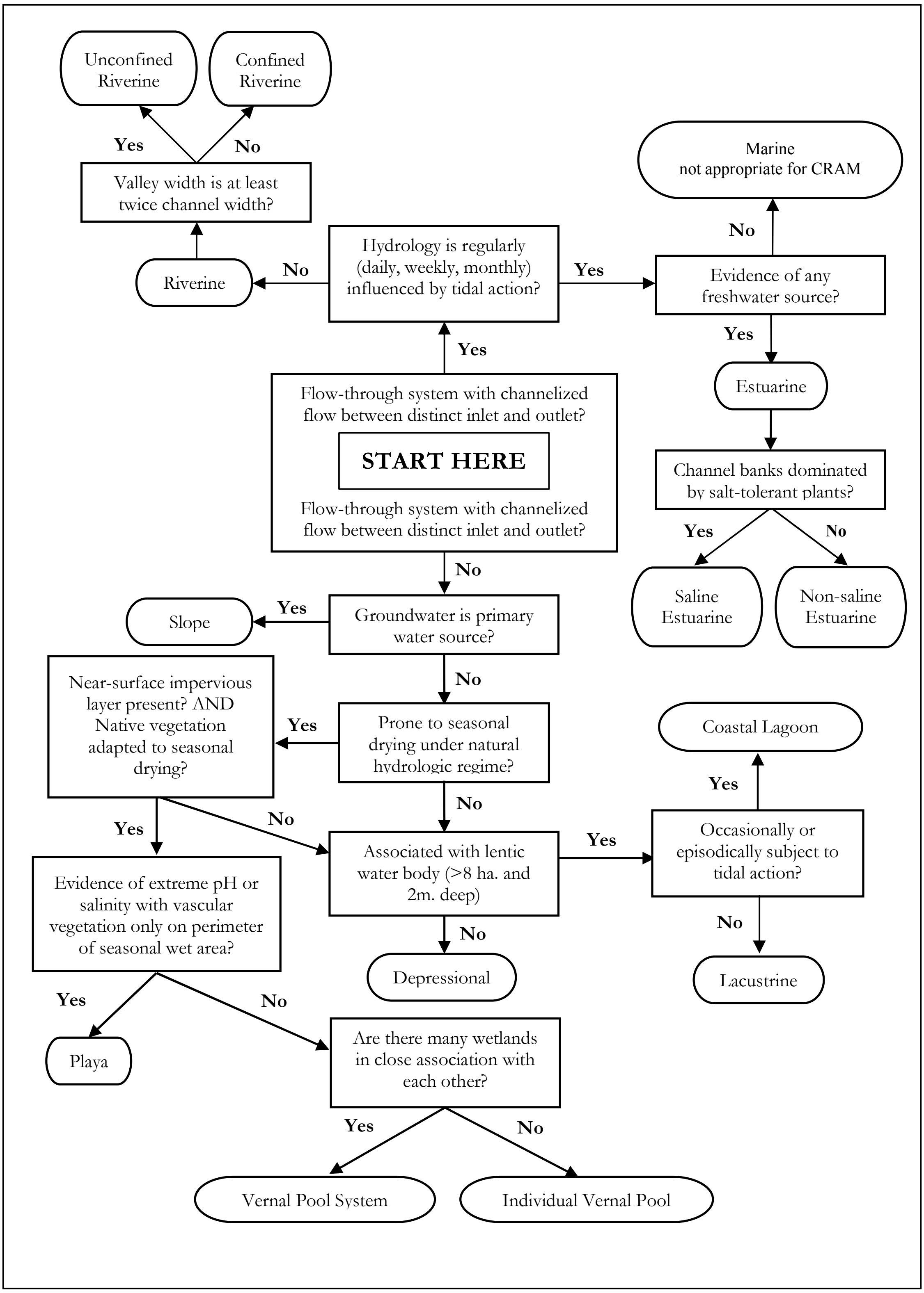

Figure 3.2: Flowchart for determining wetland class and sub-class.

3.3 Step 3: Determine Wetland Size

Wetland size cannot be estimated unless rules exist for defining wetland boundaries. For the purpose of CRAM, wetlands are usually demarcated in the inventory, which is therefore the primary source of information about wetland size. If the wetland is not included in the inventory, then the primary source of data for determining wetland size is geo-rectified, orthogonal imagery of the wetland at a pixel resolution of 1-3 m. The spatial extent of the wetland is determined based on the procedures and wetland boundary definitions used in the inventory. These procedures depend on expert interpretations of topography, vegetation, and natural or anthropogenic obstructions to surface hydrology. Field visits might be required to confirm the delineations and classifications. Where applicable, the observable boundary of the wetland should be digitized in GIS. The concept of wetland size does not apply to riverine wetlands due to their linear and bifurcated forms.

3.4 Step 4: Verify the Appropriate Season and Other Timing Aspects of Assessment

The Assessment Window is the period of time each year when assessments of wetland condition based on CRAM should be conducted. The Assessment Window will be the same for all attributes within a wetland class. For each class of wetland, an effort has been made to select attributes and metrics that, if seasonally variable, can be used in the same season.

In general, the CRAM Assessment Window falls within the growing season for wetland plants. For wetlands that are not subject to snow and that are non-tidal, the main growing season for most perennial plant species and for many annual species usually extends from March through September, although it may begin earlier at lower latitudes and altitudes. The growing season tends to start and end earlier in tidal wetlands, due to the seasonality of the maximum tides. For wetlands subject to snowfall, the start of the growing season is retarded by the spring thaw, which at very high elevations may not happen until late May or early June, depending on the depth of the annual snow pack. For wetlands that are inundated seasonally (e.g., vernal pools, playas, and some springs, seeps and wet meadows) the growing season will generally be March – June.

Since the timing of the growing season varies with elevation and latitude, the Assessment Window might vary within and between regions, and local or regional cues may be needed to determine when the window opens and closes each year. The best cues will be the early evidence of new growth of plants, and the subsequent senescence of the plants, for each of the wetland classes to be assessed. For example, the assessment of seasonal depressional wetlands might begin after the start of the growing season but before summertime desiccation of the wetland soils.

In some cases, there may be experts who can use field observations from outside the Assessment Window to infer conditions within the window. Having this ability means that an assessor can infer the status of wetlands for the past growing season based on its appearance at other times of the same or subsequent year. This ability can only be gained though abundant experience and data sheets should clearly indicate when assessments are being done outside the designated window.

Note that the assessment of estuarine wetlands should not occur at high tide, when some important indicators of conditions will be submerged and therefore invisible. Estuarine wetland should be assessed at low tide, when most of the intertidal the channels are dewater-ed.

Also note that riverine wetlands should not be assessed during high water, not only because wetland conditions might be concealed, but also because of the dangers presented by high flows. Riverine wetlands should be assessed late in the growing season, near the onset of base flow.

3.5 Step 5: Establish the Assessment Area (AA)

Establishing a proper Assessment Area (AA) is a critical step in correctly performing a rapid assessment. An incorrect assessment boundary can yield results that are erroneous, not reproducible, and unlikely to relate to stressors or management actions. Estimates of the boundary of the AA must adhere to the following guidelines.

3.5.1 Definition of Assessment Area (AA)

The Assessment Area (AA) is the portion of a wetland that is assessed using CRAM. For a smaller wetland, the boundary of the wetland and the boundary of the AA may be the same. That is, the AA is the entire wetland. For a larger wetland, the AA may be a portion of the wetland. Based on the assumptions and definitions presented above, the AA should consist of only one wetland class. The rules for delineating an AA should be clear and non-arbitrary, such that independent applications by different assessors in the same wetland yield comparable AAs. Each AA should have enough hydrological and ecological integrity that, over time, CRAM can detect changes in the condition of the AA due to identified stressors or management actions apart from natural disturbances or other sources of variability in wetland condition. Establishing a proper AA is the critical first step in correct use of CRAM.

3.5.2 General Guidelines to Delineate AAs

There are four considerations in delineating an AA.

> <u>Hydrology is the first consideration.</u> Any significant-obvious features that visibly control the source, volume, flow, or general condition of sediment or water within the wetland at the time of the field assessment should be used to help demarcate the AA. By delineating the AA according to such spatial controls on water supply and sediment supply, the ability of CRAM to detect wetland responses to changes in these supplies is increased.
>
> <u>Wetland class is the second consideration.</u> There can only be one wetland type per AA. There are many cases where a wetland of one kind is contiguous with one or more wetlands of one or more other kinds. In these cases, care must be taken to draw the AA boundary between the wetland to be assessed and the other kinds of wetlands.
>
> <u>Wetland size is the third consideration.</u> The AA should be small enough that two trained assessors can conduct the fieldwork in about one half day or less.
>
> <u>The fourth consideration is the purpose of the assessment</u>. Very large wetlands can have many possible AAs. Whether one or more AA's are defined for a large wetland depends on the purpose of the monitoring effort. For ambient monitoring, where each wetland is a replicate of a sample population of wetlands, one AA per wetland may suffice to describe the average condition and variability among the wetlands in the sample population.. But if the purpose of monitoring is to assess one large wetland in particular, such as a large mitigation or restoration project, or if there is a need to assess the variability within a wetland, then multiple replicate AAs will be required. The same guidelines for delineating AAs pertain to both ambient monitoring as well as project monitoring.

Not all wetlands or their possible AAs have obvious boundaries. For example, a seasonal depressional wetland in a natural setting may be intricately interspersed with uplands or seemingly homogeneous over a very large area. The approach to AA delineation differs in these cases from those where the boundaries are distinct or the wetlands are small. The different approaches are explained below.

3.5.3 Guidelines to Delineate AAs for Distinct Wetlands, Small Wetlands, and Large Wetlands with Obvious Delineation Features (the "Features Approach")

The boundaries of the AA must be marked on the site imagery using either the CRAM software mapping tool or a heavy pencil line on a hardcopy of the site imagery. Hardcopy maps will have to be digitized using the CRAM software mapping tool on-line at the CRAM web site before the CRAM results can be uploaded into the CRAM database. All CRAM results for each site are linked to the map of the AA. These maps enable users to assess the same AAs repeatedly over time as necessary to track changes in project performance and reference sites. The AA maps also provide evidence through the QA/QC process that the guidelines for establishing AAs are being followed.

The following features will be used to guide the delineation of an AA during the site visit (see Tables 3.4 through 3.6, below).

Table 3.4: Features that *should* be considered when delineating an AA.

<table>
<tr><th colspan="3">Flow-Through Wetlands</th><th>Non Flow-Though Wetlands</th></tr>
<tr><th>Riverine & Riparian</th><th>Slope Wetlands</th><th>Estuarine</th><th>Depressional
(except Vernal Pools; see Table 3.5)
Lacustrine, Playa & Lagoons</th></tr>
<tr><td colspan="3">• grade or water height control structures
• weirs, culverts, dams, levees, and other flow control structures
• transitions between wetland classes
• natural falls
• end-of-pipe large discharges
• diversion ditches
• major channel confluences
• open water areas broader than the wetland
• major changes in riverine entrenchment, confinement, degradation, aggradation, slope, or bed form</td><td>• berms and levees
• above-grade roads and fills
• major point sources or outflows of water
• jetties and wave deflectors
• weirs and other flow control structures
• uplands (i.e., terrestrial breaks in shorelines)
• open water areas broader than the wetland (i.e., a broad lake beside a narrow lacustrine wetland)</td></tr>
</table>

Table 3.5: Features that *should* be used to delineate individual Vernal Pool AAs.

- above-grade roads and fills
- major point sources of water inflows or outflows
- weirs, berms, levees and other flow control structures

Table 3.6: Features that should *not* be used to delineate any AAs.

- unpaved, single-lane, infrequently used roadways
- at-grade roads or dip crossings
- bike paths and jogging trails at grade
- equestrian trails
- fences (unless designed to obstruct the movement of wildlife)
- bare ground on the active floodplain or below the usual high water line
- riffle – glide – pool transitions in a riverine wetland
- spatial changes in land cover or land use along the wetland border
- property boundaries
- state and federal jurisdictional boundaries

3.5.4 Guidelines to Delineate AAs for Indistinct Depressional Wetlands and Large Wetlands Lacking Delineation Features (the "Random Approach")

Some wetlands lack the guiding features for delineating AAs using the "Features Approach" described above. And for other wetlands, the AAs that could be delineated using the "Features Approach" would be too large to be practical. In these cases, delineation of the AA will begin in the office. First, randomly select a point on the site imagery of the wetland to be assessed. Then draw a circle around the point that delineates an area of the wetland that can be investigated in the field during the maximum prescribed time of about one half day. During the site visit, the AA can be adjusted in size and shape to meet the requirements of a proper AA, based on Tables 3-4 – 3.6 above, but the starting point should not be changed unless it is found to be outside the selected wetland. The final boundaries of the AA should be mapped using either the CRAM software mapping tool or by drawing a heavy pencil line on a hardcopy of the site imagery. Hardcopy maps can be used to guide the creation of a digital map of the AA using the online version of the CRAM software as part of the process of entering CRAM results into the online CRAM database.

3.5.5 Special Considerations for Delineating AAs for Wetland Projects

In the context of this manual, a wetland project is an area of wetland delineated at least in part by one or more real estate property lines. Wetland restoration projects, mitigation projects, mitigation banks, and wetlands that are targeted for development (i.e., impacted wetlands) are often spatially delimited by real estate boundaries.

Property lines should not be used to delineate AAs. When the AA, as defined by the various considerations given in sections 3.5.2, 3.5.3, and in Tables 3.4-3.6 above, is larger than the project, arrangements must be made to investigate the part of the AA that is beyond the project boundary. Incongruity between AAs and project boundaries is seldom a significant problem; in most cases the AA is smaller than the project, or the project encompasses most of the AA.

3.5.6 Special Considerations for Delineating AAs for Riverine and Estuarine

For riverine and estuarine wetlands, the AAs should include both sides of crossable channels, but only one side of channels that cannot be safely crossed. The AA can include topographic benches, interfluves, paleo-channels, terraces, meander cutoffs, and other natural features that are at least semi-regularly influenced by fluvial or tidal processes. The AA may include confluences between significant natural tributaries. A tributary is significant if it obviously increases the flow below the confluence, or if the receiving waterway is obviously larger below the confluence than above it. In the case of a confluence, the AA is restricted to the area between the confluent waterways that is affected by the flows they convey (see Figure 3.3).

The boundary of an AA for estuarine wetlands should be determined during low tide. The AA should not extent above the usual high water line of the tide, as indicated by wrack lines, transitions from intertidal to upland vegetation, etc., and it should not extend below the low water line of the tide as observed in the field. The boundary of the AA should extend along the centerline of any adjacent tidal channels that do not dewater at low tide. The AA will therefore include all of the intertidal marsh plain and associated features, such as pannes and natural levees, plus all of the tidal channels that tend to dewater at low tide, plus the exposed tidal flats that border the marsh plain or the associated channels.

3.5.7 Special Considerations for Delineating AAs That Include Riparian Areas

Riparian areas commonly border riverine, lacustrine, freshwater estuarine, and depressional wetlands (see Section 3.2.1 above). Riparian areas should be included in the AAs for these wetland classes. There is no need to distinguish the riparian area from the non-riparian portions of their AAs. There is however, a need to define the landward limit of the riparian area.

For riverine, depressional, and lacustrine wetlands, the lateral extent of the AA should extend to the landward limit of the obvious riparian vegetation, or, if the landward limit of riparian vegetation is not distinct, or if the riparian area is so wide that including its full lateral extent would make the AA too large to cover in half a day, than the AA should extend the landward limit of vegetation that is expected to directly provide material input, such as leaves, twigs, limbs, etc., onto the active floodplain or into the channel. For example, if the dominant overstory along the shore of a stream consists of redwood trees 100 feet tall that cannot be easily distinguished from the adjacent upland canopy of redwoods, then the AA would extend landward 100 feet from the channel bank. If the dominant overstory along the landward margin of a stream's floodplain consists of cultivated grape vines 7 feet tall, then the AA should extend landward 7 feet (see Figure 3.3).

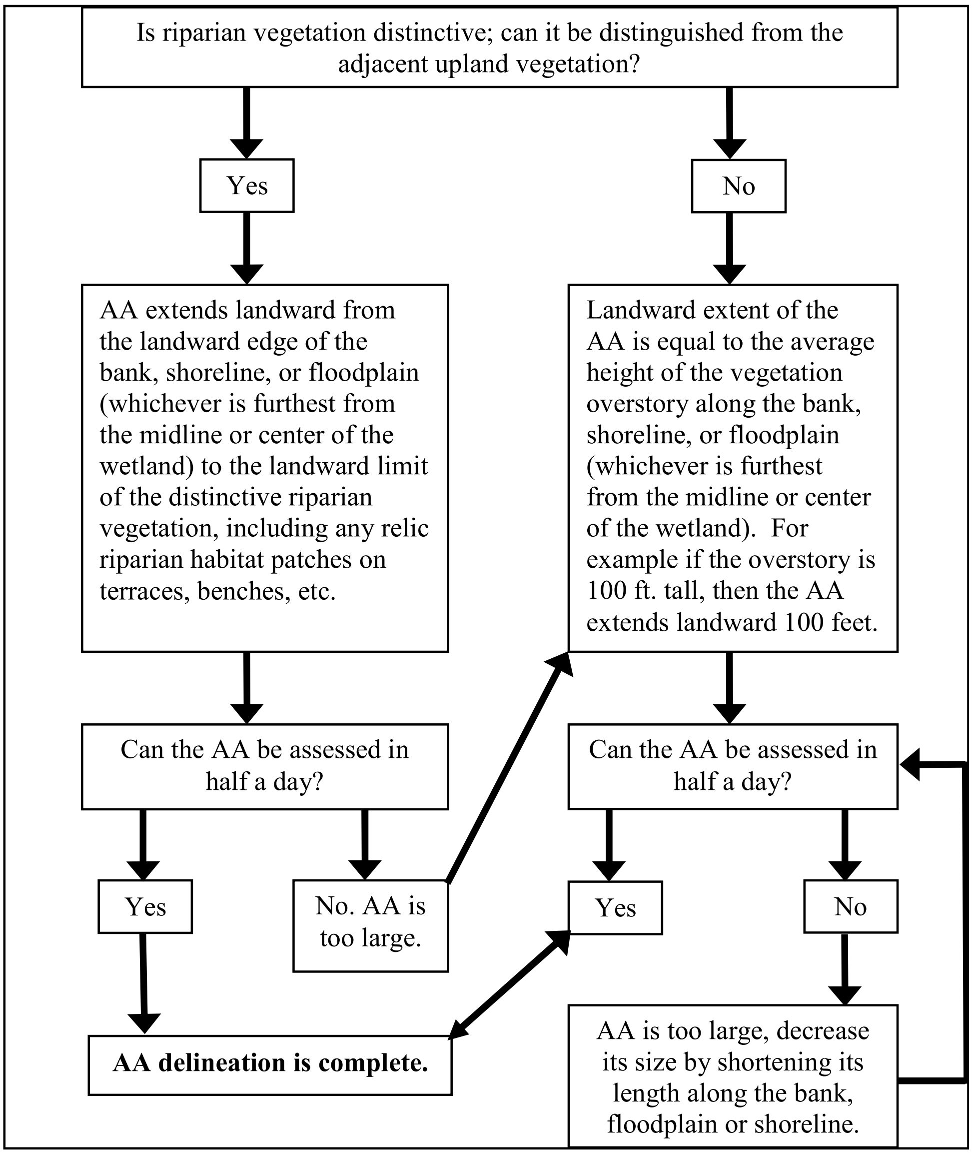

Figure 3.3: Simple decision tree for determining the lateral extent of riparian AA based on either distinctive riparian vegetation or overstory height.

3.5.8 Special Considerations for Delineating AAs for Vernal Pool Systems

Vernal pool systems consist of multiple, hydrologically interconnected, distinct or diffuse pools and/or swales plus their surrounding upland matrix. They resemble other drainage systems except that surface flow, especially channelized flow, is seldom obvious. The boundaries of vernal pool systems consist of topographic divides between relatively separate or independent flow patterns. These may coalesce or converge downslope. The divides are apparent as corridors of relatively high ground dominated by upland vegetation. They either lack vernal pools or they contain isolated pools. The divides can be detected in common aerial imaging.

Delineating a vernal pool system requires careful examination of aerial imaging to identify the drainage divides that separate one part of the system from another. Once the component systems have been outlined, then the delineation of the AA can proceed through the identification of three assessment strata: large pools, small pools, and pool clusters (Figure 3.4). There are no numerical thresholds for pool size; larger pools are simply much larger than small pools. Pool clusters are areas where three or more pools are clearly connected hydrologically by swales and channels. Large and small pool strata consist of individual pools that are not in clusters.

The assessment of a vernal pool system is conducted by the following steps.

1. Delineate the AA on imagery as the largest pools system that can be assessed during a half-day visit.
2. On the site imagery, delineate and number all small pools within the AA. Repeat the process for large pools and then for pool clusters.
3. Using a random numbers table, randomly select three small pools, three large pools, and three pool clusters from the AA.
4. Separately assess each selected small pool, large pool, and pool cluster.
5. Calculate an average score for each of the three sample strata.
6. Calculate an overall score for the AA as a whole by averaging the scores for each sample stratum.

These steps are presented again with the vernal pool system assessment score sheets and worksheets in Chapter 4.

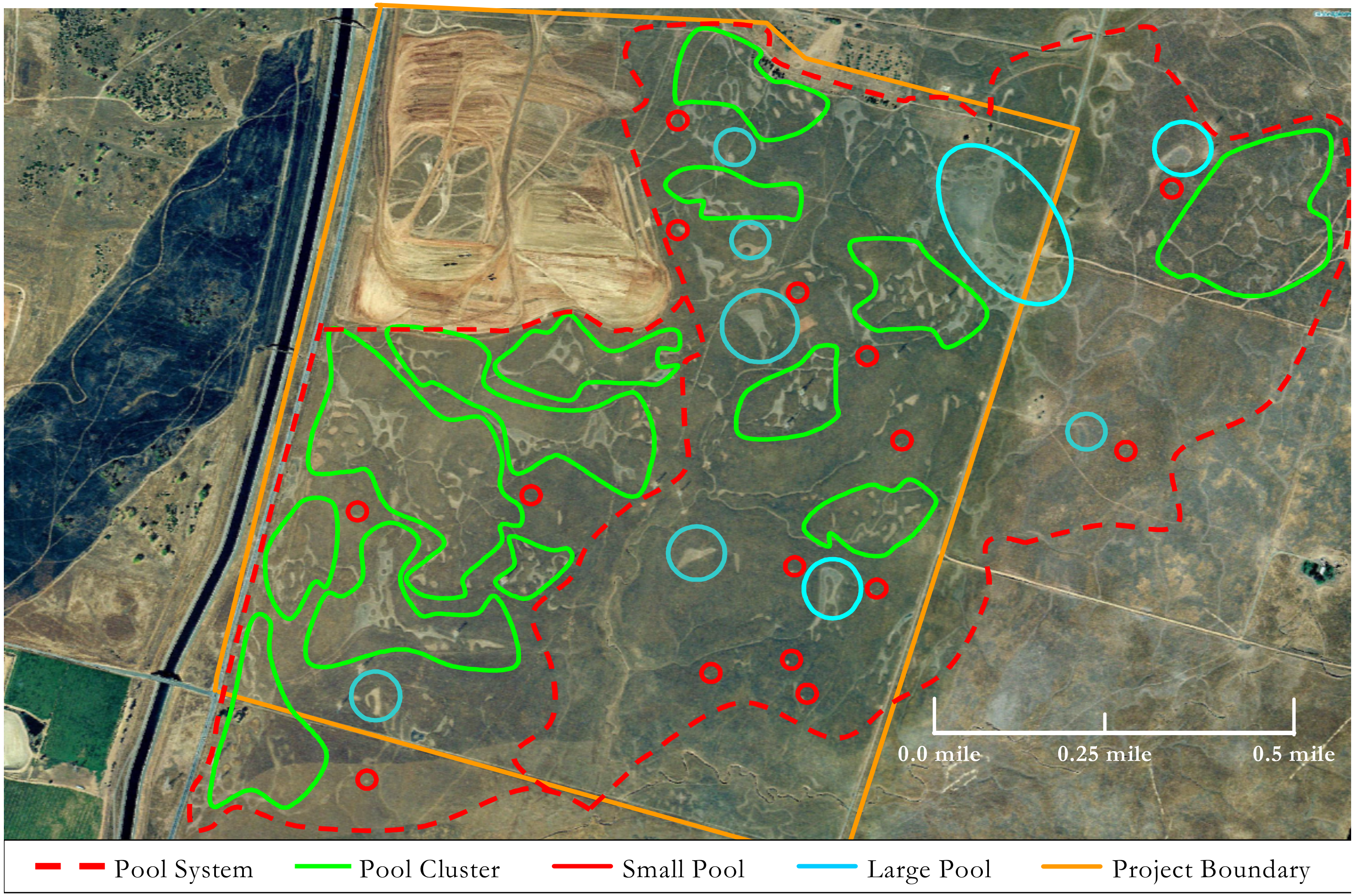

Figure 3.4: Example map of two vernal pool systems as two separate AAs, each with its own pool clusters, small pools, and large pools. Note that the AAs can extend beyond the property line of a project, in this case a vernal pool preserve.

3.6 Step 6: Conduct Initial Office Assessment of Condition Metrics and Stressors

For each wetland site to be assessed, CRAM requires initial office work to acquire the site imagery, plan logistics for the site visit, and to assemble information about the management of the site and its possible stressors. Preliminary scores can be developed for some metrics, based on existing documentation (aerial photography, reports, etc.), prior to conducting fieldwork. Such preliminary scoring is not necessary, however, and any preliminary scores must be verified during the site visit. The initial office work is itemized in Table 3.7 below.

For air photos and other imagery, the minimum pixel resolution is 3m (i.e., each pixel in the digital image of a site should represent no more than about 9 m^2 of area). Existing Digital Orthogonal Quarterly Quadrangles (DOQQs) dating from 1998 to 2004 with a pixel resolution of 3m, and geo-rectified natural color imagery dated 2005 with a pixel resolution of 1m are available for the entire state.

CRAM software is designed to work with any geo-rectified imagery. It can be loaded into the image directory and then used with a tablet computer or laptop in the field to map AAs and conduct the assessment using CRAM.

Table 3.7: CRAM metrics for which preliminary scores can be developed prior to the site visit.

<table>
<tr><th colspan="4">Background Information to Assemble Prior to the Site Visit</th></tr>
<tr><td colspan="4">• 1m -3m pixel resolution digital geo-rectified site imagery
• Site-specific and neighboring reports on hydrology, ecology, chemistry, etc.
• Access permission if needed
• Preliminary map of the Assessment Area
• Maps to the site, access points, and other logistical information</td></tr>
<tr><th colspan="4">Metrics/Submetrics Suitable for Preliminary Scoring Prior to Site Visit</th></tr>
<tr><th colspan="2">Attributes</th><th>Metrics/Submetrics</th><th>Suitable?</th></tr>
<tr><td colspan="2" rowspan="4">Buffer and Landscape Context</td><td>Landscape Connectivity</td><td>Yes</td></tr>
<tr><td>Percent of AA with Buffer</td><td>Yes</td></tr>
<tr><td>Average Buffer Width</td><td>Yes</td></tr>
<tr><td>Buffer Condition</td><td>No</td></tr>
<tr><td colspan="2" rowspan="3">Hydrology</td><td>Water Source</td><td>Yes</td></tr>
<tr><td>Hydroperiod or Channel Stability</td><td>No</td></tr>
<tr><td>Hydrologic Connectivity</td><td>Yes</td></tr>
<tr><td rowspan="9">Structure</td><td rowspan="2">Physical</td><td>Structural Patch Richness</td><td>No</td></tr>
<tr><td>Topographic Complexity</td><td>No</td></tr>
<tr><td rowspan="7">Biotic</td><td>Organic Matter Accumulation</td><td>No</td></tr>
<tr><td>Number of Plant Layers Present</td><td>No</td></tr>
<tr><td>Percent of Layers Dominated by Non-native Species</td><td>No</td></tr>
<tr><td>Number of Co-dominant Species</td><td>No</td></tr>
<tr><td>Percent of Co-dominants that are Non-native</td><td>No</td></tr>
<tr><td>Interspersion and Zonation</td><td>No</td></tr>
<tr><td>Vertical Biotic Structure</td><td>No</td></tr>
</table>

3.7 Step 7: Conduct Field Assessment of Condition Metrics and Stressors

After assembling the background information about the wetland to be assessed, the next step is to conduct an assessment of the wetland in the field. A complete description of CRAM metrics and Stressor Checklist is provided in Chapter 4. Fieldwork for CRAM consists of finding and confirming the boundaries of the AA, and scoring the AA based on the condition metrics and stressor checklist. Any field-based modifications of the preliminary AA boundary must be recorded on the site imagery.

3.8 Step 8: Complete CRAM Scores and Basic QA/QC Procedures

3.8.1 Calculating CRAM Scores

Scores for CRAM are easily calculated. There is no weighting of any metrics or attributes. Weightings are not supported by theory or the calibration exercises. Letter scores for each metric (A, B, C, D or A, B, C, depending on the number of possible alternative states) are simply converted into whole integer numeric scores (12, 9, 6, 3 or 12, 8, 4) (see Step 1 in Table 3.8). With the exception of the metrics for Attribute 1 (Buffer and Landscape Context), the raw attribute score is simply calculated as the sum of its component metric scores (see Step 2 in Table 3.8).

For Attribute 1 (Buffer and Landscape Context), the metric scores relating to buffer are combined into an overall buffer score that is added to the score for the remaining metric, Landscape Connectivity, using the following formula.

$$\left[\left[\boxed{\text{Buffer Condition}} \times \left(\boxed{\text{\% AA with Buffer}} \times \boxed{\text{Average Buffer Width}}\right)^{1/2}\right]^{1/2} + \boxed{\text{Landscape Connectivity}}\right]$$

Each raw attribute score is then converted into a percentage of the maximum possible score (see Step 3 in Table 3.8). This eliminates any weighting of one attribute relative to another due to their differences in numbers of component metrics and numbers of alternative states of the metrics. It should be noted that, for Attribute 4 (Biotic Structure), the Plant Community metric consists of four submetrics (Number of Plant Layers Present; Percent of Layers Dominated by Non-native Species; Number of Co-dominant Species; and Percent of Co-dominant Species that are Non-native). Prior to calculating the Biotic Structure attribute, the values for these submetrics should be averaged to arrive at a single value for the Plant Community metric. Then the value for the Biotric Structure attribute can be calculated as described in Table 3.8, below. For all four attributes, the overall site score is calculated as the percentage of the maximum possible site score by averaging the attribute scores. All scores are rounded to the nearest whole percentage value (see Step 4 in Table 3.8).

Table 3.8: Steps to calculate attribute and site scores.

Steps to Calculate Attribute and Site Scores	
Step 1: Calculate Metric Score	For each metric, convert the letter score into the corresponding numeric score, depending on the number of possible alternative states. For metrics with 4 alternative states, use A=12, B=9, C=6, and D=3. For metrics with 3 alternative states, use A=12, B=8, and C=4.
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 for Buffer and Landscape Context (see formula above).
Step 3: Calculate final	For each attribute, divide the raw score by the maximum possible

Attribute Score	score, which is 24 for Buffer and Landscape Context, 36 for Hydrology, 24 for Physical Structure, 36 for Biotic Structure for Playas and Vernal Pools, and 48 for Biotic Structure for all other wetland classes.
Step 4: Calculate the Overall Site Score	For each site, calculate the percentage of the maximum possible score by averaging the final attribute scores. Round the average to the nearest whole value.

3.8.2 Initial QA/QC Procedures for Data Collectors

Part of the value of CRAM is its ability to yield reproducible results for wetlands of similar condition, regardless of the data collector. Quality Control procedures should be employed to assure that the data collectors or assessors are using the same approach and are obtaining information accurately when they are conducting CRAM assessments. It is recommended for large wetlands with numerous AAs or for ambient assessments using CRAM that 10% of the AAs be revisited by an independent CRAM assessment team and compared to the original assessments for the same AAs.

All CRAM practitioners are advised to carefully read and understand the most recent version of the CRAM User's Manual before they begin conducting assessments. The Users' Manual and CRAM training materials are available at the CRAM web site (www.cramwetlands.org). Supporting materials include a photo-glossary with picture examples of many of the terms and wetland characteristics described or referenced in the User's Manual. These materials are intended to help users develop an understanding of the complete range of conditions for each metric, and arrive at consistent conclusions about wetland condition.

The initial quality assurance/quality control procedures (QA/QC) for any assessment involves a basic review of the AA map and the summary scoring sheet. The recommended topics for the initial QA/QC are listed in Table 3.9 below.

Table 3.9: Recommended topics of initial QA/QC.

Recommended Topics of Initial QA/QC for CRAM Results
• AA map quality: hardcopy maps must be clear enough to be readily digitized. AA maps must be on geo-rectified imagery with minimum pixel resolution of 3 m (i.e., each pixel should represent no more than 9 m^2). • Summary data sheet: make sure all fields of information for site name, wetland class, date of assessment, personnel making the assessment, etc. are complete and legible. • Summary score sheet: make sure that every metric and attribute has a correct score, and that the overall site score is also correct. • Summary stressor sheet: make sure the stressor checklist has been completed.

3.8.3 Initial QA/QC Procedures for Data Managers

The main objective of data management is to assure that the data are accurately collected and verified for analysis and interpretation by CRAM practitioners. Procedures described in this Users' Manual are designed to help assure the accuracy and consistency of data collection and processing. Since metric scores are combined into more complex attribute and overall CRAM site scores, any errors in data collection can be compounded if quality control measures are not adequately implemented.

Data management involves maintaining various types of data and information, including hardcopy and electronic imaging and other background information for sites assessed using CRAM, as well as completed field data sheets. Routine backups of the computing systems and databases should be performed regularly, along with measures to assure network and computer security. Backup discs containing CRAM data should be stored in fireproof facilities. In addition, hard copies of the data should be maintained and, if the data are only in electronic form, printouts of these data should be made and stored separately.

These basic criteria for secure data management are currently met through administration of the CRAM web site and supporting database at the San Francisco Estuary Institute as a data node of the enterprise data and information management system of the California State Surface Water Ambient Monitoring Program (SWAMP). CRAM software, the CRAM database, and its supporting web sites are open source. No aspect of CRAM programming is branded or subject to copyrights.

The database developed to manage CRAM data incorporates numerous measures to assure accurate data entry and processing. The following measures are implemented.

- Each field in the database that requires a value is checked for null or missing values.
- Standard codes are provided in look-up lists for use in populating the data table fields.
- The entry of duplicate records is prevented, based on a unique combination of fields that define the primary key.
- If the record set is related to another table in the database, it is checked for orphan records (i.e., all parent records have child records and all child records have parent records).
- Users are prompted to complete data fields as data are being uploaded into the database via the CRAM web site.
- Data entry and editing is password-protected; data authors can only access their own data.
- All new data for a site are time-stamped and automatically assigned to a unique site code.
- Database users are prompted to download new versions of CRAM if the version they have is outdated.

3.9 Step 9: Upload Assessment Data and Results

No CRAM assessment is complete until the results are uploaded into the CRAM database. The database is accessible at www.cramwetlands.org. Anyone who wants to enter data into the database must register on the CRAM website to obtain a database log-in name and password. Results on hardcopy versions of CRAM must be transcribed into the electronic version on the web site. Results obtained by using CRAM software in the field can be uploaded automatically. The database is only accessible to registered users, and they can only access and edit their own data and results. All results can be viewed and downloaded by the public through interactive maps accessible through the CRAM web site.

Unconfined riverine wetland at Home Ranch, Marin County.

CHAPTER 4:
GUIDELINES FOR SCORING CRAM METRICS

4.0 Summary

This chapter contains detailed guidelines for using CRAM. Each metric is supported by a definition, rationale, and an indication of the metric's sensitivity to seasonal variability in wetland condition. Also provided are visual cues or indicators of condition that can be used in the field or when studying the imagery of a site to guide the scoring of the metrics.

The attributes and stressor checklists are the same for all wetland classes and regions of the State. The wetland classes are very different from each other, however, in terms of their form and structure. Some metrics have been adjusted to reflect these differences. There is not enough evidence at this time to warrant adjustments to the metrics for regional differences in the nature of any wetland class.

A full set of data sheets and worksheets is provided for each wetland class in Volume 2. These two appendices can be used to create basic hardcopy field books for conducting CRAM assessments. CRAM training materials are also available at the CRAM web site (www.cramwetlands.org).

4.1 Attribute 1: Buffer and Landscape Context

For the purposes of CRAM, a buffer is a zone of transition between the immediate margins of a wetland or riparian area and its surrounding environment that is likely to help protect the wetland from anthropogenic stress (see Figure 2.2). Areas adjoining wetlands or riparian areas 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 the 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.

Because regulation and protection of wetlands historically did not extend to adjacent uplands, these areas in some cases have been converted to recreational, agricultural, or other human land uses and might no longer provide their critical buffer functions for wetlands.

CRAM includes four metrics to assess the buffer and landscape context of wetlands. These are (1) landscape connectivity; (2) percentage of the Assessment Area perimeter that has a buffer; (3) the average buffer width; and (4) the condition or quality of the buffer.

4.1.1 Landscape Connectivity

A. Definition: The landscape connectivity of a wetland is assessed in terms of its spatial association with other areas of aquatic resources, such as other wetlands, lakes, streams, lagoons, etc. It is assumed that wetlands close to each other have a greater potential to interact ecologically and hydrologically, and that such interactions are generally beneficial.

B. Rationale: 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. For example, Frissell *et al.* (1986) concluded that the structure and dynamics of stream habitats are determined by the surrounding watershed. 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 together without hydrological or ecological barriers between them are better able to provide refuge and alternative habitat patches for meta-populations 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 has been surmised as 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. Similarly, any permanent physical alteration of the landscape surrounding the wetland that would preclude the movements of wildlife between habitat types or patches, or that would substantially impound or divert surface water flow between the wetland of interest and other water-dependent habitats are also considered to be breaks in connectivity. In general, good landscape connectivity exists only where neighboring wetlands or other habitats do not have intervening obstructions that could inhibit the movements of wildlife.

C. Seasonality: This metric is not sensitive to seasonality.

D. Office and Field Indicators: On digital or hardcopy site imagery, a line should be drawn around the wetland of interest that includes the AA, parallel to and about 500 m away from the wetland boundary. All of the different wetland classes, lagoons, lakes, and streams that intersect this 500 m zone around the wetland of interest are to be counted.

Table 4.1: Rating for Landscape Connectivity for all Wetland Classes, except Riverine.
Note: This metric pertains to the wetland, not to the Assessment Area, unless the two are synonymous.

Rating	Alternative States
A	At least some portion of three or more other areas of water-dependent habitat (other wetlands of the same class, wetlands of different classes, lakes, streams, lagoons, etc.) exists within a 500 m zone surrounding the wetland being assessed, with no intervening barriers to wildlife movement (see Table 4.3).
B	At least some portion of two areas of water-dependent habitat exists within a 500 m zone surrounding the wetland being assessed, with no intervening barriers to wildlife movement.
C	At least some portion of one other area of water-dependent habitat exists within a 500 m zone surrounding the wetland being assessed, with no intervening barriers to wildlife movement.
D	The 500 m zone surrounding the wetland does not contain any other areas of water-dependent habitat.

Table 4.2: Rating for Landscape Connectivity for Riverine Wetland Classes.

Rating	Alternative States
A	There is at least 500 m of riparian area extending upstream and downstream of the AA on both sides of the AA that is not interrupted by any non-buffer land covers at least 10 m wide (see Table 4.3).
B	There is at least 500 m of riparian area extending upstream and downstream of the AA on one side of the AA that is not interrupted by any non-buffer land covers at least 10 m wide (see Table 4.3).
C	There is less that 500 m of riparian area extending upstream and downstream of the AA on both sides of the AA that is not interrupted by any non-buffer land covers at least 10 m wide (see Table 4.3).

4.1.2 Percent of AA with Buffer

A. Definition: The buffer is the area extending from the immediate edge of the AA that is in a natural or semi-natural state and currently not dedicated to anthropogenic uses that would severely detract from its functions as a buffer. The buffer can include uplands, adjacent wetlands of the same or different class, stream channels, small areas of open water (i.e., areas of open water than are much smaller than the wetland), or other habitats.

B. Rationale: The ability of buffers to protect a wetland increases with the extent of buffers along the wetland perimeter. For some kinds of stresses, 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.

C. Seasonality: This metric is not sensitive to seasonality.

D. Office and Field Indicators: 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 scanning the AA and visually estimating the total percentage of the perimeter of the AA that has a buffer. Open water adjacent to the wetland AA, such as a lake, large river, or lagoon is not considered part of the buffer (see Table 4.3). There are three reasons for excluding open water from wetland buffers. First, a significant portion of the adjacent environment of lacustrine, lagoon, and estuarine wetlands usually consists of open water. These areas of open water are commonly wider than 200 m. Assessments of buffer extent around a wetland and of buffer width are therefore inflated by including open water as a part of the buffer. Second, 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. Third, open water can be a direct source of stress (i.e., water pollution, waves, boat wakes) or an indirect source (i.e., promotes visitation by livestock and people, provides access for non-native plant species). Because open water is excluded from buffers, in wetland classes that are typically adjacent to open water, only the terrestrial portion of the perimeter of the AA is considered in the calculation of percent buffer.

The wetland buffer is assessed by evaluating a combination of land use, vegetation, and substrate condition, using the following guidelines. The assessment of this metric is the same across all wetland classes, *with the exception of riverine wetlands*, in which only the lateral margins of the AA, and not it's upstream and downstream limits should be included in the determination of the buffer. Ratings for Percentage of AA with Buffer are provided in Table 4.4.

Table 4.3: Guidelines for identifying wetland buffers and breaks in buffers.

Examples of Land Covers Included in Buffers	**Examples of Land Covers That are Excluded from Buffers - Buffers Do Not Cross These Land Covers**
natural upland habitats and plant communities, roads not hazardous to wildlife, railroads, vegetated levees, mowed grass or greenbelts, swales and ditches, foot trails, horse trails, bike trails, pastures subject to open range grazing pressure, dry-land farming areas	parking lots; commercial developments; residential areas; very active roadways and pedestrian/bike trails (i.e., nearly constant traffic); intensive agriculture/orchards or silviculture, pastures subject to heavy grazing pressure (e.g., horse paddock, feedlot, turkey ranch); large paved roads (two lanes plus a turning lane or larger); sound walls; fences that interfere with the movements of water, sediment, or wildlife species that are critical to the overall functions of the wetland; open water (see Section 4.1.2 part D).

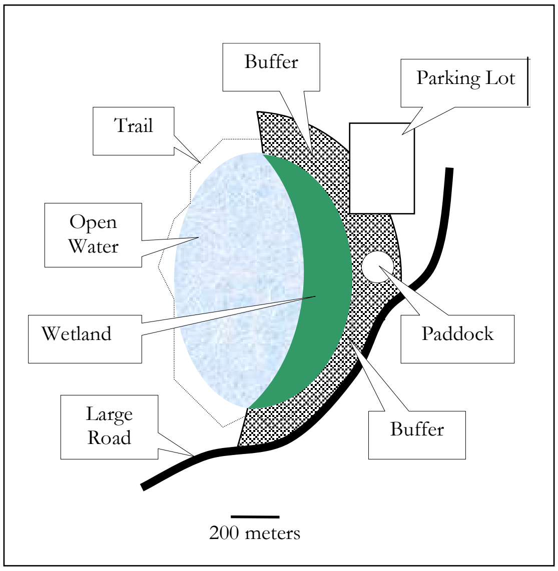

Figure 4.1: Diagram of the relationship between land cover and buffer extent for common landcover types.

Table 4.4: Rating for Percent of AA with Buffer (not including open-water areas).

Rating	**Alternative States**
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 < 25% of AA perimeter.

4.1.3 Average Buffer Width

A. Definition: Buffer width is measured in meters of distance along lines-of-sight that are perpendicular to the wetland boundary. Buffers are not infinitely wide. It is assumed that the functions of the buffer do not increase significantly beyond an average width of about 200 m. The maximum buffer width is therefore 200 m. The minimum buffer width is 2 m. Any area less than 2 m wide is too narrow to be a buffer. The height to which the buffer extends above or below the wetland is not considered as part of buffer width. For example, a vertical bluff rising 40m at the immediate edge of an AA with a flat top extending 20m horizontally to houses represents an area of buffer that is 20 m wide. See Table 4.3 above for additional guidance regarding the identification of AA buffers.

B. Rationale: 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 in Section 4.1.2 above.

C. Seasonality: This metric is not sensitive to seasonality.

D. Office and Field Indicators: The procedure to assess this metric is the same across all wetland classes. The procedure can be performed initially in the office using the site imagery, and then revised based on the field visit. The procedure has three steps: (1) subdivide the perimeter of the AA into four sections; (2) estimate the width of the buffer (where it exists) in each of the four sections; and (3) calculate the average buffer width for all four of the subdivisions. The average buffer width is only calculated for the areas where a buffer exists. For example, if a wetland has buffer on two sides, is adjacent to urban land uses on one side, and open water on one side, the average buffer width would be based only on the two sides that possess a buffer. The minimum extent of buffer along the wetland perimeter for estimating buffer width is 2m.

For riverine AAs, if the length of the AA is < 100 m, go up to the next hydrologic break (i.e., combine the AA being assessed with the next upstream) to ensure that the AA length is greater than 100m for the purpose of assessing buffer width. Ratings for Average Buffer Width are provided in Table 4.5. If there is no buffer, assign a score of D.

Worksheet for calculating average buffer width of AA

Estimate average buffer width of AA in each of its quadrants and average for scoring.

Buffer Quadrant	Buffer Width in Meters
Quadrant 1	
Quadrant 2	
Quadrant 3	
Quadrant 4	
Average buffer width	

Table 4.5: Rating for average buffer width, based on the worksheet above.

Rating	Alternative States
A	Average buffer width of AA is ≥ 200 m.
B	Average buffer width of AA is 100 – 199 m.
C	Average buffer width of AA is 50 – 99 m.
D	Average buffer width of AA is 0 - 49 m.

4.1.4 Buffer Condition

A. Definition: The condition of a buffer is assessed according to the extent and quality of its vegetation cover and the overall condition of its substrate. Evidence of direct impacts by people are excluded from this metric and included in the Stressor Checklist. Buffer conditions are assessed only for the portion of the wetland border that has already been identified or defined as buffer, based on Section 4.1.2 above.

B. Rationale: 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.

C. Seasonality: This metric is not sensitive to seasonality.

D. Office and Field Indicators: Buffer condition must be assessed in the field. The assessment method is the same across all wetland classes. 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. For the purpose of assessing substrate condition in the buffer, no evidence of problems more than 3 years old should be considered. Narratives for Buffer Condition ratings are provided in Table 4.6. If there is no buffer, assign a score of D.

Table 4.6: Rating for Buffer Condition.

Rating	Alternative States
A	Buffer for AA is characterized by abundant native vegetation and little to no cover of non-native plants, with intact soils, and little or no trash or refuse.
B	Buffer for AA is characterized by moderate cover of native vegetation, moderate cover of non-native plants, intact or moderately disrupted soils, moderate or lesser amounts of trash or refuse, and minor intensity of human visitation or recreation.
C	Buffer for AA is characterized by a prevalence of non-native plants, and either moderate or extensive soil disruption, moderate or greater amounts of trash or refuse, and moderate intensity of human visitation or recreation.
D	Buffer for AA is characterized by barren ground and highly compacted or otherwise disrupted soils, with moderate or greater amounts of trash or refuse, and moderate or greater intensity of human visitation or recreation; OR there is no buffer present.

4.2 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. For example, Richards *et al.*, 2002 concluded that meandering and braiding in riverine systems control habitat patch dynamics and ecosystem turnover. The spatial distribution of plants and animals in a tidal marsh closely correspond to patterns of tidal inundation or exposure (Sanderson *et al.*, 2000).

4.2.1 Water Source

A. Definition: Water Sources directly affect the extent, duration, and frequency of saturated or ponded conditions within an Assessment Area. Water Sources encompass the forms, or places, of direct inputs of water to the AA as well as any unnatural 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 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, direct sources include rainfall, ground water discharge, and flooding of the AA due to high tides or naturally high riverine flows. Examples of unnatural, direct sources include stormdrains that empty directly into the AA or into an immediately adjacent area. For seeps and springs that occur at the toe of an earthen dam, the reservoir behind the dam is an unnatural, direct water source. Indirect sources that should not be considered in this metric include large regional dams or urban storm drain systems that do not drain directly into the AA but that have systemic, ubiquitous effects on broad geographic areas of which the AA is a small part. For example, the salinity regime of an estuarine wetland near Napa is affected by dams in the Sierra Nevada, but these effects are not direct. But the same wetland is directly affected by the nearby discharge from the Napa sewage treatment facility. Engineered hydrological controls, such as tide gates, weirs, flashboards, grade control structures, check dams, etc., cans serve to demarcate the boundary of an AA (see Section 3.5), but they are not considered water sources.

B. Rationale: Wetlands, by definition, 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. The flow of water into a wetland also affects sediment processes and the physical structure/geometry of the wetland. Sudol and Ambrose (2002) found that one of the greatest causes of failed wetland mitigation or restoration projects is inadequate or inappropriate hydrology.

Dry season sources of water are relatively more important because they control the seasonality of the wetland and thus also control the overall structure and composition of the plant and animal communities that the wetland can support. Perturbations to the natural hydrologic budget of the AA are reflected by a decrease in the score for the Water Source metric.

C. Seasonality: Water source should be evaluated during the dry season.

D. Office and Field Indicators: The assessment of this metric is the same for all wetland classes. It is assessed initially in the office using the site imaging, and then revised based on the field visit. For all wetlands, including fringe habitat for estuaries and lagoons, this metric focuses on *direct* sources of non-tidal water as defined above (see Figure 4.1). 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 AA. Permanent or semi-permanent features that affect water source at the overall watershed or regional level should not be considered in the evaluation of this metric.

The office work should initially focus on the immediate margin of the AA and its wetland, and then expand in focus 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 or adjacent reach of the same riverine or riparian system. Landscape indicators of unnatural water sources include adjacent intensive development or irrigated agriculture, nearby wastewater treatment plants, and nearby reservoirs (see Table 4.7b).

The typical suite of natural water sources differs among the wetland classes. The effects of changing the natural sources or modifying them also differ among the classes. The following discussion may be helpful in understanding these differences and recognizing them in the field.

Estuarine: The water for estuarine wetlands is by definition a combination of marine and riverine (i.e., fluvial) sources. This metric is focused on the non-tidal water sources. 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 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.

Slope Wetlands: Ground water is the source of water for seep, spring, and slope wetlands. It is generally expected that the source is perennial and relatively constant in volume throughout most years. The water source can be assessed, therefore, based on plant indicators of its permanence and consistency. The hydrologic needs of many plant species commonly found in wetlands have been determined (Reed, 1988). A data column indicating whether each of these species is a wetland obligate, facultative, or considered to be restricted to upland habitat, is provided in the plant species table in Appendix 2.

Riverine, Depressional, Lacustrine, Lagoons, and Playas: Natural sources of water for these wetlands include rainfall, groundwater, riverine flows, and (for lagoons) ocean water. Whether the wetlands are perennial or seasonal, alterations in the water sources result in changes in either the high water or low water levels. Such changes can be assessed based on the patterns of plant growth along the wetland margins or across the bottom of the wetlands.

Vernal Pools: The hydrology of vernal pools and pool systems depends mainly on direct rainfall and runoff from the adjacent upland. Sub-surface flows between pools and swales can be subtle, multi-directional, and difficult to assess, but significant during wet years. Interannual variations in water sources can affect the hydrology. The effects of changes in water sources can be assessed according to distribution, abundance, and size of individual pools and pool systems, as well as the pattern of vegetation zonation and interspersion.

Table 4.7a: Rating for Water Source.

Rating	Alternative States
A	Dry-season freshwater source for AA is precipitation, groundwater, and/or natural runoff, or an adjacent freshwater body, or system naturally lacks water in the dry season. There is no indication of direct artificial water sources. Land use in the local drainage area of the AA is primarily open space or low density, passive uses. No large point sources discharge into or adjacent to the AA.
B	Dry-season freshwater source is mostly natural, but AA directly receives occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic input include developed land or irrigated agricultural land (< 20%) in the immediate drainage area of the AA, or the presence of small stormdrains or other local discharges emptying into the AA, or the presence of scattered homes along the wetland that probably have septic systems. No large point sources discharge into or adjacent to the AA.
C	Dry-season freshwater source is primarily urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology. Indications of substantial artificial hydrology include > 20% developed or irrigated agricultural land adjacent to the AA, and the presence of major point sources that discharge into or adjacent to the AA. OR Dry season freshwater flow exists but has been substantially diminished by known diversions of water or other withdrawals directly from the AA, its encompassing wetland, or from areas adjacent to the AA or its wetland.
D	Natural, dry-season or end-of-wet-season sources of freshwater have been eliminated based on the following indicators: observable diversion of all dry-season flow, etc., and predominance of xeric vegetation (see Table 4.7b).

Table 4.7b: Appropriate landscape positions for each wetland class.

Wetland Type	Natural Landscape Position	Unnatural Landscape Position
Riverine/Riparian Wetlands	Along valley bottoms and canyon bottoms with at least seasonal channelized flow.	Along unnatural channels (e.g., abandoned paleo-channels, flumes, agricultural ditches and canals) across hillslopes benches, or terraces above the elevation of the flood-prone area.
Depressional and Lacustrine Wetlands, Vernal Pools, Playas	Topographic low points in basins, on natural topographic saddles, or on bedrock or other impermeable substrate. The basins may be distinct or diffuse and subtle.	At elevations above the topographic low point of a basin, on hillslopes or high ground lacking adequate catchment and runoff such that water in dry season must be pumped in order to reach the AA.
Slope Wetlands	Along the bases or middle reaches of hillslopes or dunes, typically at breaks in the slope, transitions between one slope and another, or at contacts between geological strata.	In flat, "mesa-like" areas or along tops of hills or ridges where water in the dry season must be pumped in order to reach the AA.
Estuarine Wetlands and Coastal Lagoon Wetlands	At the terminus of watersheds or coastal catchments, in the transition zone between tidal and freshwater areas, at or near sea level.	At elevations or positions in the watershed upstream, above, or below local intertidal elevations.

4.2.2 Hydroperiod or Channel Stability

A. Definition: Hydroperiod is the cyclic frequency and duration of inundation or saturation of a wetland. For tidal wetlands, there are many hydroperiod cycles that correspond to different periodicities in the orbital relationships among the Earth, Moon, and Sun. Other hydro-periodicities for tidal wetlands are semi-daily, daily, semi-weekly, monthly, seasonal, and annual. Depressional, lacustrine, and riverine wetlands typically have daily cycles that are governed by diurnal increases in evapotranspiration and seasonal cycles that are governed by wet season rainfall and runoff, and dry season consumption. Seep and spring wetlands that depend on groundwater may have relatively slight seasonal variations in hydroperiod. Lagoons and lacustrine systems have similar hydroperiods, except that lagoons can be episodically subjected to tidal inundation.

The concept of channel stability only pertains to riverine wetlands. It refers to the degree to which a riverine channel is either aggrading (i.e., there is a net and chronic accumulation of sediment on the channel bed such that it is rising over time), or degrading (i.e., there is a net and chronic loss of sediment from the bed such that it is being lowered over time). There is much interest in channel entrenchment (i.e., the inability of flows in a channel to exceed the channel banks) and this is addressed in the Hydrologic Connectivity metric.

B. Rationale/Objective: For all wetlands except riverine wetlands, hydroperiod is the dominant aspect of hydrology. The pattern and balance of inflows and outflows is a major determinant of wetland functions Mitch and Gosselink (1993). The patterns of import, storage, and export of sediment and other water-borne materials are functions of the hydroperiod. In most wetlands, plant recruitment and maintenance are dependent on hydroperiod. The interactions of hydroperiod and topography are major determinants of the distribution and abundance of native wetland plants and animals. Natural hydroperiods are key attributes of successful wetland projects (National Research Council 2001).

For riverine systems, the patterns of increasing and decreasing flows that are associated with storms, releases of water from dams, seasonal variations in rainfall, or longer term trends in peak flow, base flow, and average flow are more important that hydroperiod. The patterns of flow, in conjunction with the kinds and amounts of sediment with which the flow interacts, largely determine the form of riverine systems, including their floodplains, and thus also control their ecological functions. Under natural conditions, the opposing tendencies for sediment to stop moving and for flow to move the sediment tend toward a dynamic equilibrium, such that the form of the channel that contains the sediment and the flow remains relatively constant over time (Leopold 1994). Large and persistent changes in either the flow regime or the sediment regime tend to destabilize the channel and cause it to change form. Such regime changes are associated with upstream land use changes, alterations of the drainage network of which the channel of interest is a part, and climatic changes. A riverine channel is an almost infinitely adjustable complex of interrelations between flow, width, depth, bed resistance, sediment transport, and riparian vegetation. Change in any one will be countered by adjustments in the others. The degree of channel stability can be assessed based on field indicators.

C. **Seasonality**: For all wetland classes other than depressional wetlands, vernal pools, and playas, hydroperiod should be evaluated during the dry season. For depressional wetlands and playas, hydroperiod should be assessed during the latter part of the wet season (i.e., June and July, in most years). The assessment window for vernal pools can be relatively short, and varies from one year to the next. As a general rule, however, hydroperiod for vernal pools should be assessed near the end of their growing season, when botanical indicators of successional change in hydroperiod are evident (i.e., April or May in most years).

D. **Office and Field Indicators:** This metric evaluates recent changes in the hydroperiod, flow regime, or sediment regime of a wetland and the degree to which these changes affect the structure and composition of the wetland plant community or, in the case of riverine wetlands, the stability of the riverine channel. Common indicators are presented for the different wetland classes. This metric focuses on changes that have occurred in the last 2-3 years.

Riverine: Every stable riverine channel tends to have a particular form in cross section, profile, and plan view that is in dynamic equilibrium with the inputs of water and sediment. If these supplies change enough, the channel will tend to adjust toward a new equilibrium form. For example, an increase in the supply of sediment, relative to the supply of water, can cause a channel to aggrade (i.e., the elevation of the channel bed increases), which might cause simple increases in the duration of inundation for existing wetlands, or complex changes in channel location and morphology through braiding, avulsion, burial of wetlands, creation of new wetlands, spray and fan development, etc. An increase in water relative to sediment might cause a channel to incise (i.e., the bed elevation decreases), leading to bank erosion, headward erosion of the channel bed, floodplain abandonment, and dewatering of riparian areas. For most riverine systems, chronic incision (i.e., bed degradation) is generally regarded as more deleterious than aggradation because it is more likely to cause significant decreases in the extent of riverine wetland and riparian areas (Kondolf *et al.* 1996). There are many well-known field indicators of equilibrium conditions, or deviations from equilibrium, that can be used to assess the existing mode of behavior of a channel and hence the degree to which its hydroperiod can sustain wetland and riparian areas.

To score this metric, visually survey the AA for field indicators of aggradation or degradation (listed in Table 4.8). After reviewing the entire AA and comparing the conditions to those described in the table, determine whether the AA is in equilibrium, aggrading, or degrading, then assign a rating score using the alternative state descriptions in Table 4.9.

Table 4.8: Suggested field indicators for evaluating Hydroperiod Metric for riverine wetlands.

Condition	Field Indicators
Indicators of Channel Equilibrium	• The channel (or multiple channels in braided systems) has a well-defined usual high water line, or bankfull stage that is clearly indicated by an obvious floodplain, topographic bench that represents an abrupt change in the cross-sectional profile of the channel throughout most of the AA. • The usual high water line or bank full stage corresponds to the lower limit of riparian vascular vegetation. • Leaf litter, thatch, wrack, and/or mosses exist in most pools. • The channel contains embedded woody debris of the size and amount consistent with what is available in the riparian area. • There is little or no active undercutting or burial of riparian vegetation. • There is little evidence of recent deposition of cobble or very coarse gravel on the floodplain, although recent sandy deposits may be evident. • There are no densely vegetated mid-channel bars and/or point bars. • The spacing between pools in the channel tends to be 5-7 channel widths. • The larger bed material supports abundant periphyton.
Indicators of Active Degradation	• The channel through the AA is characterized by deeply undercut banks with exposed living roots of trees or shrubs. There are abundant bank slides or slumps, or the banks are uniformly scoured and unvegetated. • Riparian vegetation may be declining in stature or vigor, and/or riparian trees and shrubs may be falling into the channel. • Abundant organic debris has accumulated on what seems to be the historical floodplain. • The channel bed appears scoured to bedrock or dense clay. • The channel bed lacks any fine-grained sediment. • Recently active flow pathways appear to have coalesced into one channel (i.e. a previously braided system is no longer braided). • There are one or more nick points along the channel, indicating headward erosion of the channel bed.
Indicators of Active Aggradation	• The channel through the AA lacks a well-defined usual high water line. • There is an active floodplain with fresh splays of sediment covering older soils or recent vegetation. • There are partially buried tree trunks or shrubs. • Cobbles and/or coarse gravels have recently been deposited on the floodplain. • There is a lack of in-channel pools, their spacing is greater than 5-7 channel widths, or many pools seem to be filling with sediment. • There are partially buried, or sediment-choked, culverts. • Transitional or upland vegetation is encroaching into the channel throughout most of the AA. • The bed material is loose and mostly devoid of periphyton.

Table 4.9: Rating for Riverine Channel Stability Metric (based on Table 4.8 above).

Rating	Alternative State
A	Most of the channel through the AA is characterized by equilibrium conditions, with little evidence of aggradation or degradation (based on the field indicators listed in Table 4.8).
B	Most of the channel through the AA is characterized by some aggradation or degradation, none of which is severe, and the channel seems to be approaching an equilibrium form (based on the field indicators listed in Table 4.8).
C	There is evidence of severe aggradation or degradation of most of the channel through the AA (based on the field indicators listed in Table 4.8), or the channel is artificially hardened through less than half of the AA.
D	The channel is concrete or is otherwise artificially hardened through most of the AA.

Depressional, Lacustrine, Playas, Slope Wetlands: Assessment of the hydroperiod for these kinds of wetlands should be initiated with an office-based review of diversions or augmentations of flows to the wetland. Field indicators for altered hydroperiod include pumps, spring boxes, ditches, hoses and pipes, encroachment of terrestrial vegetation, excessive exotic vegetation along the perimeter of the wetland, and desiccation during periods of the year when comparable wetlands are typically inundated or saturated (Table 4.10). Table 4.11 provides narratives for rating Hydroperiod for depressional, lacustrine, and seep and spring wetlands.

Table 4.10: Field Indicators of Altered Hydroperiod for Depressional, Lacustrine, Playas, Slope Wetlands, Individual Vernal Pools, and Vernal Pool Systems.

Direct Engineering Evidence	**Indirect Ecological Evidence**
Reduced Extent and Duration of Inundation or Saturation	
Upstream spring boxes, diversions, impoundments, pumps, ditching or draining ***from*** the wetland	Evidence of aquatic wildlife mortality Encroachment of terrestrial vegetation Stress or mortality of hydrophytes Compressed or reduced plant zonation
Increased Extent and Duration of Inundation or Saturation	
Berms, dikes, or other water-control features that increase duration of ponding: pumps, diversions, ditching or draining ***into*** the wetland	Late-season vitality of annual vegetation Recently drowned riparian or terrestrial vegetation Extensive fine-grain deposits on the wetland margins

Table 4.11a: Rating of Hydroperiod Metric for Depressional, Lacustrine, Playas, Slope Wetlands (based on Table 4.10, above).

Rating	Alternative States
A	Hydroperiod of the AA is characterized by natural patterns of filling or inundation and drying or drawdown.
B	The filling or inundation patterns in the AA are of greater magnitude or duration than would be expected under natural conditions, but thereafter, the AA is subject to natural drawdown or drying.
C	Hydroperiod of the AA is characterized by natural patterns of filling or inundation, but thereafter, is subject to more rapid or extreme drawdown or drying, as compared to more natural wetlands. OR The filling or inundation patterns in the AA are of substantially lower magnitude or duration than would be expected under natural conditions, but thereafter, the AA is subject to natural drawdown or drying.
D	Both the filling/inundation and drawdown/drying of the AA deviate from natural conditions (either increased or decreased in magnitude and/or duration).

Table 4.11b: Rating of Hydroperiod for Inidividual Vernal Pools and Vernal Pool Systems (based on Table 4.10, above).

Rating	Alternative States
A	Hydroperiod of the AA is characterized by natural patterns of filling or inundation and drying or drawdown (e.g., without berms, dams, or ditches).
B	The filling or inundation patterns in the AA are of greater magnitude or duration than would be expected under natural condition (or compared to comparable natural wetlands), but thereafter, the AA is subject to natural drawdown or drying.
C	Both the filling/inundation and drawdown/drying of the AA deviate from natural conditions (either increased or decreased in magnitude and/or duration).

Lagoon: The hydroperiod of a natural lagoon can be highly variable due to interannual variations in freshwater inputs and occasional breaching of the tidal barrier. For the purposes of CRAM, the wetland fringe of a "lagoon" that is breached and experiencing significant tidal action is classified as either estuarine (if it is significantly affected by fluvial inputs), or marine (if it lacks significant fluvial inputs). Here we assume that the wetlands of interest are in fact associated with a lagoon, meaning an impoundment of freshwater with marine or estuarine influences being mostly restricted to wind-driven over-wash across the tidal barrier, aeolian deposition of salts, seepage of saline water through the tidal barrier, etc. The Hydroperiod Metric for lagoon wetlands therefore focuses on freshwater influences and the evidence of the dynamic nature of lagoon hydroperiods. Alteration of the hydroperiod can be inferred from atypical wetting and drying patterns along the shoreline (e.g., a preponderance of shrink-swell cracks or dried pannes in inappropriate locations within the lagoon and/or that do not occur in similar, un-impacted lagoons). Inadequate tidal flushing, or, in arid systems, excessive freshwater input during the dry season may be indicated by algal blooms or by encroachment of freshwater vegetation. Dikes, levees, ponds, ditches, and tide-control structures are indicators of an altered hydroperiod resulting from management for flood control, salt production, waterfowl hunting, boating, etc. Table 4.12 provides narratives for rating Hydroperiod for lagoons.

Table 4.12: Rating of Hydroperiod for Lagoons.

Rating	Alternative States
A	AA is subject to natural interannual tidal fluctuations (range may be severely muted or vary seasonally), and is episodically fully tidal by natural breaching due to either fluvial flooding or storm surge.
B	AA is subject to full tidal range more often than would be expected under natural circumstances, because of artificial breaching of the tidal barrier.
C	AA is subject to full tidal range less often than would be expected under natural circumstances due to management of the breach to prevent its opening.
D	AA probably has no episodes of full tidal exchange.

Estuarine: The volume of water that flows into and from an estuarine wetland due to the changing stage of the tide is termed the "tidal prism". This volume of water consists of inputs from both tidal (i.e., marine) and non-tidal (e.g., fluvial or upland) sources. The timing, duration, and frequency of inundation of the wetland by these waters is termed the tidal hydroperiod. Under natural conditions, increases in tidal prism result in increases in sedimentation, such that increases in hydroperiod do not persist. For example, estuarine marshes tend to build upward in quasi-equilibrium with sea level rise. A decrease in tidal prism usually results in a decrease in hydroperiod. A change in the hydroperiod of an estuarine wetland (i.e., a change in the tidal prism) can be inferred based on changes in the relative abundance of plants indicative of either high or low marsh. A preponderance of shrink cracks or dried pannes is indicative of decreased hydroperiod. In addition, inadequate tidal flushing may be indicated by algal blooms or by encroachment of freshwater vegetation. Dikes, levees, ponds, or ditches are indicators of an altered hydroperiod resulting from management for flood control, salt production, waterfowl hunting, etc. Table 4.13 provides narratives for rating Hydroperiod for estuaries.

Table 4.13: Rating of the Hydroperiod Metric for Estuarine Wetlands.

Rating	Alternative States
A	AA is subject to the full tidal prism, with two daily tidal minima and maxima.
B	AA is subject to reduced, or muted, tidal prism, although two daily minima and maxima are observed.
C	AA is subject to muted tidal prism, with tidal fluctuations evident only in relation to extreme daily highs or spring tides.
D	AA is subject to muted tidal prism, plus there is inadequate drainage, such that the marsh plain tends to remain flooded during low tide.

4.2.3 Hydrologic Connectivity

A. Definition: Hydrologic Connectivity describes relationships between riverine, estuarine, or lagoon wetlands and their adjacent uplands that influence the ability of water to flow into, or out of, the wetland or to inundate the adjacent uplands during periods of high water.

B. Rationale: Hydrologic connectivity between wetlands and adjacent uplands supports ecologic function by promoting exchange of water, sediment, nutrients, and organic carbon. Inputs of organic carbon are of great importance to ecosystem function. Litter and allochthonous input from adjacent uplands provides energy that subsidizes the aquatic food web (Roth 1966). Connection with adjacent water bodies promotes the import and export of water-borne materials, including nutrients. Surface and subsurface hydrologic connections, including connections with shallow aquifers and hyporheic zones, influence most wetland functions. Plant and animal communities are affected by these hydrologic connections. Plant diversity tends to be positively correlated with connectivity between wetlands and natural uplands and negatively correlated with increasing inter-wetland distances (Lopez *et al.* 2002). Diversity of amphibian communities is directly correlated with connectivity between streams and their floodplains (Amoros and Bornette, 2002). Linkages between aquatic and terrestrial habitats allow wetland-dependent species to move between habitats to complete life cycle requirements.

C. Seasonality: This metric is not sensitive to seasonality.

D. Field Indicators: Scoring of this metric is based solely on field indicators. No office work is required. This metric pertains only to Riverine, Estuarine, Lagoon, Vernal Pool and Playas and individual Vernal Pools. Tables 4.14a and 4.14b contain narratives for rating the Hydrologic Connectivity Metric.

Table 4.14a: Rating of Hydrologic Connectivity for Estuarine, Depressional, Lagoon, Lacustrine, Slope Wetlands, Playas, and Vernal Pools.

Rating	Alternative States
A	Rising water in the AA has unrestricted access to adjacent upland, without levees, excessively high banks, artificial walls, or other obstructions to the lateral movement of flood flows.
B	Lateral excursion of rising waters in the AA is partially restricted by unnatural features, such as levees or excessively high banks, but less than 50% of the AA is restricted by barriers to drainage. Restrictions may be intermittent along the AA, or the restrictions may occur only along one bank or shore. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.
C	Lateral excursion of rising waters in the AA is partially restricted by unnatural features, such as levees or excessively high banks, and 50-90% of the AA is restricted by barriers to drainage. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.
D	All water stages in the AA are contained within artificial banks, levees, sea walls, or comparable features, or greater than 90% of wetland is restricted by barriers to drainage. There is essentially no hydrologic connection to adjacent uplands.

Riverine: For riverine wetlands and riparian areas, Hydrologic Connectivity is assessed based on the degree of channel entrenchment (Leopold *et al.* 1964; Rosgen 1996; Montgomery and MacDonald 2002). Entrenchment is a field measurement calculated as the flood-prone width divided by the bankfull width. Bankfull depth is the channel depth at the height of bankfull flow. The flood-prone channel width is measured at the elevation of twice the maximum bankfull depth. The process for estimating entrenchment in outlined below.

Entrenchment varies naturally with channel confinement. Channels in steep canyons naturally tend to be confined, and tend to have small entrenchment ratios indicating less hydrologic connectivity. Assessments of hydrologic connectivity based on entrenchment must therefore be adjusted for channel confinement. It is essential that the riverine AA be further classified as confined or unconfined, based on the definitions provided in section 3.2.2.1 above.

Riverine Wetland Entrenchment Ratio Calculation Worksheet

Step 1:	Estimate bankfull width.	This is a critical step requiring experience. If the stream is entrenched, the depth of bankfull flow is identified as a scour line, narrow bench, or the top of active point bars well below the top of apparent channel banks. If the stream is not entrenched, bankfull stage can correspond to the elevation of a broader floodplain with indicative riparian vegetation. Once the bankfull contour is identified, estimate the bankfull channel width.	
Step 2:	Estimate bankfull depth.	Once the bankfull contour is identified, estimate its maximum depth from the channel bottom.	
Step 3:	Estimate flood prone depth.	Double the estimate of maximum bankfull depth from Step 2, and note the location of the new depth on the channel bank.	
Step 4:	Estimate flood prone width.	Estimate the width of the channel at the flood prone depth.	
Step 5:	Calculate entrenchment ratio.	Divide the flood prone width (result of Step 4) by the maximum bankfull width (result of Step 1)	
Result (enter here and use in Tables 4.14b,c)			

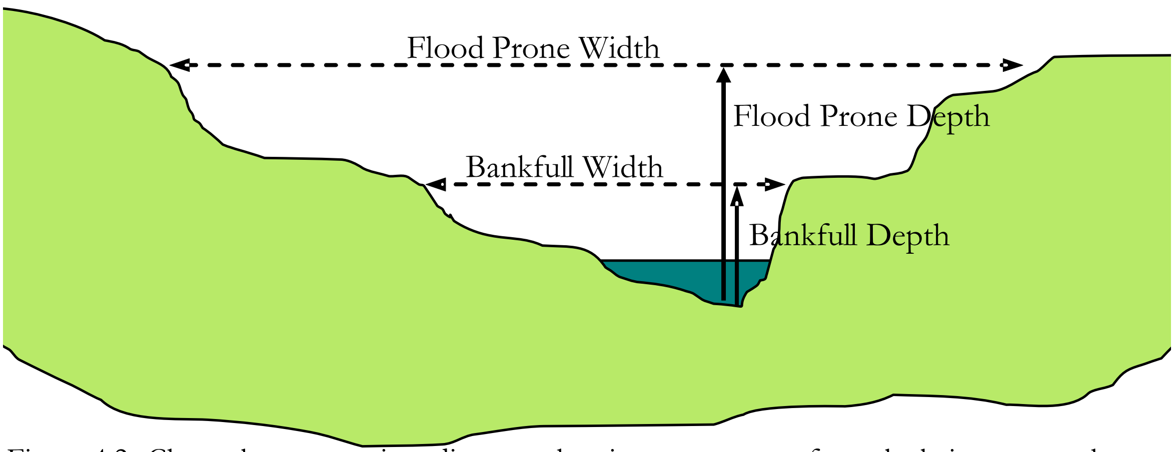

Figure 4.2: Channel cross-section diagram showing parameters for calculating entrenchment. Flood prone depth is twice bankfull depth. Entrenchment is measured as flood prone width divided by bankfull width.

Table 4.14b: Rating of Hydrologic Connectivity Metric for ***Unconfined*** Riverine Wetlands and riparian areas based on the results from the entrenchment ratio calculation worksheet above.

Rating	Alternative States
A	Entrenchment ratio is > 7.5.
B	Entrenchment ratio is 3.0 – 7.5.
C	Entrenchment ratio is < 3.0.

Table 4.14c: Rating of Hydrologic Connectivity Metric for ***Confined*** Riverine Wetlands and riparian areas based on the results from the entrenchment ratio calculation worksheet above.

Rating	Alternative States
A	Entrenchment ratio is > 2.0.
B	Entrenchment ratio is 1.5 – 2.0.
C	Entrenchment ratio is < 1.5.

4.3 Attribute 3: Physical Structure

Physical structure is defined as the local physical, chemical, or biological features that provide or support habitat for biota (Maddock 1999). For example, the biological communities in streams are largely driven by the organization, structure, and dynamics of physical processes (e.g., Frissell *et al.* 1986). Metrics of the Physical Structure Attribute in CRAM therefore focus on physical conditions that indicate the capability of a wetland to support characteristic native flora and fauna. CRAM assumes that this capability is positively correlated to physical structural complexity.

4.3.1 Structural Patch Richness

A. 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.

B. Rationale: The richness of physical, structural surfaces and features in a wetland or riparian area 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. For each wetland class, there are visible patches of physical structure that typically occur at multiple points along the hydrologic/moisture gradient. But not all patch types will occur in all wetland types. Therefore, the rating is based on the percent of total expected patch types for a given wetland class.

C. Seasonality: This metric is not sensitive to seasonality.

D. Field Indicators: Prior to fieldwork, the imagery of the AA should be reviewed to survey the major physical features or patch types present. The office work must be field-checked using the Structural Patch Worksheet below, by noting the presence of each of the patch types expected for a given wetland type, and calculating the percentage of expected patch types actually found in the AA. Table 4.15 contains narratives for rating the Structural Patch Richness Metric for each wetland class.

Structural Patch Type Worksheet for All Wetland Classes, Except Vernal Pool Systems

Circle each type of patch that is observed in the AA and enter the total number of observed patches in Table 4.15 below. In the case of riverine wetlands and riparian areas, their status as confined or unconfined must first be determined (see section 3.2.2.2).

STRUCTURAL PATCH TYPE (check for presence)	**Riverine (Unconfined)**	**Riverine (Confined)**	**Estuarine (Saline & Non-saline)**	**Coastal Lagoon**	**Depressional**	**Slope Wetlands**	**Lacustrine**	**Individual Vernal Pools**	**Playas**
Minimum Patch Size	**3m²**	**3m²**	**3m²**	**3m²**	**3m²**	**1m²**	**3m²**	**1m²**	**3m²**
Secondary channels on floodplains or along shorelines	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**1**
Swales on floodplain or along shoreline	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**1**
Pannes or pools on floodplain	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**1**	**1**
Islands (exposed at high-water stage)	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**
Pools in channels	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
Riffles or rapids	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Unvegetated flats (sandflats, mudflats, gravel flats, etc.)	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Point bars and in-channel bars	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
Debris jams	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**
Abundant wrackline or organic debris in channel or on floodplain	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**
Hummocks and/or sediment mounds	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**
Bank slumps or undercut banks in channels or along shoreline	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**
Variegated foreshore overall (instead of broadly arcuate or essentially straight)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Animal mounds and burrows	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**1**
Standing snags	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Macroalgae	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**
Shellfish beds	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**0**
Concentric or parallel high water marks	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**
Soil cracks	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**1**
Cobble and/or Boulders	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**
Total Possible	**16**	**11**	**14**	**14**	**12**	**10**	**15**	**10**	**10**
No. Observed Patch Types (enter here and use in Table 4.15 below)									

Structural Patch Type Worksheet for Vernal Pool Systems

Identify each type of patch that is observed in the AA and enter the total number of observed patch types in Table 4.15 below (see Figure 4.3 for guidance)

STRUCTURAL PATCH TYPE (check for presence)	**Vernal Pool Systems**
Small individual pools	
Large individual pools	
Small swales	
Large swales	
Pool clusters (more than 1 pool cluster)	
Drainage branches (more than 1 drainage branch)	
Round or oval pools	
Convoluted-shaped pools	
Mounds	
Bare soil	
Total Possible	**10**
No. Observed Patch Types (enter here and use in Table 4.15 below)	

4.3.1.1 Patch Type Definitions

Secondary channels on floodplains or along shorelines

Channels represent the physical confine of riverine or estuarine flow. A channel consists of a bed and its opposing banks, plus its functional floodplain. Wetlands can have a primary channel that conveys most flow, and secondary channels that convey flood flows. Short tributary channels that originate in the wetland and that only convey flow between the wetland and the primary channel are also regarded as secondary channels. Secondary channels may be located in the main channel basin or on the floodplain and may be dry or wetted at the time of assessment.

Swales on floodplain or along shoreline

Swales are broad, elongated, sometimes-vegetated, tributaries that convey seasonal runoff and lack a well defined bed and bank, obvious deeps and shallows, or other characteristics of channels. Swales can act as zones of infiltration, as well as groundwater discharge.

Pannes or pools on floodplain

A panne is a broad, shallow depression composed of very fine sediments, and surrounded by a vegetated wetland plain. Pannes fill with water at least seasonally, and differ from vernal pools by lacking an abundance of emergent vegetation of any kind.

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 river, lake, lagoon, or estuary. Islands differ from hummocks and other mounds by being large enough to support multiple trees or large shrubs.

Pools in channels

Pools are areas along tidal and fluvial channels that fill with water at least seasonally, and that tend to retain water when the rest of the channel or plain is drained. Pools in channels are generally too deep to support emergent vegetation.

Riffles or rapids

Riffles and rapids are standing waves caused by channel bed forms such as plunge pools, or submerged bed materials such as gravel, cobbles, boulders, etc. Riffles and rapids add oxygen to the water, and provide habitat for many fish and invertebrates.

Unvegetated flats (sandflats, mudflats, gravel flats, etc.)

A flat is an area lacking vascular vegetation that consists of silt, clay, sand, shell hash, gravel, or cobble. Flats are similar to bars (see **Point bars and in-channel bars** definition below), except that flats are not convex in profile and their material is everywhere similar in size and texture.

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 the lower margins. They can consist of any mixture of silt, sand, gravel, cobble, and boulders.

Debris jams

A debris jam is an accumulation of drift wood and other flotage across a channel that partially obstructs water flow.

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.

Hummocks or sediment mounds

Hummocks are mounds created by plants in slope wetlands, depressions, and along the banks and floodplains of fluvial and tidal systems. Hummocks are typically less than 1m high. Sediment mounds are similar to hummocks without the vegetated cover.

Bank slumps or undercut banks in channels or along shoreline

Bank slumps form when a chunk of bank material breaks off and slides into the channel in a fluvial or tidal system, where it becomes cemented in place. Both bank slumps and boulders are durable objects that are intransient except under extremely high-powered flow events. Boulders (rocks with a diameter of more than 10" (256mm)) and hardened bank slumps within the channel or along the shoreline can influence channel formation and create microhabitats. Undercut banks are concave features created when strong currents scour earthen banks. Bank erosion below the water line creates "shelves" that provide habitat for fish and other aquatic organisms.

Variegated foreshore overall

For lacustrine, riverine, lagoon, and playa wetlands, the shoreline is the boundary between the wetland and the aquatic system or open water environment, including the banks of tidal creeks. For all other wetlands, the shoreline is the boundary between the wetland and the upland. As viewed from above, the shoreline can be straight, curved, or variegated. A variegated shoreline can be sketched as a sequence of s-shaped curves of varying amplitude and asymmetry, such that the line seems to meander or wander.

Animal mounds and burrows

Many vertebrates make mounds or holes as a consequence of their foraging, denning, predation, predator avoidance, or other common behaviors. The disturbance to the upper part of the soil horizon 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 occupies or recently occupied the Assessment Area. Such evidence includes recently tilled soil mounds, scat, or footprints associated with the burrow. A single burrow or mound does not constitute a patch.

Standing snags

Tall, woody vegetation, such as trees and tall shrubs, can take many years to fall to the ground after dying. As these standing "snags" decompose, they provide habitat for birds and many other organisms. Any standing, dead woody vegetation that is at least 12 feet tall is considered a snag.

Macroalgae

Benthic macroalgae attach to the bottom sediments or other substrates in fresh, brackish, and saline water bodies. Macroalgae also occur in surface layers of soils and porous rocks, on the bark and leaves of trees, and in symbiotic association with fungi to form lichens. These organisms are important primary producers, representing the base of the food chain in some wetlands. They also contribute to the fertility of the soil in providing habitat for benthic and soil organisms.

Shellfish beds

Oysters, clams and mussels are common bivalves that create beds on the banks and bottoms of wetland systems. Shellfish beds influence the condition of their environment by affecting flow velocities, providing three-dimensional structure and habitat for plant and animal life, and playing particularly important roles in the uptake and cycling of nutrients and other water-borne materials.

Concentric or parallel high water marks

Repeated, seasonal and interannual 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 and soils, greatly increasing overall ecological diversity.

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 and promote subsidence while providing refuge for amphibians and breeding sites for mosquitoes and other macroinvertebrates.

Cobble and boulders

Cobble and boulders are rocks of different size categories. The long axis of cobble ranges from about 2.5" to 10.0". A boulder is any rock having a long axis greater than 10". Submerged cobbles and boulders provide abundant habitat for aquatic macroinvertebrates and small fish. Emergent or exposed cobbles and boulders provide roosting habitat for birds, shelter for amphibians, and they contribute to patterns of shade and light and air movement near the ground surface that affect soil moisture gradients, aeolian deposition of seeds and organic debris, and overall substrate complexity.

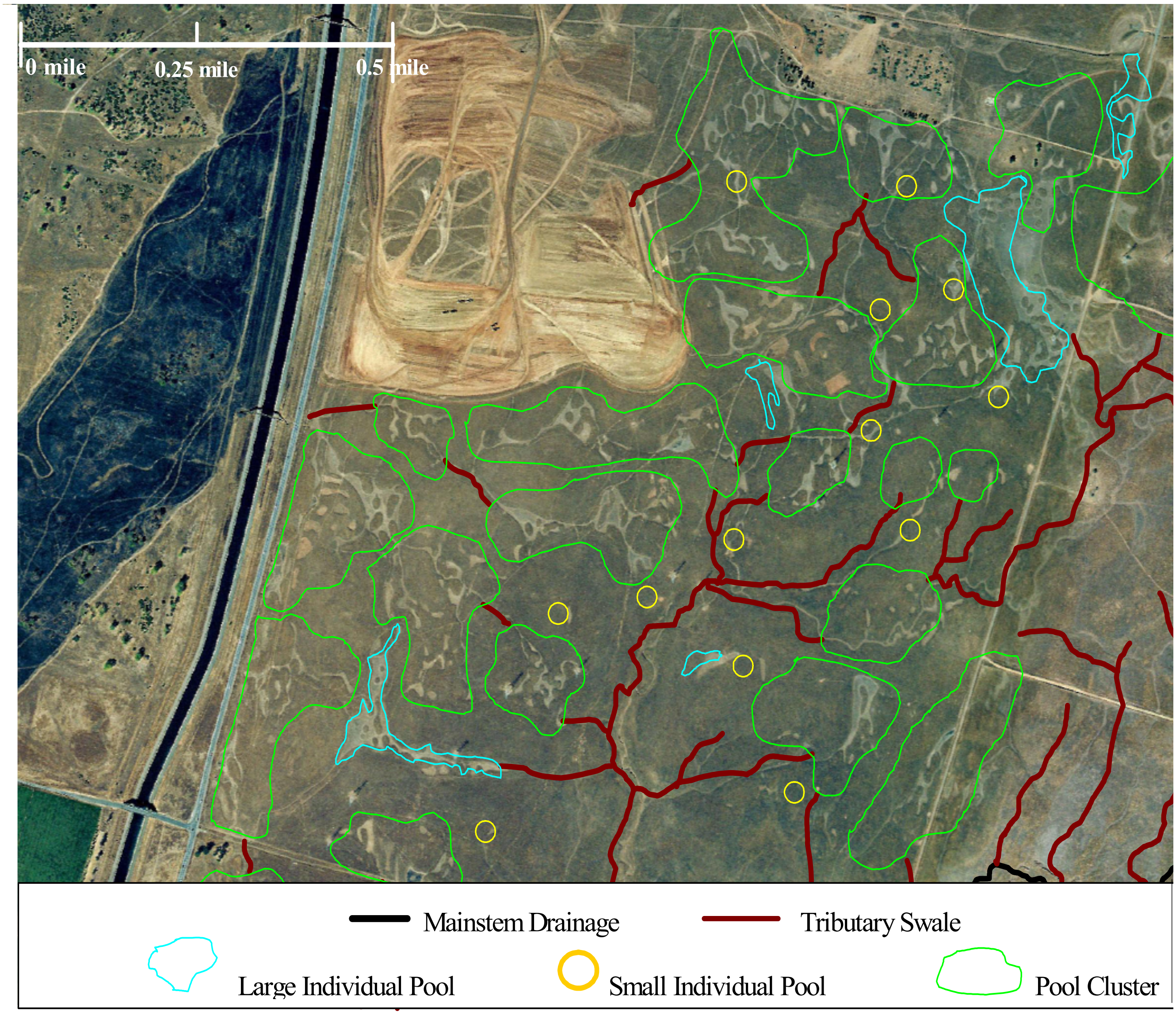

Figure 4.3: Examples of vernal pool system patch types that appear at the landscape scale (refer to Structural Patch Type Worksheet for Vernal Pool Systems).

Table 4.15: Rating of Structural Patch Richness (based on results from worksheets).

Rating	Confined Riverine, Playas, Slope Wetlands, Individual Vernal Pools, Vernal Pool Systems	Depressional	Estuarine, Coastal Lagoon	Unconfined Riverine, Lacustrine
A	≥ 8	≥ 10	≥ 11	≥ 12
B	6 – 7	7 – 9	8 – 10	9 – 11
C	4 – 5	4 – 6	5 – 7	6 – 8
D	≤ 3	≤ 3	≤4	≤ 5

4.3.2 Topographic Complexity

A. Definition: Topographic complexity refers to the variety and interspersion of elevation zones or depth zones within a wetland.

B. Rationale: Topographic complexity promotes variable hydroperiods and concomitant 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 flow across complex surfaces may promote volatilization of compounds, or re-suspension and export of water-borne material.

C. Seasonality: This metric is not sensitive to seasonality.

D. Field Indicators: Topographic complexity is assessed by walking the AA and noting the overall variability in physical patches and topographic features (Table 4.16 and Figure 4.4). Care must be taken to distinguish indicators of topographic complexity or habitat features within a wetland from different kinds of wetlands. For each wetlands class, topographic complexity can be evaluated by observing the number of elevational features that affect moisture gradients or that influence the path of water flow along a transect across the AA. Topographic gradients may be indicated by plant assemblages with different inundation/saturation or salinity tolerances. Table 4.17 provides narratives for rating Topographic Complexity for all wetland classes.

Table 4.16: Typical Indicators of Topographic Complexity For Each Wetland Class.

Class	Examples of Topographic Features
Riverine	pools, runs, glides, pits, ponds, hummocks, bars, debris jams
Depressional and Playas	pools, islands, bars, mounds or hummocks, variegated shorelines
Estuarine	islands, bars, pannes, natural levees, shellfish beds, hummocks, slump blocks
Lacustrine	islands, bars, boulders, cliffs, benches, variegated shorelines
Slope Wetlands	pools, hummocks, burrows, changes in slope of the wetland surface
Lagoons	channels large and small, natural levees, pannes, potholes, dunes
Vernal Pools and Pool Systems	soil cracks, mounds, rivulets between pools or along swales, cobble

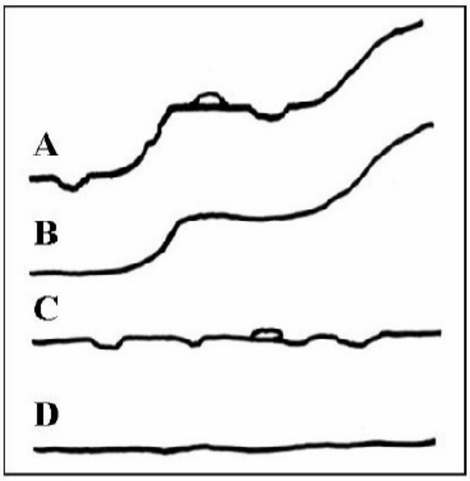

Figure 4.4: Scale-independent schematic profiles of wetlands in cross-section showing decreasing degrees of Topographic Complexity from A through D.

Table 4.17: Rating of Topographic Complexity Metric for all wetland classes (based on diagrams in Figure 4.4 above).

Rating	Alternative States
A	AA as viewed along cross-sections has a variety of slopes, or elevations, that are characterized by different moisture gradients. Each sub-slope contains physical patch types or features that contribute to irregularity in height, edges, or surface of the AA and to complex topography overall.
B	AA has a variety of slopes, or elevations, that are characterized by different moisture gradients; however, each sub-slope lacks many physical patch types, such that the slopes or elevation zones tend to be regular and uniform.
C	AA has a single, uniform slope or elevation. However that slope, or elevation, has a variety of physical patch types.
D	AA has a single, uniform slope, or elevation, with few physical patch types.

4.4 Attribute 4: Biotic Structure

The biotic structure of a wetland includes all of its organic matter that contributes to its material construct or architecture. Living vegetation and coarse detritus are examples of biotic structure. In many wetlands, including bogs and tidal marshes, much of the sediment pile is organic. Evaluation of the fine and coarse organic material is included as biotic structure. The physical condition of the sediment is captured in other metrics, such as hydroperiod, physical patch richness, and topographic complexity. Plants strongly influence the quantity, quality, and spatial distribution of water and sediment within wetlands. For example, vascular plants entrap suspended sediment and contribute organic matter to the sedimentary pile. Plants reduce wave energies and decrease the velocity of water flowing through wetlands. Plant detritus is a main source of essential nutrients. Vascular plants and large patches of macroalgae function as habitat for wetland wildlife.

4.4.1 Organic Matter Accumulation

A. Definition: Wetlands are depositional and retentive environments within which organic matter of various kinds tends to accumulate. Fine and coarse organic material, including whole and broken trees, shrubs, branches, leaves, stems, and finer plant litter is transported by water into wetlands, or is blown in, or is produced within the wetland.

B. Rationale: The accumulation of organic material and an intact litter layers are integral to a variety of wetland functions, such as surface water storage, percolation and recharge, nutrient cycling, and support of wetland plants. Intact litter layers provide areas for primary production and decomposition that are important to maintaining functioning food chains. They nurture fungi essential to the growth of rooted wetland plants. They support soil microbes and other detritivores that comprise the base of the food web in many wetlands. The abundance of organic debris and coarse litter on the substrate surface can significantly influence overall species diversity and food web structure. Fallen debris serves as cover for macroinvertebrates, amphibians, rodents, and even small birds. Litter is the precursor to detritus, which is a dominant source of energy for most wetland ecosystems. However, organic matter accumulation can be a problem in vernal pools and playas because it encourages biological invasions and can lead to deleterious algal blooms.

C. Seasonality: This metric is not sensitive to seasonality

D. Field Indicators: The accumulation of organic matter is evaluated by observing evidence of leaf detritus, duff, thatch, plant litter, algal mats, and large organic debris, including fallen limbs and trees. Special attention should be paid to pits, pannes, ponds, pools, or backwaters, as well as topographic lows on floodplains and along shorelines. For estuaries and lagoons, this metric should be assessed in areas that would typically support sedimentation of fine-grained, organic-rich substrates, such as back bays, off-channel basins, or on the surface of the vegetated marsh plain. Areas that are hydro-dynamically active, including tidal channels or areas near the inlets to water, should not be used to evaluate this metric. Tables 4.18a, 4.18b, and 4.18c provide narratives for rating the Organic Matter Accumulation Metric for all wetland classes.

Table 4.18a: Rating of Organic Matter Accumulation for all wetland classes (including *Unconfined* Riverine Wetlands), except Vernal Pools, Vernal Pool Systems, and *Confined* Riverine Wetlands.

Rating	Alternative States
A	The AA is characterized by an abundance of fine organic matter in topographic lows, along high-water shorelines, and across vegetated plains. There is a range of kinds of organic matter representing all the visible stages of processing, from whole plant parts to fine detritus.
B	The AA is characterized by a moderate amount of fine organic matter in a patchy distribution. There is some matter of various sizes, but new materials seem much more prevalent than old materials. Litter layers, duff layers, and leaf piles in pools or topographic lows are thin.
C	The AA is characterized by occasional small amounts of coarse organic debris, such as leaf litter or thatch, with only traces of fine debris, and with little evidence of organic matter recruitment.
D	The AA contains essentially no significant amounts of coarse plant debris, and only scant amounts of fine debris.

Table 4.18b: Rating of Organic Matter Accumulation for ***Confined*** Riverine Wetlands and riparian areas.

Rating	Alternative States
A	The AA is characterized by a moderate amount of fine organic matter in a patchy distribution. There is some matter of various sizes, but new materials seem much more prevalent than old materials. Litter layers, duff layers, and leaf piles in pools or topographic lows are thin.
B	The AA is characterized by occasional small amounts of coarse organic debris, such as leaf litter or thatch, with only traces of fine debris, and with little evidence of organic matter recruitment.
C	The AA contains essentially no significant amounts of coarse plant debris, and only scant amounts of fine debris.

Table 4.18c: Rating of Organic Matter Accumulation for Vernal Pools and Pool Systems
[Note: Only the vernal pools and swales should be assessed and not the upland matrix.]

Rating	Alternative States
A	The pools in the AA contain essentially no significant amounts of coarse plant debris, and only scant amounts of fine debris.
B	The pools or pool system in the AA are characterized by occasional small amounts of coarse organic debris, such as leaf litter or thatch, with only traces of fine debris, and with little evidence of organic matter recruitment.
C	The pools or pool system in the AA are characterized by a moderate amount of fine organic matter in a patchy distribution. There is some matter of various sizes, but new materials seem much more prevalent than old materials. Litter layers, duff layers, and leaf piles in pools or topographic lows are thin.
D	The pools or pool system in the AA are characterized by an abundance of fine organic matter in topographic lows, along high-water shorelines, and across vegetated plains. There is a range of kinds of organic matter representing all the visible stages of processing, from whole plant parts to fine detritus.

4.4.2 CRAM Plant Community Metric

A. Definition: A "plant" is defined as an individual of any species of tree, shrub, herb/forb, moss, fern, emergent or floating macrophyte, or submerged aquatic plant, including non-native (exotic) plant species. For the purposes of CRAM, Plant "layers" are vertical strata of vegetation indicated by discreet canopies at different heights. Exotic, or "non-native", plants species owed their occurrence in California to the actions of people since shortly before Euroamerican contact. Non-native invasive plants are exotic species that have begun to dominate one or more plant layers within an Assessment Area (AA).

B. Rationale: The functions of whole-wetland systems are optimized when a rich native flora dominates the plant community, and when the botanical structure of the wetland is complex in 3-dimensional space, due to species diversity and recruitment, and resulting in suitable habitat for multiple animal species. Much of the natural microbial, invertebrate, and vertebrate communities of wetlands are adjusted to the architectural forms, phenologies, detrital materials, and chemistry of the native vegetation. Furthermore, the physical form of wetlands is partly the result of interactions between plants and physical processes, especially hydrology. A sudden change in plant-community dominance, such as that which results from plant invasions, can have cascading effects on whole-system form, structure, and function.

C. Seasonality: This suite of metrics is ideally assessed during the latter third of the growing season, when all plant layers have developed to their full extent.

D. Field Indicators: The Plant Community Metric is assessed in terms of the similarity between the dominant species composition of the plant community and what is expected based on CRAM verification and calibration studies, regional botanical surveys, and historical resources. This metric requires the ability to recognize the major-dominant aquatic, wetland, and riparian plants species of each layer or stratum. The required level of botanical expertise to assess a wetland based on this metric is about the same as what is required to conduct a legal jurisdictional delineation of a wetland. When a CRAM field team lacks the necessary botanical expertise, voucher specimens will need to be collected using standard plant presses and site documentation. This can greatly increase the time required to complete a CRAM assessment.

Five vegetation layers are recognized by CRAM for Non-saline Estuarine, Riverine, Lacustrine, Slope, and Depressional wetlands, and four vegetation layers for Saline Estuarine and Lagoon wetlands. These same plant layers are used to assess the Vertical Biotic Structure Metric. For Riverine, Lacustrine, Slope, and Depressional wetlands, two of the layers, *Emergent* and *Submergent* vegetation, are found in aquatic or semi-aquatic portions of AAs, where there is standing water or highly saturated soil. The other three layers, *Short*, *Medium*, and *Tall* vegetation, are found within the non-aquatic, riparian or terrestrial part of the AAs, and are distinguished from one another in terms of the maximum heights of the plants that comprise each layer (< 1m, 1m – 3m, or > 3m). For Estuarine and Lagoon wetlands, the two layers, *Emergent* and *Submergent* vegetation, are found in aquatic or semi-aquatic portions of AAs, where there is standing water or highly saturated soil. The *Emergent* layers are distinguished from one another in terms of the maximum heights of the plants that comprise each layer (< 0.3m, 0.3m – 1m, or > 1m).

Submergent vegetation consists of rooted plant species that are adapted to spending their lifespan, from germination to fruiting, under water, although flowers and foliage may extend to the water surface. Examples of such species include *Ruppia cirrhosa* (ditchgrass), *Zannichellia palustris* (horned pondweed), *Ranunculus aquatilis* (water buttercup), and *Potamogeton foliosus* (leafy pondweed). *Emergent* vegetation consists of rooted plant species typically growing on saturated soils or on soils covered with water for most of the growing season, but unlike *Submergent* vegetation, the leaves and flowers of emergent aquatic species are mostly borne above the water surface. Examples of such species include *Rorippa nasturtium-aquaticum* (watercress), *Scirpus californicus* (tule, bulrush), *Veronica anagallis-aquatica* (water speedwell), *Polygonum amphibium* (water knotweed), *Typha angustifolia* (narrow-leaved cattail), and *Mimulus guttatus* (common monkeyflower).

The Plant Community Metric is composed of four submetrics that are assessed by walking throughout the entire AA and determining which of the vegetation layers defined by CRAM are present, what plant species dominate them, and what proportion of the co-dominant plants within and among the layers are non-native. This information is recorded in a set of Plant Community Worksheets. The four Plant Community submetrics are calculated based on this information.

The first submetric is the *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 for *Submergent* and *Emergent* layers. The other terrestrial/riparian layers are expected to occur throughout the rest of the AA, except where there are exposed areas of bedrock, mudflat, beaches, active point bars, etc. It is essential that the layers be identified by the actual canopy heights (i.e., the maximum heights) of the vegetation in the AA, regardless of its growth *potential*. For example, a young sapling redwood would belong to the short terrestrial layer, even though it may represent the future tall layer. Some species might dominant multiple plant layers. For example, redwoods might dominant all three terrestrial layers, depending on their different heights. Riparian vines, like wild grape, sometimes dominate all three terrestrial layers.

The next submetric is *Percent of Layers Dominated by Non-native Species*. For each plant layer in the AA, the observer is asked to estimate if non-native plant species comprise more than 50% of the total cover within the layer. The submetric is calculated as the percentage of the total number of layers that are dominated by non-native plants.

The third submetric, *Number of Co-dominant Species*, deals directly with dominant plant species richness. For each plant layer in the AA, all species representing at least 10% relative cover (within that layer) are considered to be dominant. The investigator lists the names of all dominant plant species in each layer. Once all the dominant species have been listed, the observer sums them, across layers, to assess the total number of co-dominants within the AA.

Some plant species (e.g. *S. laevigata*) can dominate multiple vertical strata depending on age class and growth form. Although it may seem that noting such dominance of one species among multiple strata can amount to "double counting" it in terms of overall species richness, each of these age classes or growth forms can provide different ecological services such as food, refuge, nesting resources, etc. Therefore, the presence of multiple growth forms or age classes of a species, as indicated by its dominance among multiple vertical strata, adds to the overall complexity of the site, which is the parameter assessed by this submetric. As such, the species is counted in each stratum in which it occurs when summing the dominant species across strata.

For the final submetric, *Percent of Co-dominant Species that are Non-native,* the observer counts the number of native co-dominant species for all plant layers as a percentage of the total number of co-dominants. Information about the native and non-native status for a multitude of California wetland plant species is provided in Appendix 2.

For the submetrics *Percent of Layers Dominated by Non-native Species*, *Number of Codominant Species* and *Percent of Codominants that are Non-native*, data collectors should identify the dominant taxa in the AA to the level of species. In the event that this is not possible, it may be acceptable to identify certain taxa only to genus. This is appropriate only if *all species* of the genus of the plant in question that are documented as occurring in California are either native or non-native (as opposed to a mix of both). If such is the case, the unknown species can be attributed as native or non-native based on the status characterizing that genus, using as the final authority the Jepson Manual (Hickman, 1993). An example of a genus for which the Jepson Manual lists only native species is *Baccharis*. An example of a genus for which the Jepson Manual lists only non-native species is *Cortaderia*. If the species of interest is not listed in the Jepson manual, in the form of any of its botanical synonyms (if alternate names exist), it should be assumed that the species is not native to California.

Conversely, for all California plant genera containing a mix of native and non-native species, in order to arrive at plant submetric scores, it will be necessary to collect as much information about the unknown plant as possible, such that it can later be identified to species. The data collector should, at a minimum, do the following in the field:

- Take photographs of one or several specimens of the species, making sure to capture the nature of the growth habit (vine, shrub, tree, etc.), size (using the aid of a visual scale, such as a pen or a person, in the photo), and close-ups of bark (if applicable), leaves, and any flowers or fruit, if available at the time of assessment.
- Take detailed notes on other aspects of the plant, such as whether it emits any odors, whether there is any substance (such as a milky latex) released when the stems or leaves are broken, the presence, location, and size of any spines, whether or not leaves and/or stems are hairy or smooth, and whether the plant is herbaceous (green and flexible stems) or "woody".
- If collection is permissible, collect a specimen. The specimen should include as much of the plant as possible (*e.g.*, roots as well as stems, leaves, and flowers and/or fruits). Ideally, the specimen should be immediately pressed (flattened) using a plant press lined with absorptive paper, and allowed to dry this way over an extended period. If necessary, the specimen can be temporarily stored in a plastic bag with water (and refrigerated, if possible) until it is possible to properly press and dry it.
- Take the above information (and specimen, if applicable) to a botanist with expertise in the region in which the plant was encountered. You may also wish to consult an herbarium associated with a local university or natural history museum for assistance in identifying the species.

Once values for the four submetrics have been determined, they are averaged in order to arrive at a value for the Plant Community metric of CRAM.

Plant Community Metric Worksheet 1 of 6: Plant layers and their dominance by non-native species for all Non-saline Estuarine, Riverine, Slope, Lacustrine, and Depressional Wetlands

Non-saline Estuarine, Riverine, Slope, Lacustrine, and Depressional	Plant Layer				
	Aquatic/Semi-aquatic		Terrestrial/Riparian		
	Submergent	Emergent (all)	Short (< 1 m)	Medium (1-3 m)	Tall (> 3 m)
Mark if layer present (covers at least 5% of suitable habitat area)					
Mark if dominated by non-native species (at least 50% of the layer is represented by non-natives)					
Total number of layers present (enter here and use in Table 4.19)					
Percent of layers dominated by non-native species (enter here and use in Table 4.19)					

Plant Community Metric Worksheet 2 of 6: Plant layers and their dominance by non-native species for Saline Estuarine and Lagoon Wetlands

NOTE: All intertidal plants are either submergent or emergent. Emergent plants include those occupying tidal floodplains and areas above the plains but below the maximum height of the tide.

Saline Estuarine and Lagoon	Plant Layer			
	Submergent	Emergent		
		< 0.3 m	0.3 – 1 m	> 1 m
Mark if layer present (covers at least 5% of suitable habitat area)				
Mark if dominated by non-native species (at least 50% of the layer is represented by non-natives)				
Total number of layers present (enter here and use in Table 4.19)				
Percent of layers dominated by non-native species (enter here and use in Table 4.19)				

Plant Community Metric Worksheet 3 of 6: Co-dominant species richness for all wetlands, except Saline Estuarine, Lagoon Wetlands, Vernal Pools, and Playas.

(A dominant species represents ≥10% *relative* cover. Mark all non-native species based on Appendix 2)

Submergent Aquatic/Semi-aquatic	Non-native?	Tall Terrestrial/Riparian	Non-native?
Emergent Aquatic/Semi-aquatic	**Non-native?**	**Medium Terrestrial/Riparian**	**Non-native?**
Short Terrestrial/Riparian	**Non-native?**		
Total number of co-dominant species for all layers combined (enter here and use in Table 4.19)			
Percent of co-dominant species that are non-native (enter here and use in Table 4.19)			

Plant Community Metric Worksheet 4 of 6: Co-dominant species richness for Saline Estuarine and Lagoon Wetlands.

(A dominant species represents ≥10% *relative* cover – Mark all non-native species based on Appendix 2)

Submergent	Non-native?	Emergent (0.3 – 1 m)	Non-native?
Emergent (< 0.3 m)	**Non-native?**	**Emergent (< 1 m)**	**Non-native?**
Total number of co-dominant species for all layers combined (enter here and use in Table 4.19)			
Percent of co-dominant species that are non-native (enter here and use in Table 4.19)			

Plant Community Metric Worksheet 5 of 6: Co-dominant plant species in Vernal Pool Systems

List species that represent at least 10% of the absolute cover.					
Circle species that represent at least 50% of absolute cover:					
Small Pools Stratum	**Non-native?**	**Large Pools Stratum**	**Non-native?**	**Pool Clusters Stratum**	**Non-native?**
Total number of co-dominant species across all pool strata (enter here and use in Table 4.19)					
Percent of total co-dominant species that are non-native (enter here and use in Table 4.19)					

Plant Community Metric Worksheet 6 of 6: Co-dominant plant species in Individual Vernal Pools and Playas

List species that represent at least 10% of the absolute cover.					
Circle species that represent at least 50% of absolute cover:					
	Non-native?		**Non-native?**		**Non-native?**
Total number of co-dominant species across all pool strata (enter here and use in Table 4.19)					
Percent of total co-dominant species that are non-native (enter here and use in Table 4.19)					

Table 4.19: Ratings for the Plant Community Metric's Four Submetrics.

Rating	Number of Plant Layers Present	Percent of Layers Dominated by Non-native Species	Number of Co-dominant Species	Percent of Co-dominant Species that are Non-native
Slope or Depressional Wetlands				
A	> 3	0 – 24%	≥ 7	0 – 14%
B	2 – 3	25 – 49%	5 – 6	15 – 30%
C	1	50 – 74%	3 – 4	31 – 60%
D	0	75 – 100%	0 – 2	61 – 100%
Lacustrine or *Confined* Riverine Wetlands				
A	4 – 5	0 – 24%	≥ 12	0 – 20%
B	3	25 – 49%	8 – 11	21 – 35%
C	2	50 – 74%	5 – 7	36 – 60%
D	0 – 1	75 – 100%	0 – 4	61 – 100%
Saline Estuarine				
A	≥ 3	0 – 24%	≥ 5	0 – 20%
B	2	25 – 49%	4	21 – 40%
C	1	50 – 74%	2 – 3	41 – 60%
D	0	75 – 100%	0 – 1	61 – 100%
Non-saline Estuarine Wetlands or Lagoon Wetlands				
A	≥ 4	0 – 24%	≥ 10	0 – 20%
B	3	25 – 49%	7 – 9	21 – 40%
C	2	50 – 74%	4 – 6	41 – 60%
D	0-1	75 – 100%	0 – 3	61 – 100%
***Unconfined* Riverine Wetlands**				
A	4 – 5	0 – 24%	≥ 12	0 – 20%
B	3	25 – 49%	7 – 11	21 – 35%
C	2	50 – 74%	4 – 6	36 – 60%
D	0 – 1	75 – 100%	0 – 3	61 – 100%
Playas, Individual Vernal Pools, or Vernal Pool Systems				
A	Not Applicable	Not Applicable	≥ 9	0 – 15%
B			5 – 8	16 – 35%
C			3 – 4	36 – 55%
D			0 – 2	56 – 100%

4.4.3 Interspersion and Zonation

A. Definition: Horizontal biotic structure refers to the variety and spatial interspersion of plant "zones". Interspersion is essentially a measure of the amount of edge between plant zones.

B. Rationale: The existence of multiple horizontal plant zones indicates a well-developed plant community and predictable sedimentary and bio-chemical processes. The amount of interspersion among these plant zones is indicative of the spatial heterogeneity of these processes. Richer native communities of plants and animals tend to be associated with greater zonation and more interspersion of the plant zones.

C. Seasonality: This metric is not sensitive to seasonality.

D. Field Indicators: The distribution and abundance of horizontal plant zones, plus their interspersion, are combined into a single indicator. The zones are usually apparent as different plant patches that signify different elevations or distances away from the usual high-water contour of a wetland, such as the shoreline of a lake, bank of a channel, or the transition from the wetland to the adjacent upland (i.e., hydrologic gradient). For large wetlands, the prominent zonation is evident in aerial photographs of scale 1:24,000 or smaller. For vernal pools and other depressional wetlands that are essentially round in plan form, the plant zones might be more or less concentric. For small wetlands, the zonation is apparent only in the field. The zones may be discontinuous and they can vary in number within a wetland. Plant zones often consist of more than one plant species, but some zones may be mono-specific. In most cases, one plant species dominates each zone.

In order to score this metric, the practitioner must evaluate the wetland from a "plan view," i.e., as if the observer was hovering above the wetland in the air and looking down upon it. Figure 4.5a through 4.5f can aid evaluating the degree of horizontal interspersion (adapted from Mack, 2001), which is rated using Table 4.20.

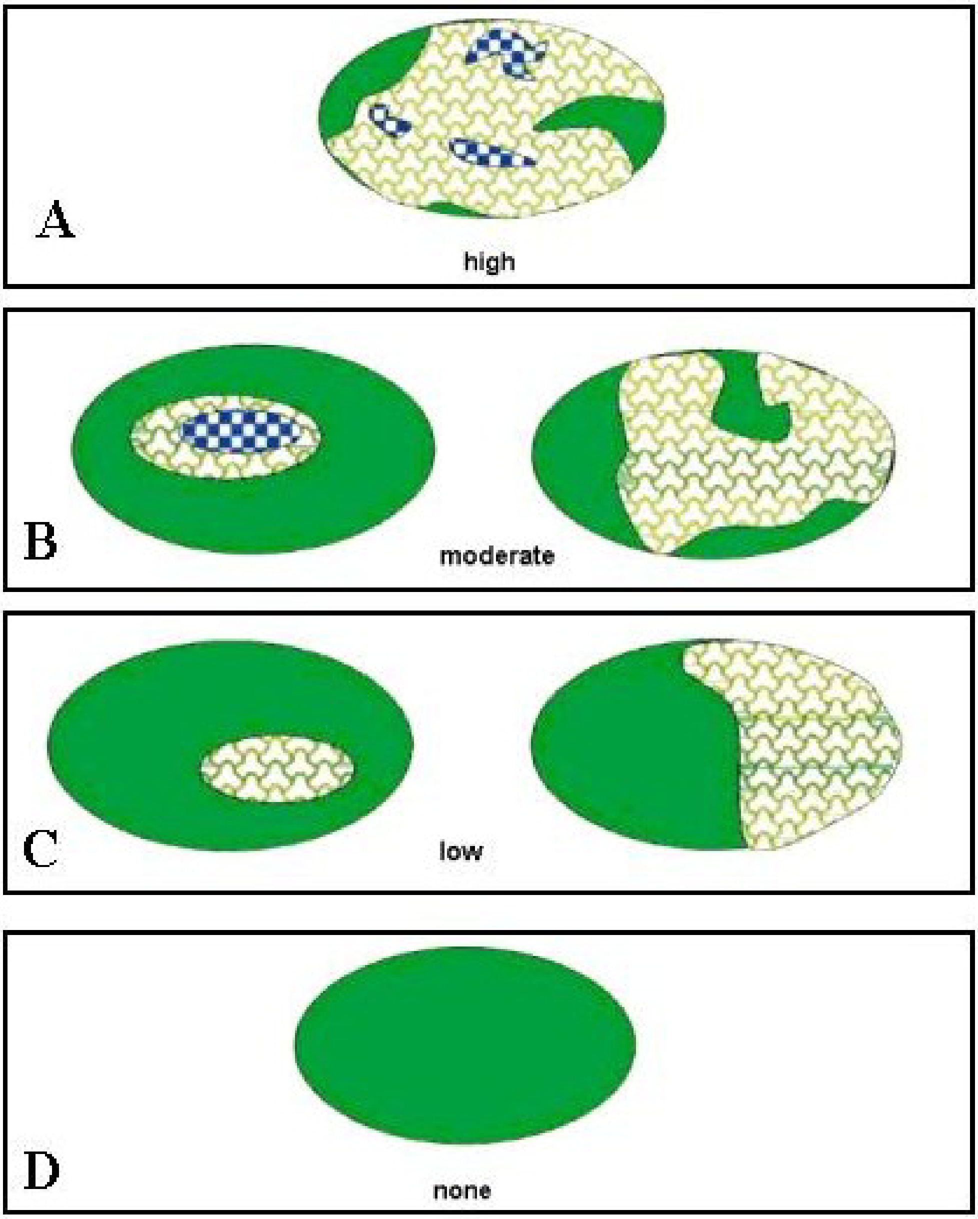

Figure 4.5a: Degrees of interspersion of plant zones for use in Table 4.20, except for Riverine, Estuarine, and Vernal Pool Wetland Classes (adapted from Mack, 2001). Each hatching pattern represents a distinct plant zone.

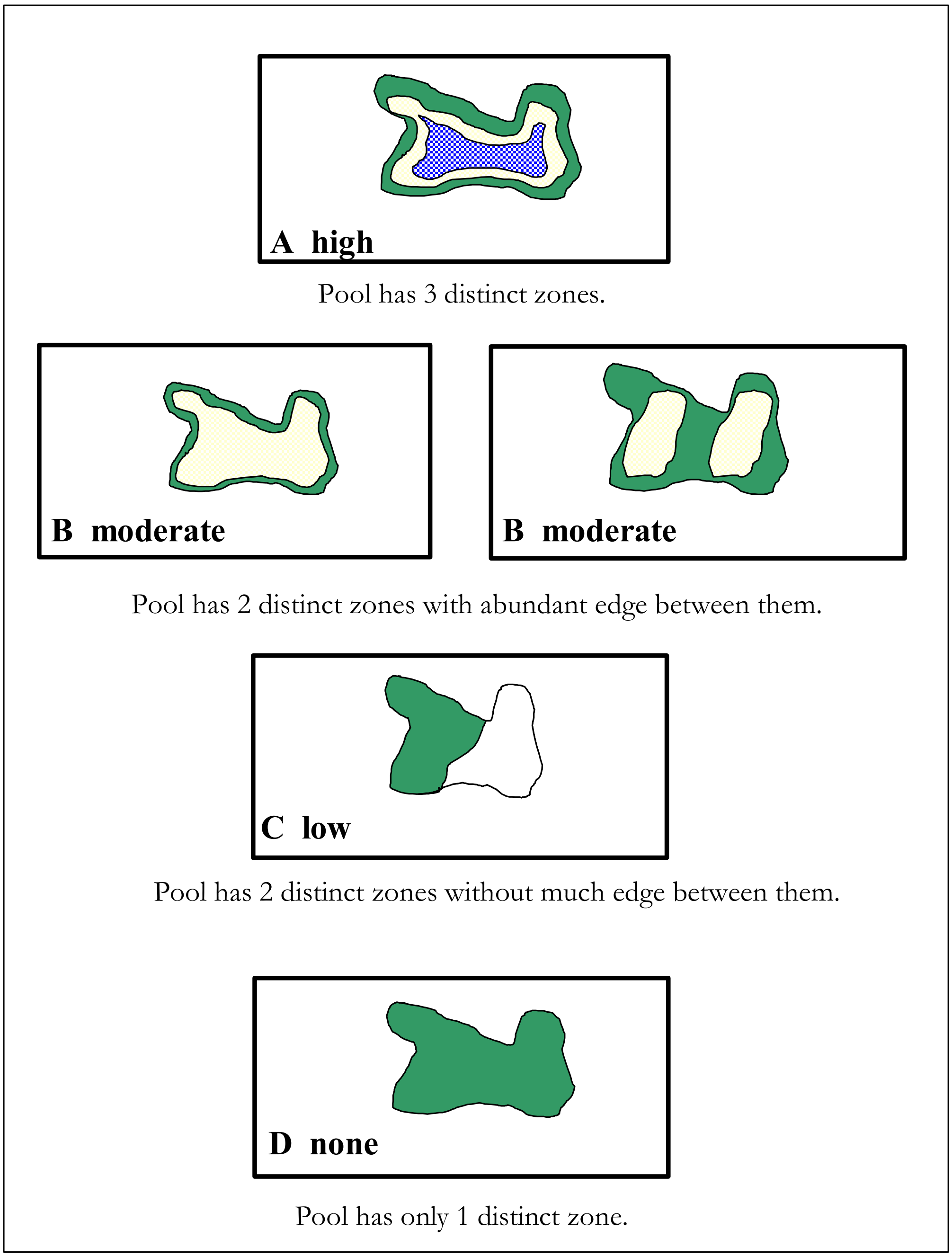

Figure 4.5b: Degrees of interspersion of plant zones for Individual Vernal Pools for use in Table 4.20 (adapted from Mack, 2001).

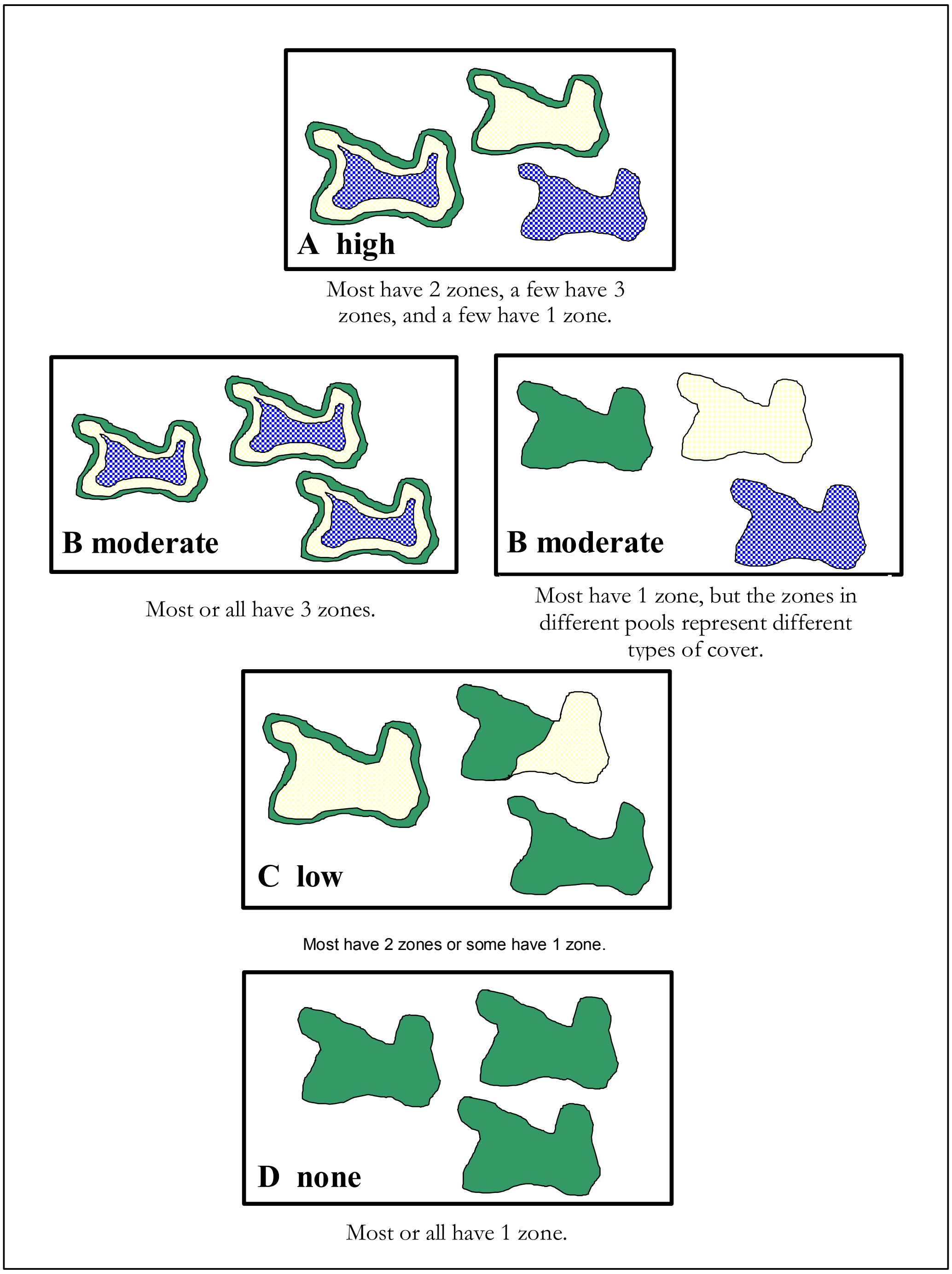

Figure 4.5c: Degrees of interspersion of plant zones for Vernal Pool Systems for use in Table 4.20.

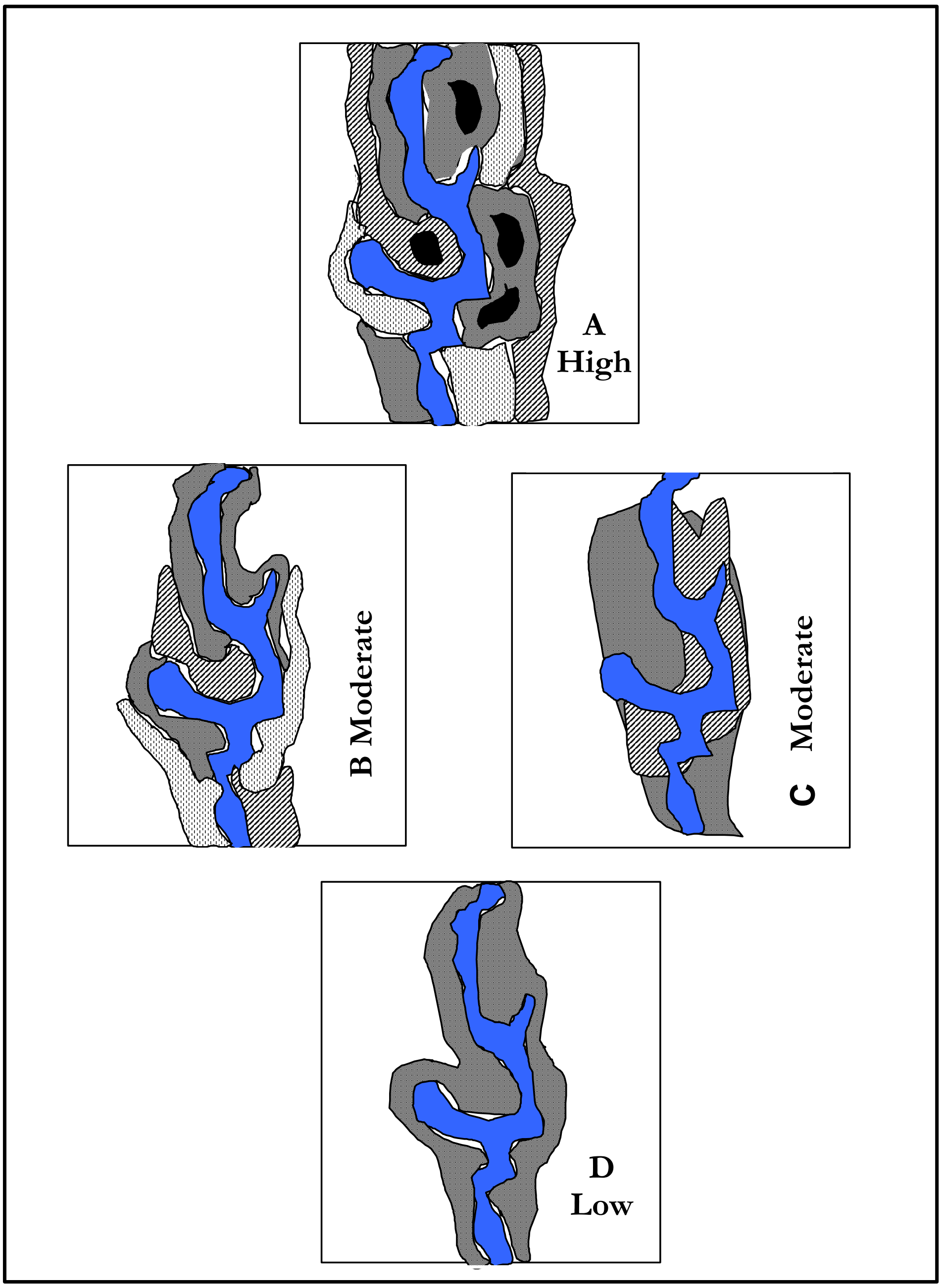

Figure 4.5d: Degrees of interspersion of plant zones showing decreasing complexity from A through D, for use in Table 4.20 for all Riverine Wetlands. Each hatching pattern represents a distinct plant zone.

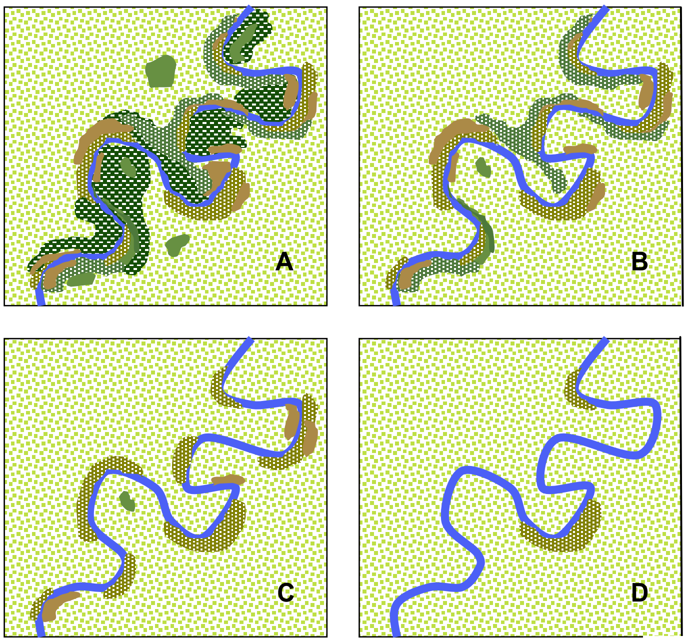

Figure 4.5e: Degrees of interspersion of plant zones showing decreasing complexity from A through D, for use in Table 4.20 for Saline Estuarine Wetlands. Each pattern represents a distinct plant zone or type.

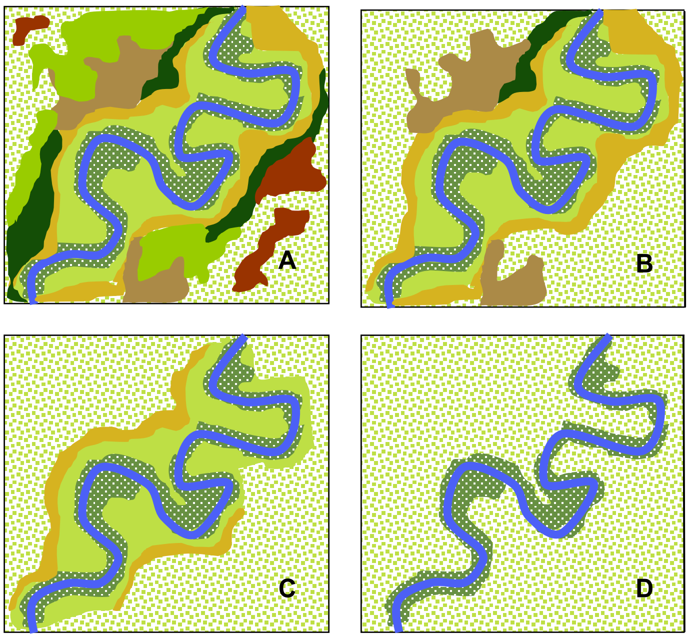

Figure 4.5f: Degrees of interspersion of plant zones showing decreasing complexity from A through D, for use in Table 4.20 for Non-saline Estuarine Wetlands. Each pattern represents a distinct plant zone or type.

Table 4.20: Rating of Interspersion of Plant Zones (based on Figures 4.5a through 4.5f).

Rating	Alternative States
A	Wetland has a high degree of plan-view interspersion.
B	Wetland has a moderate degree of plan-view interspersion.
C	Wetland has a low degree of plan-view interspersion.
D	Wetland has essentially no plan-view interspersion.

4.4.4 Vertical Biotic Structure

A. Definition: The vertical component of biotic structure consists of the distribution of vegetation among plant layers or strata. The same five plant layers used to assess the Plant Community Composition Metrics (see Section 4.4.2) are used to assess Vertical Biotic Structure. Two of the layers, *Emergent* and *Submergent* vegetation, are found in aquatic or semi-aquatic portions of AAs. The other three layers, *Short*, *Medium*, and *Tall* vegetation, are found within the non-aquatic, riparian or terrestrial part of the AAs, and are distinguished from one another in terms of the maximum heights of the plants that comprise each layer. 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 metric does not pertain to Vernal Pools, Vernal Pool Systems, or Playas.**

B. Rationale: The overall ecological diversity of a wetland tends to correlate with its overall variability in plant height. For some wetland classes, especially forested riverine wetlands, the existence of well-developed vegetation strata, one above the other, indicates well-developed wildlife habitat. Dense plant cover, with one or more well-developed canopies, is especially important to protect birds and small mammals from predation. Many species of bird that nest in wetlands commonly require a cover of vegetation at their nest sites. Multiple layers of vegetation also enhance hydrological functions, including rainfall interception, filtration of floodwaters, and flood stage de-synchronization.

Entrained canopies are an important structural feature of estuarine wetlands that is much less common in other kinds of wetlands. As the tide rises into the vegetative cover of an estuarine marsh, it lifts plant debris and other materials that can become suspended in the above-ground foliage. As the tide goes out, the material is left hanging in the plant cover. Over time an entrained canopy of debris can form beneath the living plant canopy. This entrained canopy provides important shelter for many species of birds and small mammals that inhabit estuarine marshes. The degree to which an entrained canopy exists is therefore included in the assessment of Biotic Vertical Structure of estuarine wetlands.

C. Seasonality: This metric should be assessed late during the growing season.

D. Field Indicators: Vertical structure must be assessed in the field. The vertical component of biotic structure is commonly recognized as the overall number of plant layers, their spatial extent, and their vertical overlap relative to the expected conditions.

Only the maximum height of any vegetation type is used to determine its height class. For example, although a tall tree might span the entire range of all the height classes, it can only represent one height class, based on its overall height. Standing live and dead vegetation are both considered in the assessment. The length of prostrate stems or shoots and the horizontal extent of canopies are not considered. Only the vertical aspect of structure is considered in this metric.

Use the following worksheet and figures to assess the Vertical Biotic Structure Metric. Note that the plant strata of lagoons and estuarine wetlands can be difficult to distinguish, and assessing the entrained canopy of estuarine wetlands requires close examination of the vegetation.

Vertical Biotic Structure Worksheet: Reference table of plant layer heights

Wetland Class	Height Class Definitions for Terrestrial Vegetation		
	Short	**Medium**	**Tall**
Riverine and Lacustrine	< 1 m	1-3 m	> 3 m
Slope Wetlands, Lagoons, Estuarine, and Depressional	< 0.3 m	0.3 – 1 m	> 1 m
Playas and Vernal Pools	< 0.3 m	NA	NA

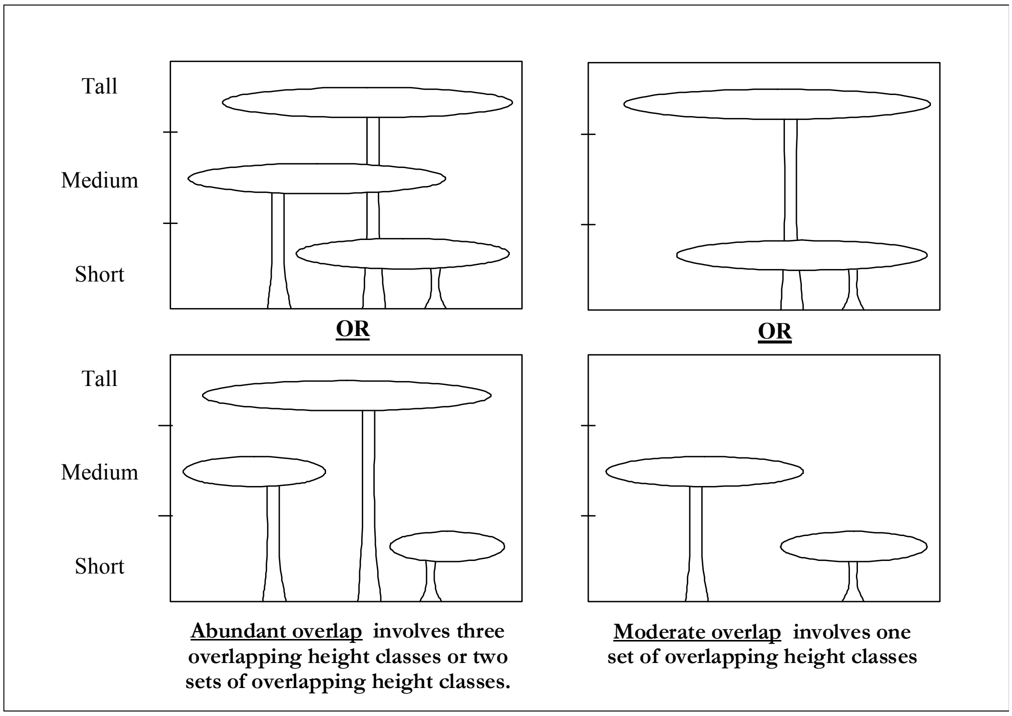

Figure 4.6: Schematic of abundant and moderate vertical interspersion of plant layers.

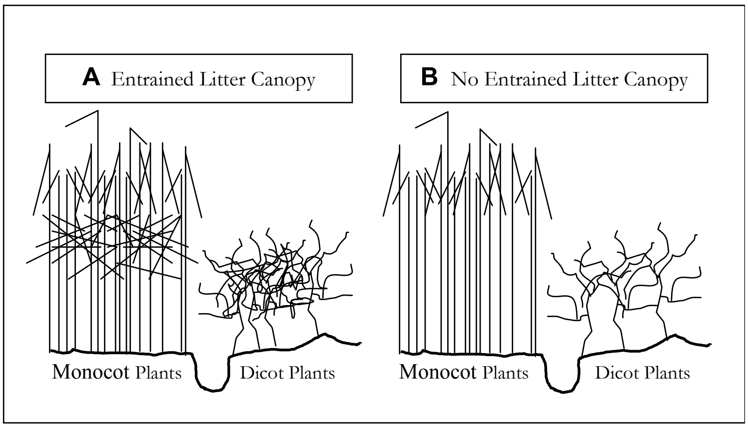

Figure 4.7: Schematic cross-section of estuarine marsh plain through small channel with and without entrained canopy.

Table 4.21: Rating of Vertical Biotic Structure for all Riverine Wetland and Riparian Areas, Slope, and Lagoon Wetlands.

Rating	Alternative States
A	More than 50 % of the vegetated area of the AA supports abundant overlap of height classes (see Figure 4.6).
B	More than 50 % of the area supports at least moderate overlap of height classes.
C	25 – 50 % of the vegetated AA supports at least moderate overlap of plant layers, **or** three plant layers are well represented in the AA but there is little to no overlap.
D	Less than 25% of the vegetated AA supports moderate overlap of height classes, **or** two layers are well represented with little overlap, **or** AA is sparsely vegetated overall.

Table 4.22: Rating of Vertical Biotic Structure for Depressional and Lacustrine Wetlands.

Rating	Alternative States
A	About 75 – 100 % of the vegetated area of the AA supports 4 plant layers.
B	About 50 – 75 % of vegetated area of the AA supports 4 plant layers, or more than 75 % of the area supports 3 plant layers.
C	About 25 – 50 % of the vegetated area supports 4 plant layers, or 50 - 75 % of the area supports 3 plant layers.
D	Less than 25 % of the vegetated area of the AA supports 4 height classes, or less than 50 % of the area supports 3 plant layers.

Table 4.23: Rating of Vertical Biotic Structure for Estuarine Wetlands.

Rating	Alternative States
A	Most of the AA has entrained canopy (see Figure 4.7) and three plant layers.
B	Most of the AA has an entrained canopy and supports two plant layers, or it has poor entrainment but mostly supports three plant layers.
C	Most of the AA has an entrained canopy and supports one plant layer, or it has poor entrainment but mostly supports two plant layers.
D	Most of the AA has poor entrainment and supports one plant layer.

Riparian area surrounding a small lacustrine system, Marin County.

CHAPTER 5:
GUIDELINES FOR COMPLETING THE STRESSOR CHECKLIST

A. Definition: Wetlands are connected by physical and biological mechanisms to a terrestrial watershed; the characteristics of this watershed, and, in particular, the human activities that take place there, greatly influence wetland structure and function (Frissell *et al.*, 1986; Scott *et al.* 2002, Roth *et al.* 1996). A stressor, as defined for the purposes of the CRAM, is an anthropogenic perturbation within a watershed that can negatively affect the condition and function of a wetland.

B. Rationale: The purpose of this metric is to develop a checklist of stress associated with human activities surrounding the wetland to be assessed. The overarching purpose of this checklist is to identify likely anthropogenic causes for poor wetland conditions as assessed by CRAM. A list of potential stressors corresponds to each of the major attributes of wetland condition. Thus, relationships between stressors, attributes, and their component metrics might be surmised. In some cases, a single stressor may cause deviation from "good" condition, but in most cases multiple stressors interact to affect wetland condition (USEPA, 2002).

There are four underlying assumptions of the Stressor Checklist: (1) deviation from a "good" 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.

C. Seasonality: The Stressor Checklist is not sensitive to seasonality.

D. Office and Field Indicators: The assessment of this attribute is the same across all wetland classes. For each CRAM attribute, a variety of human actions that are likely sources of stress are listed, and their presence, and likelihood of affecting the AA in question, are recorded in Table5.1, below. The hydrology, physical structure, and biotic structure stressor checklists should be scored for those visible within the AA itself. Adjacent land use should be scored only for those land uses outside the AA. In addition to the potential stressors relating to the CRAM attributes, stress relating to adjacent land use is also assessed.

Stressor Checklist Worksheet

HYDROLOGY	**Present and likely to have negative effect on AA**	**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	**Present and likely to have negative effect on AA**	**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		

Stressor Checklist Worksheet

BIOTIC STRUCTURE	**Present and likely to have negative effect on AA**	**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		
Evidence of fire		
Evidence of flood		
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 appropriate treatment of invasive plant species adjacent to AA or buffer		
Comments		

ADJACENT LAND USE	**Present and likely to have negative effect on AA**	**Significant negative effect on AA**
Urban residential		
Industrial/commercial		
Military training/Air traffic		
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		

Estuarine wetlands, Martin Luther King, Jr. Regional Shoreline Park, Alameda County.

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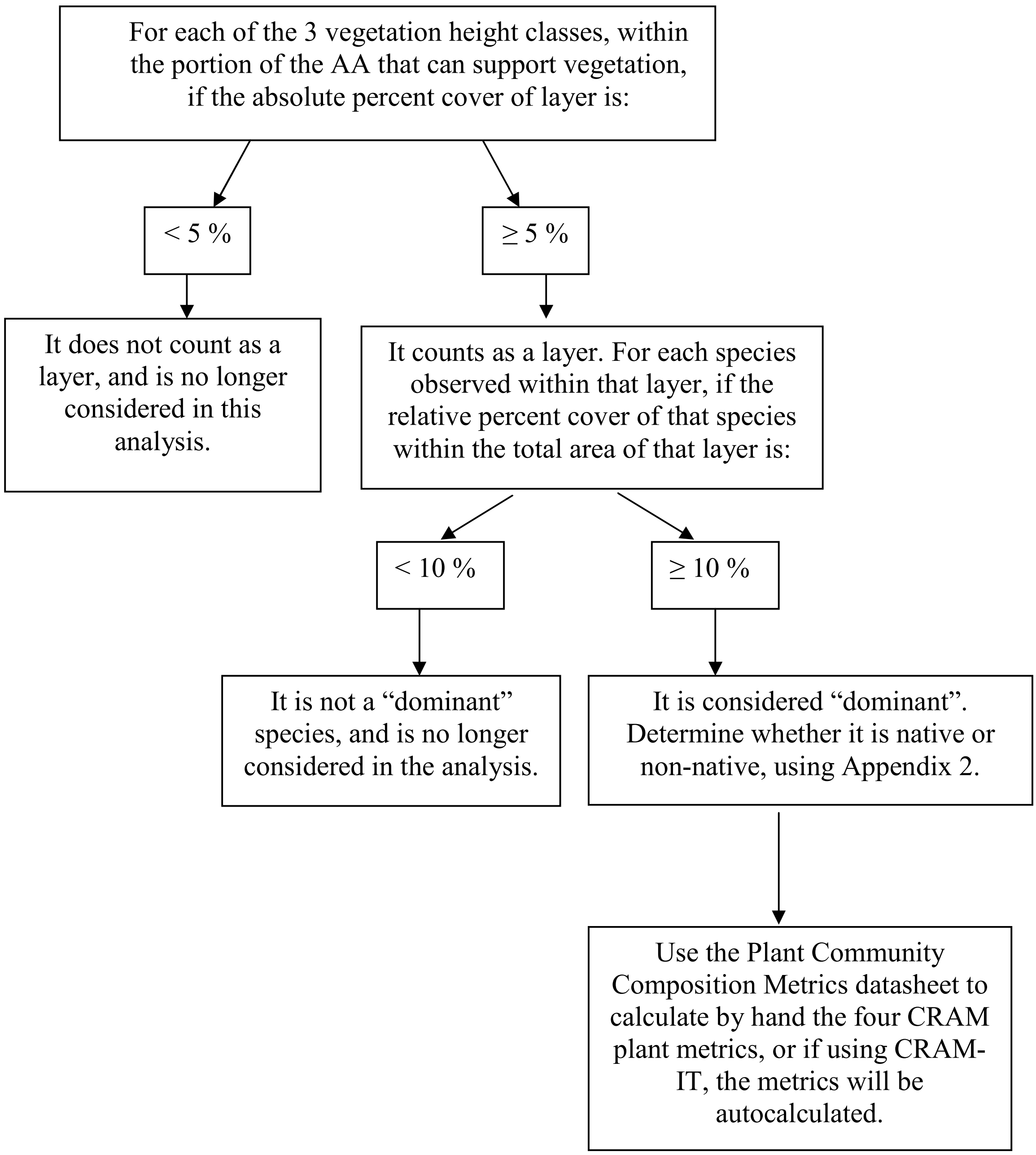
APPENDIX 1:
FLOW CHART FOR DETERMINATION OF DOMINANT PLANT SPECIES



APPENDIX 2-A:
LIST OF CALIFORNIA PLANT SPECIES (alphabetized by plant species)

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Abies concolor	Abco	white fir	Yes	tree	Pinaceae
Acer circinatum	Acci	vine maple	Yes	shrub	Aceraceae
Acer macrophyllum	Acma	big-leaf maple	Yes	tree	Aceraceae
Acer negundo L.	Acne	box elder	Yes	tree	Aceraceae
Adiantum aleuticum	Adal	Five fingered fern	Yes	herb	Pteridaceae
Adiantum jordanii	Adjo	California maidenhair	Yes	herb	Pteridaceae
Aesculus californica	Aeca	California buckeye	Yes	tree	Hippocastanaceae
Ageratina adenophora	Agad	sticky eupatorium	No	herb	Asteraceae
Agrostis gigantea	Aggi	redtop	No	herb	Poaceae
Agrostis stolonifera L.	Agst	creeping bentgrass	No	herb	Poaceae
Agrostis viridis	Agvi	water bentgrass	No	herb	Poaceae
Ailanthus altissima (P. Mill.) Swingle	Aial	tree of heaven	No	tree	Simaroubaceae
Alisma plantago-aquatica	Alpl	water plantain	Yes	herb	Alismataceae
Allenrolfea occidentalis	Aloc	iodine bush	Yes	shrub	Chenopodiaceae
Alnus incana	Alin	mountain alder	Yes	shrub	Betulaceae
Alnus rhombifolia	Alrh	white alder	Yes	tree	Betulaceae
Alnus rubra	Alru	red alder	Yes	tree	Betulaceae
Alopecurus aequalis	Alae	shortawn foxtail	Yes	herb	Poaceae
Amaranthus albus	Amal	tumbleweed	No	herb	Amaranthaceae
Amaranthus californicus	Amca	California pigweed	Yes	herb	Amaranthaceae
Ambrosia artemisiifolia	**Amat**	common ragweed	No	herb	Asteraceae
Ambrosia chamissonis	Amch	beach-bur	Yes	shrub	Asteraceae
Ambrosia psilostachya DC.	Amps	western ragweed	Yes	herb	Asteraceae
Ammannia coccinea Rottb.	Amco	tooth-cup	Yes	herb	Lythraceae
Ammophila arenaria	Amar	European beach grass	No	herb	Poaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Anagallis arvensis L.	Anar	scarlet pimpernel	No	herb	Primulaceae
Andropogon glomeratus (Walt.) B.S.P.	Angl	southwestern bushy bluestem	Yes	herb	Poaceae
Anemopsis californica (Nutt.)	Anca	yerba mansa	Yes	herb	Saururaceae
Anthriscus caucalis	**Ancc**	bur chervil	No	herb	Apiaceae
Apium graveolens L.	Apgr	celery	No	herb	Apiaceae
Apocynum cannabinum	Apca	indian hemp	Yes	shrub	Apocynaceae
Aquilegia formosa	Aqfo	columbine	Yes	herb	Ranunculaceae
Aralia californica A. Wats.	**Arcl**	California spikenard	Yes	herb	Araliaceae
Artemisia californica	Arca	California sagebrush	Yes	shrub	Asteraceae
Artemisia douglasiana Bess.	**Ardg**	mugwort	Yes	shrub	Asteraceae
Artemisia ludoviciana	Arlu	silver wormwood	Yes	shrub	Asteraceae
Artemisia tridentata	Artr	Great Basin sage	Yes	shrub	Asteraceae
Arundo donax L.	Ardo	giant reed	No	shrub	Poaceae
Aster subulatus Michx.	Assu	slender aster	Yes	herb	Asteraceae
Athyrium filix-femina	Atfi	common ladyfern	Yes	herb	Dryopteridaceae
Atriplex californica Moq.	Atca	California saltbush	Yes	shrub	Chenopodiaceae
Atriplex lentiformis ssp. lentiformis	Atle	Brewer's saltbush	Yes	shrub	Chenopodiaceae
Atriplex semibaccata	Atse	Australian saltbush	No	shrub	Chenopodiaceae
Atriplex triangularis	Attr	saltbush	Yes	herb	Chenopodiaceae
Atriplex wattsonii	Atwa	Watson's saltbush	Yes	shrub	Chenopodiaceae
Avena barbata	Avba	slender wild oat	No	herb	Poaceae
Avena fatua	Avfa	wild oat	No	herb	Poaceae
Avena sativa	Avsa	hay	No	herb	Poaceae
Baccharis douglasii	Bado	marsh baccharis/Douglas' false-willow	Yes	shrub	Asteraceae
Baccharis emoryi Gray	Baem	Emory baccharis	Yes	shrub	Asteraceae
Baccharis pilularis	Bapi	coyote brush	Yes	shrub	Asteraceae
Baccharis salicifolia	Basa	mule fat	Yes	shrub	Asteraceae
Baccharis sarothroides Gray	**Basr**	broom baccharis	Yes	shrub	Asteraceae
Bassia hyssopifolia	Bahy	bassia	No	herb	Chenopodiaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Batis maritima L.	Bama	saltwort, beachwort	Yes	shrub	Bataceae
Bergia texana (Hook.) Seub. ex Walp.	Bete	Texas bergia	Yes	herb	Elatinaceae
Berula erecta (Huds.) Coville	Beer	cutleaf water-parsnip	Yes	herb	Apiaceae
Beta vulgaris	Bevu	wild beet	No	herb	Chenopodiaceae
Bidens laevis (L.) B.S.P.	Bila	bur-marigold	Yes	herb	Asteraceae
Blennosperma nanum	Blna	common blennosperma	Yes	herb	Asteraceae
Boykinia occidentalis	Booc	coast boykinia	Yes	herb	Saxifragaceae
Brassica nigra	Brni	black mustard	No	herb	Brassicaceae
Brickellia californica	Brca	California brickellbush	Yes	shrub	Scrophulariaceae
Bromus diandrus	Brdi	ripgut brome	No	herb	Poaceae
Bromus madritensis	Brma	foxtail chess	No	herb	Poaceae
Bromus mollis	Brmo	soft brome	No	herb	Poaceae
Bromus tectorum	Brte	cheat grass	No	herb	Poaceae
Callitriche heterophylla Pursh	Cahe	water starwort	Yes	herb	Callitrichaceae
Calocedrus decurrens	Cade	incense cedar	Yes	tree	Cupressaceae
Caltha palustris	Capa	marsh marigold	No	herb	Ranunculaceae
Calystegia macrostegia	Cama	morning-glory	Yes	herb	Convovulaceae
Calystegia sepium (L.) R. Br.	Case	hedge bindweed	Yes	herb	Convovulaceae
Camissonia chieranthifolia var. suffruticosa	Cach	beach evening primrose	Yes	shrub	Onagraceae
Cardamine californica	Caca	milk maids, tooth wort	Yes	herb	Brassicaceae
Carduus pycnocephalus	Capy	Italian thistle	No	herb	Asteraceae
Carex barbarae	Caba	Santa Barbara sedge	Yes	herb	Cyperaceae
Carex lenticularis	Cale	lakeshore sedge	Yes	herb	Cyperaceae
Carex lyngbyei	Caly	Lyngbyei's sedge	No	herb	Cyperaceae
Carex praegracilis W. Boott	Capr	clustered field sedge	Yes	herb	Cyperaceae
Carex schottii	Casc	Schott's sedge	Yes	herb	Cyperaceae
Carex spissa Bailey	Casp	San Diego sedge	Yes	herb	Cyperaceae
Carex Whitneyi	Cawh	sedge	Yes	herb	Cyperaceae
Carpobrotus edulis	Caed	iceplant	No	herb	Aizoaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Casuarina equisetifolia	Caeq	river she-oak	No	tree	Casuarinaceae
Centaurea solstitialis	Ceso	yellow starthistle	No	herb	Asteraceae
Centella asiatica	Ceas	Asiatic pennywort	No	herb	Apiaceae
Cercocarpus betuloides	Cebe	mountain mahogany	Yes	shrub	Rosaceae
Chenopodium album	Chal	lamb's quarters	No	herb	Chenopodiaceae
Chenopodium ambrosioides	Cham	Mexican tea	No	herb	Chenopodiaceae
Chrysanthemum coronarium	Chco	garland chrysanthemum	No	herb	Asteraceae
Chrysothamnus nauseosus	Chna	rabbit brush	Yes	shrub	Asteraceae
Cicuta douglasii	Cido	western waterhemlock	Yes	herb	Apiaceae
Cirsium arvense	Ciar	Canada thistle	No	herb	Asteraceae
Cirsium vulgare (Savi) Ten.	Civu	bull thistle	No	herb	Asteraceae
Clematis ligusticifolia	Clli	virgin's bower	Yes	shrub	Ranunculaceae
Conium maculatum L.	Coma	poison hemlock	No	herb	Apiaceae
Conyza bonariensis	Cobo	horseweed	No	herb	Asteraceae
Conyza canadensis (L.) Cronq.	Coca	horseweed	Yes	herb	Asteraceae
Cordylanthus maritimus ssp. maritimus	**Comr**	salt marsh bird's beak	Yes	herb	Scrophulariaceae
Cordylanthus mollis ssp. mollis	Como	soft bird's beak	Yes	herb	Scrophulariaceae
Cornus sericea	Cosr	creek dogwood	Yes	shrub	Cornaceae
Cortaderia jubata	Coju	Andean pampas grass	No	herb	Poaceae
Cortaderia selloana	Cose	pampas grass	No	herb	Poaceae
Cotula coronopifolia L.	Coco	brass buttons	No	herb	Asteraceae
Crassula aquatica (L.) Schoenl.	Craq	water pygmyweed	Yes	herb	Crassulaceae
Cressa truxillensis Kunth	Crtr	alkali weed	Yes	shrub	Convovulaceae
Crypsis schoenoides	Crsc	swamp pickle-grass	No	herb	Poaceae
Crypsis vaginiflora (Forsk.) Opiz	Crva	sharp-leaved Timothy	No	herb	Poaceae
Cuscuta salina	Cusa	witch's hair/dodder	Yes	herb	Cuscutaceae
Cynara cardunculus	Cyca	artichocke thistle	No	herb	Asteraceae
Cynodon dactylon	Cyda	Bermuda grass	No	herb	Poaceae
Cynosurus echinatus	Cyec	bristly dogstail grass	No	herb	Poaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Cyperus eragrostis Lam.	Cyer	umbrella sedge	Yes	herb	Cyperaceae
Cyperus esculentus	Cyes	nutsedge	Yes	herb	Cyperaceae
Cyperus involucratus	Cyin	nutsedge	No	herb	Cyperaceae
Cyperus rotundus L.	Cyro	purple nutsedge	No	herb	Cyperaceae
Cyperus squarrosus L.	Cysq	awned flatsedge/bearded flatsedge	Yes	herb	Cyperaceae
Datisca glomerata (K. Presl) Baill.	Dagl	Durango root	Yes	herb	Datiscaceae
Delairea odorata/Senecio mikanoides	Deod	Cape (German) ivy	No	herb	Asteraceae
Deschampsia cespitosa	Dece	tufted hairgrass	Yes	herb	Poaceae
Dichelostemma capitatum ssp. capitatum	Dica	blue dicks	Yes	herb	Liliaceae
Distichlis spicata (L.) Greene	Disp	saltgrass	Yes	herb	Poaceae
Downingia cuspidata	Docu	toothed calicoflower	Yes	herb	Campanulaceae
Dryopteris arguta	Drar	wood fern	Yes	herb	Dryopteridaceae
Echinochloa crus-galli (L.) Beauv.	Eccr	banyard grass	No	herb	Poaceae
Eclipta prostrata	Ecpr	eclipta	Yes	herb	Asteraceae
Ehrharta erecta	Eher	veldt grass	No	herb	Poaceae
Elatine brachysperma Gray	Elbr	shortseed waterwort	Yes	herb	Elatinaceae
Eleocharis acicularis	Elac	hairgrass	Yes	herb	Cyperaceae
Eleocharis geniculata	Elge	annual spikerush	Yes	herb	Cyperaceae
Eleocharis macrostachya	Elma	common spikerush	Yes	herb	Cyperaceae
Eleocharis montevidensis	Elmo	sand spikerush	Yes	herb	Cyperaceae
Eleocharis parishii	Elpa	Parish's spikerush	Yes	herb	Cyperaceae
Eleocharis radicans	Elra	rooted spikerush	Yes	herb	Cyperaceae
Eleocharis rostellata	Elro	beaked spikerush	Yes	herb	Cyperaceae
Elymus elymoides	Elel	squirreltail	Yes	herb	Poaceae
Emmenanthe penduliflora	Empe	whispering bells	Yes	herb	Hydrophyllaceae
Encelia californica	Enca	bush sunflower	Yes	shrub	Asteraceae
Epilobium (Zauschneria) canum	Epca	california fuchsia	Yes	herb	Onagraceae
Epilobium ciliatum Raf.	Epci	hairy willow-herb	Yes	herb	Onagraceae
Epilobium pygmaeum (Speg.)	Eppy	smooth willow-herb	Yes	herb	Onagraceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Equisetum arvense	Eqar	common horsetail	Yes	herb	Equisetaceae
Equisetum laevigatum	Eqla	smooth scouring rush	Yes	herb	Equisetaceae
Equisetum telmateia Ehrh.	Eqte	giant horsetail	Yes	herb	Equisetaceae
Eriogonum fasciculatum	Erfa	California buckwheat	Yes	shrub	Polygonaceae
Eriophyllym confertifolium	Erco	golden yarrow	Yes	shrub	Asteraceae
Erodium botrys	Erbo	long-beaked filaree	No	herb	Geraniaceae
Erodium cicutarium	Erci	red-stem filaree	No	herb	Geraniaceae
Eryngium aristulatum var. parishii	Erar	San Diego-button celery	Yes	herb	Apiaceae
Eucalyptus globulus	Eugl	Tasmanian blue gum	No	tree	Mytaceae
Euphorbia peplus	Eupe	petty spurge	No	herb	Euphorbiaceae
Euphorbia terracina	Eute	Geraldton carnation weed	No	herb	Euphorbiaceae
Foeniculum vulgare P. Mill.	Fovu	sweet fennel	No	herb	Apiaceae
Frankenia salina (Molina)	Frsa	alkali heath	Yes	herb	Frankeniaceae
Fraxinus dipetala	Frdi	California ash	Yes	tree	Oleaceae
Fraxinus latifolia	Frla	Oregon ash	Yes	tree	Oleaceae
Fraxinus velutina Torr.	Frve	velvet ash	Yes	tree	Oleaceae
Galium aparine	Gaap	goose grass	Yes	herb	Rubiaceae
Genista monspessulana	Gemo	French broom	No	shrub	Fabaceae
Glaux maritima	Glma	sea-milkwort	Yes	herb	Primulaceae
Gnaphalium californicum	**Gncl**	California everlasting	Yes	herb	Asteraceae
Gnaphalium canescens ssp. beneolens	Gnca	fragrant everlasting	Yes	herb	Asteraceae
Gnaphalium palustre Nutt.	Gnpa	lowland cudweed	Yes	herb	Asteraceae
Grindelia hirsutula var. hirsutula	Grhi	hairy gumweed	Yes	herb	Asteraceae
Grindelia stricta	Grst	marsh gum-plant	Yes	shrub	Asteraceae
Hedera helix	Hehe	English ivy	No	vine ("shrub")	Araliaceae
Helianthus annuus L.	Hean	common sunflower	Yes	herb	Asteraceae
Helianthus californicus DC.	**Hecl**	California sunflower	Yes	herb	Asteraceae
Heliotropium curassavicum L.	Hecu	alkali heliotrope	Yes	herb	Boraginaceae
Hemizonia paniculata Gray	Hepa	fascicled tarweed	Yes	herb	Asteraceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Hemizonia parryi var. australis	**Hepr**	southern tarplant	Yes	herb	Asteraceae
Heracleum lanatum	Hela	cow parsnip	Yes	herb	Apiaceae
Hesperevax caulescens	Heca	hogwallow starfish	Yes	herb	Asteraceae
Hesperocnide tenella	Hete	western nettle	Yes	herb	Urticaceae
Heteromeles arbutifolia	Hear	toyon	Yes	shrub	Rosaceae
Heterotheca grandiflora	Hegr	telegraph weed	No	herb	Asteraceae
Hirschfeldia incana	Hiin	summer mustard	No	herb	Brassicaceae
Holcus lanatus	Hola	velvet grass	No	herb	Poaceae
Holodiscus discolor	Hodi	oceanspray	Yes	shrub	Rosaceae
Hordeum brachyantherum	Hobr	barley	Yes	herb	Poaceae
Hordeum geniculatum/H. marinum gussonianum	Hoge	Mediterrenean barley	No	herb	Poaceae
Hordeum intercedens Nevski	Hoin	vernal barley	Yes	herb	Poaceae
Hordeum secalinum	Hose	meadow barley	No	herb	Poaceae
Hydrilla verticillata (L. f.) Royle	Hyve	waterthyme	No	herb	Hydrocharitaceae
Hydrocotyle ranunculoides L. f.	Hyra	floating marsh pennywort	Yes	herb	Apiaceae
Hydrocotyle umbellata L.	Hyum	water-pennywort	Yes	herb	Apiaceae
Hydrocotyle verticillata Thunb.	**Hyvr**	whorled marsh pennywort	Yes	herb	Apiaceae
Iris pseudacorus	Irps	yellow water iris/yellow flag	No	herb	Iridaceae
Isocoma menziesii	Isme	coast goldenbush	Yes	shrub	Asteraceae
Isoetes howellii Engelm.	Isho	Howell's quillwort	Yes	herb	Isoetaceae
Isoetes nuttallii A. Braun ex Engelm.	Isnu	Nuttall's quillwort	Yes	herb	Isoetaceae
Isomeris arborea	Isar	bladderpod	Yes	shrub	Capparaceae
Jaumea carnosa (Less.) Gray	Jaca	marsh jaumea/salty Susan	Yes	herb	Asteraceae
Juglans californica	Juca	California black walnut	Yes	tree	Juglandaceae
Juncus acutus	Juac	southwestern spiny rush/sharp rush	Yes	herb	Juncaceae
Juncus balticus	Juba	Baltic rush	Yes	herb	Juncaceae
Juncus bufonius L.	Jubu	toadrush	Yes	herb	Juncaceae
Juncus effusus	Juef	common rush	Yes	herb	Juncaceae
Juncus lesueurii	Jule	salt rush	Yes	herb	Juncaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Juncus longistylus	Julo	long-beaked rush	Yes	herb	Juncaceae
Juncus mexicanus	Jume	Mexican rush	Yes	herb	Juncaceae
Juncus nevadensis	June	Sierra rush	Yes	herb	Juncaceae
Juncus occidentalis	Juoc	rush	Yes	herb	Juncaceae
Juncus phaeocephalus	Juph	brown-headed creeping rush	Yes	herb	Juncaceae
Juncus rugulosus Engelm.	Juru	wrinkled rush	Yes	herb	Juncaceae
Juncus textilis	Jute	basket rush	Yes	herb	Juncaceae
Kyllinga brevifolia	Kybr	kyllinga	No	herb	Cyperaceae
Lactuca serriola L.	Lase	prickly lettuce	No	herb	Asteraceae
Larrea tridentata	Latr	creosote bush	Yes	shrub	Zygophyllaceae
Lasthenia glabrata Lindl.	Lagl	goldfields	Yes	herb	Asteraceae
Lathryus jepsonii var. jepsonii	Laje	tule pea	Yes	herb	Fabaceae
Lemna minor L.	Lemi	lesser duckweed	Yes	herb	Lemnaceae
Lemna minuta	**Lemu**	least duckweed	Yes	herb	Lemnaceae
Lepidium latifolium L.	**Lelf**	perennial pepperweed	No	herb	Brassicaceae
Lepidium latipes Hook.	Lela	dwarf pepper grass	Yes	herb	Brassicaceae
Lepidium nitidum	Leni	peppergrass	Yes	herb	Brassicaceae
Lepidospartum squamatum	Lesq	scalebroom	Yes	shrub	Asteraceae
Leptochloa uninervia (J. Presl)	Leun	Mexican sprangletop	Yes	herb	Poaceae
Leymus condensatus	Leco	giant wild-rye	Yes	herb	Poaceae
Leymus triticoides	Letr	beardless wild-rye	Yes	herb	Poaceae
Lilaeopsis masonii	Lima	Mason's lilaeopsis	Yes	herb	Apiaceae
Lilaeopsis occidentalis	Lioc	western grasswort	Yes	herb	Apiaceae
Limonium californicum	Lica	sea lavender/marsh rosemary	Yes	herb	Plumbaginaceae
Lithocarpus densiflorus	Lide	Tanbark oak	Yes	tree	Fagaceae
Lobularia maritima	Loma	sweet alyssum	No	herb	Brassicaceae
Lolium multiflorum	Lomu	Italian ryegrass	No	herb	Poaceae
Lolium perenne L.	Lope	perennial ryegrass	No	herb	Poaceae
Lonicera hispidula	Lohi	California honeysuckle	Yes	shrub	Caprifoliaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Lonicera involucrata	Loin	twinberry honeysuckle	Yes	vine ("shrub")	Caprifoliaceae
Lotus argophyllus	Loar	silver lotus	Yes	herb	Fabaceae
Lotus corniculatus	Loco	birdfoot trefoil	No	herb	Fabaceae
Lotus scoparius	Losc	deerweed	Yes	shrub	Fabaceae
Ludwigia peploides (Kunth) Raven	Lupe	floating water primrose, false loosestrife	Yes	herb	Onagraceae
Lupinus arboreus	Luar	yellow bush lupine	Yes	shrub	Fabaceae
Lupinus chamissonis	Luch	silver dune lupine	Yes	shrub	Fabaceae
Lupinus lepidus	Lule	dwarf lupine	Yes	herb	Fabaceae
Lupinus polyphyllus	Lupo	bigleaf lupine	Yes	herb	Fabaceae
Lythrum californicum Torr. & Gray	Lyca	California loosestrife	Yes	herb	Lythraceae
Lythrum hyssopifolium	Lyhy	loosestrife	No	herb	Lythraceae
Malacothrix californica	Maca	malacothrix	Yes	herb	Asteraceae
Malacothrix torreyi	Mato	Torrey's desertdandelion	Yes	herb	Asteraceae
Malosma laurina	Mala	laurel sumac	Yes	shrub	Anacardiaceae
Malvella leprosa (Ortega) Krapov.	Male	alkali mallow/whiteweed	Yes	herb	Malvaceae
Marrubium vulgare L.	Mavu	horehound	No	herb	Lamiaceae
Marsilea vestita	Mave	hairy pepperwort	Yes	herb	Marsileaceae
Matricaria suaveolens	Masu	pineapple weed	No	herb	Asteraceae
Medicago polymorpha L.	Mepo	California burclover	No	herb	Fabaceae
Melilotus alba	Meal	white sweetclover	No	herb	Fabaceae
Melilotus indica	Mein	sourclover	No	herb	Fabaceae
Mentha piperita	Mepi	peppermint	No	herb	Lamiaceae
Mentha pulegium	Mepu	pennyroyal	No	herb	Lamiaceae
Mentha spicata L.	Mesp	spearmint	No	herb	Lamiaceae
Mesembryanthemum crystallinum L.	Mecr	crystalline iceplant	No	herb	Aizoaceae
Mesembryanthemum nodiflorum	Meno	slender-leaved iceplant	No	herb	Aizoaceae
Mimulus aurantiacus	Miau	bush monkeyflower	Yes	shrub	Scrophulariaceae
Mimulus cardinalis Dougl. ex Benth.	Mica	scarlet monkeyflower	Yes	herb	Scrophulariaceae
Mimulus guttatus DC.	Migu	common monkeyflower	Yes	herb	Scrophulariaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Mimulus moschatus	Mimo	musk monkeyflower	Yes	herb	Scrophulariaceae
Monanthochloe littoralis	Moli	wiregrass/shoregrass	Yes	herb	Poaceae
Muhlenbergia rigens (Benth.) A.S. Hitchc.	Muri	deergrass	Yes	herb	Poaceae
Myoporum laetum	Myla	mousehole tree	No	tree	Myoporaceae
Myosotis symphytifolia	Mysy	forget-me-not	No	herb	Boraginaceae
Myosurus minimus L.	Mymi	mouse tail	Yes	herb	Ranunculaceae
Myriophyllum aquaticum	Myaq	parrot's feather	No	herb	Haloragaceae
Najas marina	Nama	holly-leaved water-nymph	Yes	herb	Hydrocharitaceae
Nemacaulis denudata var. denudata	Nede	wooly-heads	Yes	herb	Polygonaceae
Nicotiana glauca Graham	Nigl	tree tobacco	No	shrub	Solanaceae
Olea europaea	Oleu	olive	No	tree	Oleaceae
Orizopsis mileaceum	Ormi	smilo grass	No	herb	Poaceae
Osmorhiza brachypoda	Osbr	California sweetcicely	Yes	herb	Apiaceae
Oxalis pes-caprae	Oxpe	Bermuda buttercup	No	herb	Oxalidaceae
Parapholis incurva	Pain	sickle grass	No	herb	Poaceae
Paspalum distichum	Padi	knot grass	Yes	herb	Poaceae
Pennisetum clandestinum	Pecl	kikuyu grass	No	herb	Poaceae
Petasites frigidus (L.) Fries	Pefr	coltsfoot	Yes	herb	Asteraceae
Phacelia distans	Phdi	phacelia	Yes	herb	Hydrophyllaceae
Phalaris aquatica	Phaq	Harding grass	No	herb	Poaceae
Phalaris arundinacea	Phar	reed canary grass	Yes	herb	Poaceae
Phalaris lemmonii	Phle	Lemmon's canary grass	Yes	herb	Poaceae
Phoenix canariensis	Phca	Phoenix date palm	No	tree	Arecaceae
Phragmites australis (Cav.) Trin. ex Steud.	Phau	common reed	Yes	herb	Poaceae
Phyllospadix scouleri Hook.	Phsc	Scouler's surfgrass	Yes	herb	Zosteraceae
Phyllospadix torreyi S. Wats.	Phto	Torrey's surfgrass	Yes	herb	Zosteraceae
Picris echioides L.	Piec	bristly ox-tongue	No	herb	Asteraceae
Pilularia americana	Piam	American pillwort	Yes	herb	Marsileaceae
Pimpinella anisum	Pian	anise	No	herb	Umbelliferae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Pinus jeffryi	Pije	Jeffrey pine	Yes	tree	Pinaceae
Pinus ponderosa	Pipo	ponderosa pine	Yes	tree	Pinaceae
Piptatherum miliaceum	Pimi	smilo grass	No	herb	Poaceae
Plagiobothrys leptocladus	Plle	alkali plagiobothrys	Yes	herb	Boraginaceae
Plagiobothrys stipitatus	Plst	stipitate popcorn flower	Yes	herb	Boraginaceae
Plagiobothrys undulatus	Plun	coast popcorn-flower	Yes	herb	Boraginaceae
Plantago elongata Pursh	Plel	slender plantain	Yes	herb	Plantaginaceae
Plantago erecta	Pler	dwarf plantain	Yes	herb	Plantaginaceae
Plantago lanceolata L.	Plla	English plantain	No	herb	Plantaginaceae
Plantago major	Plma	common plantain	No	herb	Plantaginaceae
Plantago subnuda	Plsu	naked plantain	Yes	herb	Plantaginaceae
Platanus racemosa	Plra	western sycamore	Yes	tree	Platanaceae
Pluchea odorata	Plod	salt marsh fleabane	Yes	herb	Asteraceae
Pluchea sericea (Nutt.) Cav.	Plse	arrow weed	Yes	shrub	Asteraceae
Poa pratensis	Popr	Kentucky bluegrass	No	herb	Poaceae
Polygonum amphibium L.	Poam	water smartweed	Yes	herb	Polygonaceae
Polygonum arenastrum Jord. ex Boreau	Poar	common knotweed	No	herb	Polygonaceae
Polygonum lapathifolium L.	Pola	willow weed	Yes	herb	Polygonaceae
Polygonum punctatum	Popu	water smartweed	Yes	herb	Polygonaceae
Polypogon monspeliensis (L.) Desf.	Pomo	annual beard grass/rabbitfoot grass	No	herb	Poaceae
Populus balsamifera	Poba	black cottonwood	Yes	tree	Salicaceae
Populus fremontii S. Wats.	Pofr	Fremont cottonwood	Yes	tree	Salicaceae
Portulaca oleracea	Pool	common purslane	No	herb	Portulacaceae
Potamogeton foliosus Raf.	Pofo	leafy pondweed	Yes	herb	Potamogetonaceae
Potamogeton nodosus Poir.	Pono	long-leaved pondweed	Yes	herb	Potamogetonaceae
Potamogeton pectinatus	Pope	fennel-leaf pondweed	Yes	herb	Potamogetonaceae
Potentilla anserina	Poan	cinquefoil	Yes	herb	Rosaceae
Prunus ilicifolia	Pril	holly-leaved cherry	Yes	tree	Rosaceae
Pseudotsuga menziesii	Psme	douglas fir	Yes	tree	Pinaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Psilocarphus brevissimus Nutt.	Psbr	wooly marbles	Yes	herb	Asteraceae
Pteridium aquilinum	Ptaq	bracken fern	Yes	herb	Polypodiaceae
Puccinellia distans (Jacq.) Parl.	Pudi	European alkali grass	No	herb	Poaceae
Pulicaria paludosa Link	Pupa	Spanish sunflower	No	herb	Asteraceae
Purshia tridentata	Putr	antelope bush	Yes	shrub	Rosaceae
Quercus agrifolia	Quag	coast live oak	Yes	tree	Fagaceae
Quercus berberidifolia	Qube	scrub oak	Yes	shrub	Fagaceae
Quercus durata	Qudu	leather oak	Yes	tree	Fagaceae
Quercus garryana	Quga	Oregon oak	Yes	tree	Fagaceae
Quercus kelloggii	Quke	California black oak	Yes	tree	Fagaceae
Quercus lobata	Qulo	valley oak	Yes	tree	Fagaceae
Ranunculus aquatilis L.	Raaq	water buttercup	Yes	herb	Ranunculaceae
Raphanus sativus L.	Rasa	wild radish	No	herb	Brassicaceae
Retama monosperma	Remo	bridal broom	No	shrub	Fabaceae
Rhamnus californica	Rhca	California coffeeberry	Yes	shrub	Rhamnaceae
Rhododendron occidentalis	Rhoc	western azalea	Yes	shrub	Ericaceae
Rhus intergrifolia	Rhin	lemonadeberry	Yes	shrub	Anacardiaceae
Rhus ovata	Rhov	sugar bush	Yes	shrub	Anacardiaceae
Ribes divaricatum	Ridi	spreading gooseberry	Yes	shrub	Grossulariaceae
Ribes speciosum	Risp	fucshia-flowered gooseberry	Yes	shrub	Grossulariaceae
Ribes visicosissimum	Rivi	sticky currant	Yes	shrub	Grossulariaceae
Ricinus communis L.	Rico	castor bean	No	herb	Euphorbiaceae
Robinia pseudoacacia	Rops	black locust	No	tree	Fabaceae
Rorippa curvipes Greene	Rocu	bluntleaf yellow-cress	Yes	herb	Brassicaceae
Rorippa nasturtium-aquaticum	Rona	water cress	Yes	herb	Brassicaceae
Rorippa palustris (L.) Bess.	Ropa	marsh yellow-cress	Yes	herb	Brassicaceae
Rosa californica	Roca	California rose	Yes	shrub	Rosaceae
Rosa gymnocarpa	Rogy	wood rose	Yes	shrub	Rosaceae
Rosa woodsii	Rowo	Wood's rose	Yes	shrub	Rosaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Rubus discolor	Rudi	Himalaya blackberry	No	shrub	Rosaceae
Rubus parviflorus	Rupa	thimbleberry	Yes	shrub	Rosaceae
Rubus rosaefolius	Ruro	Mauritius raspberry	No	shrub	Rosaceae
Rubus ursinus	Ruur	California blackberry	Yes	herb	Rosaceae
Rubus villosus	Ruvi	low-running blackberry	No	shrub	Rosaceae
Rumex conglomeratus Murr.	Ruco	clustered dock	No	herb	Polygonaceae
Rumex crispus L.	Rucr	curly dock	No	herb	Polygonaceae
Rumex maritimus L.	**Rumr**	golden dock	Yes	herb	Polygonaceae
Ruppia maritima L.	Ruma	ditch-grass	Yes	herb	Potamogetonaceae
Salicornia bigelovii Torr.	Sabi	pickleweed	Yes	herb	Chenopodiaceae
Salicornia europea (S. rubra)	Saeu	slender glasswort	Yes	herb	Chenopodiaceae
Salicornia subterminalis	Sasu	Parish's glasswort	Yes	herb	Chenopodiaceae
Salicornia utahensis	Saut	Utah pickleweed	Yes	herb	Chenopodiaceae
Salicornia virginica L.	Savi	common pickleweed	Yes	herb	Chenopodiaceae
Salix babylonica	Saba	weeping willow	No	tree	Chenopodiaceae
Salix exigua Nutt.	Saex	sandbar willow/narrow-leaved willow	Yes	shrub	Salicaceae
Salix gooddingii Ball	Sago	Goodding's black willow	Yes	tree	Salicaceae
Salix laevigata Bebb	Sala	red willow	Yes	tree	Salicaceae
Salix lasiolepis Benth.	**Sals**	arroyo willow	Yes	shrub/tree	Salicaceae
Salix lemmonii	Sale	Lemmon's willow	Yes	shrub	Salicaceae
Salix lucida Muhl.	Salu	shining willow	Yes	shrub/tree	Salicaceae
Salix lutea Nutt.	**Salt**	yellow willow	Yes	shrub/tree	Salicaceae
Salix melanopsis	**Samp**	dusky willow	Yes	shrub	Salicaceae
Salix scouleriana	Sasc	Scouler willow	Yes	shrub	Salicaceae
Salix sitchensis	Sasi	Sitka willow	Yes	shrub/tree	Salicaceae
Salsola soda L.	Saso	oppositeleaf Russian thistle	No	herb	Chenopodiaceae
Salsola tragus	Satr	Russian thistle/tumbleweed	No	herb	Chenopodiaceae
Salvia apiana	Saap	white sage	Yes	shrub	Lamiaceae
Sambucus melanocarpa	Saml	black elderberry	Yes	shrub	Caprifoliaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Sambucus mexicana K. Presl ex DC.	Same	Mexican elderberry/blue elderberry	Yes	shrub	Caprifoliaceae
Saponaria officinalis	Saof	bouncing bet	No	herb	Caryophyllaceae
Schinus molle	Scmo	Peruvian pepper tree	No	tree	Anacardiaceae
Schinus terebinthifolius Raddi	Scte	Brazilian pepper tree	No	tree	Anacardiaceae
Scirpus acutus Muhl. ex Bigelow	Scac	common tule	Yes	herb	Cyperaceace
Scirpus americanus Pers.	Scam	three-square bulrush	Yes	herb	Cyperaceace
Scirpus californicus (C.A. Mey.) Steud.	Scca	California bulrush	Yes	herb	Cyperaceace
Scirpus cernuus Vahl	Scce	bulrush	Yes	herb	Cyperaceace
Scirpus maritimus L.	Scma	alkali bulrush	Yes	herb	Cyperaceace
Scirpus microcarpus	Scmi	bulrush	Yes	herb	Cyperaceace
Scirpus robustus Pursh	Scro	bulrush	Yes	herb	Cyperaceace
Senecio mikanoides/Delairea odorata	Semi	Cape (German) ivy	No	herb	Asteraceae
Senecio triangularis	Setr	arrowleaf ragwort	Yes	herb	Asteraceae
Senecio vulgaris	Sevu	common groundsel	No	herb	Asteraceae
Sequoia sempervirens	Sese	redwood	Yes	tree	Taxodiaceae
Silybum marianum	Sima	milk thistle	No	herb	Asteraceae
Sisymbrium irio	Siir	London rocket	No	herb	Brassicaceae
Sisyrinchium bellum S. Wats.	Sibe	blue-eyed grass	Yes	herb	Iridaceae
Solanum douglasii	Sodo	white-flowered nightshade	Yes	herb	Solanaceae
Solanum xantii	Soxa	nightshade	Yes	herb	Solanaceae
Sonchus asper (L.) Hill	Soas	prickly sow-thistle	No	herb	Asteraceae
Sonchus oleraceous	Sool	common sow-thistle	No	herb	Asteraceae
Spartina alterniflora Loisel.	Spal	salt-water cordgrass	No	herb	Poaceae
Spartina densiflora Brongn.	Spde	dense-flowered cordgrass	No	herb	Poaceae
Spartina foliosa Trin.	Spfo	California cordgrass	Yes	herb	Poaceae
Spartina HYBRID	Sphy	cordgrass	No	herb	Poaceae
Spartina patens (Ait.) Muhl.	Sppa	salt-meadow cordgrass	No	herb	Poaceae
Spergularia bocconii	Spbo	Boccone's sandspurrey	No	herb	Carophyllaceae
Spergularia macrotheca	**Spmc**	sand-spurrey	Yes	herb	Carophyllaceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Spergularia marina	Spma	saltmarsh sand-spurrey	Yes	herb	Carophyllaceae
Spergularia rubra	Spru	red sand-spurrey	No	herb	Carophyllaceae
Spirodela punctata (G.F.W. Mey.)	Sppu	dotted duckmeat	Yes	herb	Lemnaceae
Sporobolus airoides	Spai	alkali sacaton	Yes	herb	Poaceae
Stachys ajugoides Benth.	Staj	Ajuga hedgenettle	Yes	herb	Lamiaceae
Stachys albens Gray	Stal	rigid hedgenettle/marsh hedgenettle	Yes	herb	Lamiaceae
Stellaria media	Stme	common chickweed	No	herb	Caryophyllaceae
Suaeda calceoliformis	**Sucl**	horned sea-blite	Yes	herb	Chenopodiaceae
Suaeda californica	Suca	sea-blite	Yes	shrub	Chenopodiaceae
Suaeda esteroa	Sues	estuary sea-blite	Yes	herb	Chenopodiaceae
Suaeda moquinii	Sumo	bush seepweed	Yes	shrub	Chenopodiaceae
Suaeda taxifolia	Suta	woolly sea-blite	Yes	shrub	Chenopodiaceae
Taeniatherum caput-medusae	Taca	medusa-head	No	herb	Poaceae
Tamarix parviflora	Tapa	tamarisk	No	shrub/tree	Tamaricaceae
Tamarix ramosissima Ledeb.	Tara	saltceder	No	shrub/tree	Tamaricaceae
Taraxacum officinale	Taof	dandelion	No	herb	Asteraceae
Tetragonia tetragonioides	Tete	New Zealand spinach	No	herb	Aizoaceae
Tolmiea menziesii	Tome	pig-a-back plant	Yes	herb	Saxifragaceae
Toxicodendron diversilobum	Todi	poison oak	Yes	shrub	Anacardiaceae
Tribulus terrestris	Trte	puncturevine	No	herb	Zygophyllaceae
Trifolium repens L.	Trre	white clover	No	herb	Fabaceae
Triglochin concinna	Trco	arrow-grass	Yes	herb	Juncaginaceae
Triglochin maritima	Trma	seaside arrow-grass	Yes	herb	Juncaginaceae
Tropaeolum majus	**Trmj**	garden nasturtium	No	herb	Tropaeolaceae
Tsuga heterophylla	Tshe	hemlock	Yes	tree	Pinaceae
Typha angustifolia	Tyan	narrow-leaved cattail	Yes	herb	Typhaceae
Typha domingensis	Tydo	southern cattail	Yes	herb	Typhaceae
Typha latifolia	Tyla	common cattail/broad-leaved cattail	Yes	herb	Typhaceae
Umbellularia californica	Umca	California bay/California laurel	Yes	tree	Lauraceae

Appendix 2-A: List of California Plant Species (alphabetized by plant species)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Urtica dioica L.	Urdi	stinging nettle	Yes	herb	Urticaceae
Veratrum californicum Dur.	**Vecl**	California corn lily	Yes	herb	Liliaceae
Verbascum thapsus	Veth	woolly mullein	No	herb	Scrophulariaceae
Verbena scabra Vahl	Vesc	sandpaper vervain	Yes	herb	Verbenaceae
Veronica americana Schwein	Veam	American speedwell/ brooklime	Yes	herb	Scrophulariaceae
Veronica anagallis-aquatica L.	Vean	water speedwell	No	herb	Scrophulariaceae
Veronica catenata.	Veca	chain speedwell	No	herb	Scrophulariaceae
Veronica peregrina L.	Vepe	hairy purslane/speedwell	Yes	herb	Scrophulariaceae
Vinca major	Vima	greater periwinkle	No	herb	Apocynaceae
Viola adunca	Viad	hookedspur violet	Yes	herb	Violaceae
Vitis californica	Vica	California wild grape	Yes	vine ("shrub")	Vitaceae
Vulpia myuros (L.) K.C. Gmel.	Vumy	foxtail fescue	No	herb	Poaceae
Washingtonia filifera	Wafi	California fan palm	Yes	tree	Arecaceae
Wolffia columbiana Karst.	Woco	watermeal	Yes	herb	Lemnaceae
Woodwardia fimbriata	Wofi	giant chain fern	Yes	herb	Blechnaceae
Xanthium spinosum L.	Xasp	spiny cocklebur	Yes	herb	Asteraceae
Xanthium strumarium L.	Xast	cocklebur	Yes	herb	Asteraceae
Yucca whipplei	Yuwh	chaparral yucca	Yes	shrub	Liliaceae
Zannichellia palustris L.	Zapa	horned-pondweed	Yes	herb	Zannichelliaceae
Zostera marina L.	Zoma	common eelgrass	Yes	herb	Zosteraceae
Zostera pacifica L.	Zopa	seawrack/eelgrass	Yes	herb	Zosteraceae

[1]In general, code names consist of the first two letters of the genus and the first two letters of the species. For species in which this formula produces duplicate code names within the list, the final letter in the code is changed for one of the two species. In all such cases, the resulting code names of both species are presented in **bold** as a "flag" to warn the observer about the potential for an error of duplication (CalEPPC, 1999).

APPENDIX 2-B:
LIST OF CALIFORNIA PLANT SPECIES (alphabetized by common name)

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Stachys ajugoides Benth.	Staj	Ajuga hedgenettle	Yes	herb	Lamiaceae
Scirpus maritimus L.	Scma	alkali bulrush	Yes	herb	Cyperaceace
Frankenia salina (Molina)	Frsa	alkali heath	Yes	herb	Frankeniaceae
Heliotropium curassavicum L.	Hecu	alkali heliotrope	Yes	herb	Boraginaceae
Malvella leprosa (Ortega) Krapov.	Male	alkali mallow/whiteweed	Yes	herb	Malvaceae
Plagiobothrys leptocladus	Plle	alkali plagiobothrys	Yes	herb	Boraginaceae
Sporobolus airoides	Spai	alkali sacaton	Yes	herb	Poaceae
Cressa truxillensis Kunth	Crtr	alkali weed	Yes	shrub	Convovulaceae
Pilularia americana	Piam	American pillwort	Yes	herb	Marsileaceae
Veronica americana Schwein	Veam	American speedwell/ brooklime	Yes	herb	Scrophulariaceae
Cortaderia jubata	Coju	Andean pampas grass	No	herb	Poaceae
Pimpinella anisum	Pian	anise	No	herb	Umbelliferae
Polypogon monspeliensis (L.) Desf.	Pomo	annual beard grass/rabbitfoot grass	No	herb	Poaceae
Eleocharis geniculata	Elge	annual spikerush	Yes	herb	Cyperaceae
Purshia tridentata	Putr	antelope bush	Yes	shrub	Rosaceae
Pluchea sericea (Nutt.) Cav.	Plse	arrow weed	Yes	shrub	Asteraceae
Triglochin concinna	Trco	arrow-grass	Yes	herb	Juncaginaceae
Senecio triangularis	Setr	arrowleaf ragwort	Yes	herb	Asteraceae
Salix lasiolepis Benth.	**Sals**	arroyo willow	Yes	shrub/tree	Salicaceae
Cynara cardunculus	Cyca	artichocke thistle	No	herb	Asteraceae
Centella asiatica	Ceas	Asiatic pennywort	No	herb	Apiaceae
Atriplex semibaccata	Atse	Australian saltbush	No	shrub	Chenopodiaceae
Cyperus squarrosus L.	Cysq	awned flatsedge/bearded flatsedge	Yes	herb	Cyperaceae
Juncus balticus	Juba	Baltic rush	Yes	herb	Juncaceae
Echinochloa crus-galli (L.) Beauv.	Eccr	banyard grass	No	herb	Poaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)

Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Hordeum brachyantherum	Hobr	barley	Yes	herb	Poaceae
Juncus textilis	Jute	basket rush	Yes	herb	Juncaceae
Bassia hyssopifolia	Bahy	bassia	No	herb	Chenopodiaceae
Camissonia chieranthifolia var. suffruticosa	Cach	beach evening primrose	Yes	shrub	Onagraceae
Ambrosia chamissonis	Amch	beach-bur	Yes	shrub	Asteraceae
Eleocharis rostellata	Elro	beaked spikerush	Yes	herb	Cyperaceae
Leymus triticoides	Letr	beardless wild-rye	Yes	herb	Poaceae
Oxalis pes-caprae	Oxpe	Bermuda buttercup	No	herb	Oxalidaceae
Cynodon dactylon	Cyda	Bermuda grass	No	herb	Poaceae
Lupinus polyphyllus	Lupo	bigleaf lupine	Yes	herb	Fabaceae
Acer macrophyllum	Acma	big-leaf maple	Yes	tree	Aceraceae
Lotus corniculatus	Loco	birdfoot trefoil	No	herb	Fabaceae
Populus balsamifera	Poba	black cottonwood	Yes	tree	Salicaceae
Sambucus melanocarpa	Saml	black elderberry	Yes	shrub	Caprifoliaceae
Robinia pseudoacacia	Rops	black locust	No	tree	Fabaceae
Brassica nigra	Brni	black mustard	No	herb	Brassicaceae
Isomeris arborea	Isar	bladderpod	Yes	shrub	Capparaceae
Dichelostemma capitatum ssp. capitatum	Dica	blue dicks	Yes	herb	Liliaceae
Sisyrinchium bellum S. Wats.	Sibe	blue-eyed grass	Yes	herb	Iridaceae
Rorippa curvipes Greene	Rocu	bluntleaf yellow-cress	Yes	herb	Brassicaceae
Spergularia bocconii	Spbo	Boccone's sandspurrey	No	herb	Carophyllaceae
Saponaria officinalis	Saof	bouncing bet	No	herb	Caryophyllaceae
Acer negundo L.	Acne	box elder	Yes	tree	Aceraceae
Pteridium aquilinum	Ptaq	bracken fern	Yes	herb	Polypodiaceae
Cotula coronopifolia L.	Coco	brass buttons	No	herb	Asteraceae
Schinus terebinthifolius Raddi	Scte	Brazilian pepper tree	No	tree	Anacardiaceae
Atriplex lentiformis ssp. lentiformis	Atle	Brewer's saltbush	Yes	shrub	Chenopodiaceae
Retama monosperma	Remo	bridal broom	No	shrub	Fabaceae
Cynosurus echinatus	Cyec	bristly dogstail grass	No	herb	Poaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Picris echioides L.	Piec	bristly ox-tongue	No	herb	Asteraceae
Baccharis sarothroides Gray	**Basr**	broom baccharis	Yes	shrub	Asteraceae
Juncus phaeocephalus	Juph	brown-headed creeping rush	Yes	herb	Juncaceae
Cirsium vulgare (Savi) Ten.	Civu	bull thistle	No	herb	Asteraceae
Scirpus cernuus Vahl	Scce	bulrush	Yes	herb	Cyperaceace
Scirpus microcarpus	Scmi	bulrush	Yes	herb	Cyperaceace
Scirpus robustus Pursh	Scro	bulrush	Yes	herb	Cyperaceace
Anthriscus caucalis	**Ancc**	bur chervil	No	herb	Apiaceae
Bidens laevis (L.) B.S.P.	Bila	bur-marigold	Yes	herb	Asteraceae
Mimulus aurantiacus	Miau	bush monkeyflower	Yes	shrub	Scrophulariaceae
Suaeda moquinii	Sumo	bush seepweed	Yes	shrub	Chenopodiaceae
Encelia californica	Enca	bush sunflower	Yes	shrub	Asteraceae
Fraxinus dipetala	Frdi	California ash	Yes	tree	Oleaceae
Umbellularia californica	Umca	California bay/California laurel	Yes	tree	Lauraceae
Quercus kelloggii	Quke	California black oak	Yes	tree	Fagaceae
Juglans californica	Juca	California black walnut	Yes	tree	Juglandaceae
Rubus ursinus	Ruur	California blackberry	Yes	herb	Rosaceae
Brickellia californica	Brca	California brickellbush	Yes	shrub	Scrophulariaceae
Aesculus californica	Aeca	California buckeye	Yes	tree	Hippocastanaceae
Eriogonum fasciculatum	Erfa	California buckwheat	Yes	shrub	Polygonaceae
Scirpus californicus (C.A. Mey.) Steud.	Scca	California bulrush	Yes	herb	Cyperaceace
Medicago polymorpha L.	Mepo	California burclover	No	herb	Fabaceae
Rhamnus californica	Rhca	California coffeeberry	Yes	shrub	Rhamnaceae
Spartina foliosa Trin.	Spfo	California cordgrass	Yes	herb	Poaceae
Veratrum californicum Dur.	**Vecl**	California corn lily	Yes	herb	Liliaceae
Gnaphalium californicum	**Gncl**	California everlasting	Yes	herb	Asteraceae
Washingtonia filifera	Wafi	California fan palm	Yes	tree	Arecaceae
Epilobium (Zauschneria) canum	Epca	california fuchsia	Yes	herb	Onagraceae
Lonicera hispidula	Lohi	California honeysuckle	Yes	shrub	Caprifoliaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Lythrum californicum Torr. & Gray	Lyca	California loosestrife	Yes	herb	Lythraceae
Adiantum jordanii	Adjo	California maidenhair	Yes	herb	Pteridaceae
Amaranthus californicus	Amca	California pigweed	Yes	herb	Amaranthaceae
Rosa californica	Roca	California rose	Yes	shrub	Rosaceae
Artemisia californica	Arca	California sagebrush	Yes	shrub	Asteraceae
Atriplex californica Moq.	Atca	California saltbush	Yes	shrub	Chenopodiaceae
Aralia californica A. Wats.	**Arcl**	California spikenard	Yes	herb	Araliaceae
Helianthus californicus DC.	**Hecl**	California sunflower	Yes	herb	Asteraceae
Osmorhiza brachypoda	Osbr	California sweetcicely	Yes	herb	Apiaceae
Vitis californica	Vica	California wild grape	Yes	vine ("shrub")	Vitaceae
Cirsium arvense	Ciar	Canada thistle	No	herb	Asteraceae
Delairea odorata/Senecio mikanoides	Deod	Cape (German) ivy	No	herb	Asteraceae
Senecio mikanoides/Delairea odorata	Semi	Cape (German) ivy	No	herb	Asteraceae
Ricinus communis L.	Rico	castor bean	No	herb	Euphorbiaceae
Apium graveolens L.	Apgr	celery	No	herb	Apiaceae
Veronica catenata.	Veca	chain speedwell	No	herb	Scrophulariaceae
Yucca whipplei	Yuwh	chaparral yucca	Yes	shrub	Liliaceae
Bromus tectorum	Brte	cheat grass	No	herb	Poaceae
Potentilla anserina	Poan	cinquefoil	Yes	herb	Rosaceae
Rumex conglomeratus Murr.	Ruco	clustered dock	No	herb	Polygonaceae
Carex praegracilis W. Boott	Capr	clustered field sedge	Yes	herb	Cyperaceae
Boykinia occidentalis	Booc	coast boykinia	Yes	herb	Saxifragaceae
Isocoma menziesii	Isme	coast goldenbush	Yes	shrub	Asteraceae
Quercus agrifolia	Quag	coast live oak	Yes	tree	Fagaceae
Plagiobothrys undulatus	Plun	coast popcorn-flower	Yes	herb	Boraginaceae
Xanthium strumarium L.	Xast	cocklebur	Yes	herb	Asteraceae
Petasites frigidus (L.) Fries	Pefr	coltsfoot	Yes	herb	Asteraceae
Aquilegia formosa	Aqfo	columbine	Yes	herb	Ranunculaceae
Blennosperma nanum	Blna	common blennosperma	Yes	herb	Asteraceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Typha latifolia	Tyla	common cattail/broad-leaved cattail	Yes	herb	Typhaceae
Stellaria media	Stme	common chickweed	No	herb	Caryophyllaceae
Zostera marina L.	Zoma	common eelgrass	Yes	herb	Zosteraceae
Senecio vulgaris	Sevu	common groundsel	No	herb	Asteraceae
Equisetum arvense	Eqar	common horsetail	Yes	herb	Equisetaceae
Polygonum arenastrum Jord. ex Boreau	Poar	common knotweed	No	herb	Polygonaceae
Athyrium filix-femina	Atfi	common ladyfern	Yes	herb	Dryopteridaceae
Mimulus guttatus DC.	Migu	common monkeyflower	Yes	herb	Scrophulariaceae
Salicornia virginica L.	Savi	common pickleweed	Yes	herb	Chenopodiaceae
Plantago major	Plma	common plantain	No	herb	Plantaginaceae
Portulaca oleracea	Pool	common purslane	No	herb	Portulacaceae
Ambrosia artemisiifolia	**Amat**	common ragweed	No	herb	Asteraceae
Phragmites australis (Cav.) Trin. ex Steud.	Phau	common reed	Yes	herb	Poaceae
Juncus effusus	Juef	common rush	Yes	herb	Juncaceae
Sonchus oleraceous	Sool	common sow-thistle	No	herb	Asteraceae
Eleocharis macrostachya	Elma	common spikerush	Yes	herb	Cyperaceae
Helianthus annuus L.	Hean	common sunflower	Yes	herb	Asteraceae
Scirpus acutus Muhl. ex Bigelow	Scac	common tule	Yes	herb	Cyperaceace
Spartina HYBRID	Sphy	cordgrass	No	herb	Poaceae
Heracleum lanatum	Hela	cow parsnip	Yes	herb	Apiaceae
Baccharis pilularis	Bapi	coyote brush	Yes	shrub	Asteraceae
Cornus sericea	Cosr	creek dogwood	Yes	shrub	Cornaceae
Agrostis stolonifera L.	Agst	creeping bentgrass	No	herb	Poaceae
Larrea tridentata	Latr	creosote bush	Yes	shrub	Zygophyllaceae
Mesembryanthemum crystallinum L.	Mecr	crystalline iceplant	No	herb	Aizoaceae
Rumex crispus L.	Rucr	curly dock	No	herb	Polygonaceae
Berula erecta (Huds.) Coville	Beer	cutleaf water-parsnip	Yes	herb	Apiaceae
Taraxacum officinale	Taof	dandelion	No	herb	Asteraceae
Muhlenbergia rigens (Benth.) A.S. Hitchc.	Muri	deergrass	Yes	herb	Poaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Lotus scoparius	Losc	deerweed	Yes	shrub	Fabaceae
Spartina densiflora Brongn.	Spde	dense-flowered cordgrass	No	herb	Poaceae
Ruppia maritima L.	Ruma	ditch-grass	Yes	herb	Potamogetonaceae
Spirodela punctata (G.F.W. Mey.)	Sppu	dotted duckmeat	Yes	herb	Lemnaceae
Pseudotsuga menziesii	Psme	douglas fir	Yes	tree	Pinaceae
Datisca glomerata (K. Presl) Baill.	Dagl	Durango root	Yes	herb	Datiscaceae
Salix melanopsis	**Samp**	dusky willow	Yes	shrub	Salicaceae
Lupinus lepidus	Lule	dwarf lupine	Yes	herb	Fabaceae
Lepidium latipes Hook.	Lela	dwarf pepper grass	Yes	herb	Brassicaceae
Plantago erecta	Pler	dwarf plantain	Yes	herb	Plantaginaceae
Eclipta prostrata	Ecpr	eclipta	Yes	herb	Asteraceae
Baccharis emoryi Gray	Baem	Emory baccharis	Yes	shrub	Asteraceae
Hedera helix	Hehe	English ivy	No	vine ("shrub")	Araliaceae
Plantago lanceolata L.	Plla	English plantain	No	herb	Plantaginaceae
Suaeda esteroa	Sues	estuary sea-blite	Yes	herb	Chenopodiaceae
Puccinellia distans (Jacq.) Parl.	Pudi	European alkali grass	No	herb	Poaceae
Ammophila arenaria	Amar	European beach grass	No	herb	Poaceae
Hemizonia paniculata Gray	Hepa	fascicled tarweed	Yes	herb	Asteraceae
Potamogeton pectinatus	Pope	fennel-leaf pondweed	Yes	herb	Potamogetonaceae
Adiantum aleuticum	Adal	Five fingered fern	Yes	herb	Pteridaceae
Hydrocotyle ranunculoides L. f.	Hyra	floating marsh pennywort	Yes	herb	Apiaceae
Ludwigia peploides (Kunth) Raven	Lupe	floating water primrose, false loosestrife	Yes	herb	Onagraceae
Myosotis symphytifolia	Mysy	forget-me-not	No	herb	Boraginaceae
Bromus madritensis	Brma	foxtail chess	No	herb	Poaceae
Vulpia myuros (L.) K.C. Gmel.	Vumy	foxtail fescue	No	herb	Poaceae
Gnaphalium canescens ssp. beneolens	Gnca	fragrant everlasting	Yes	herb	Asteraceae
Populus fremontii S. Wats.	Pofr	Fremont cottonwood	Yes	tree	Salicaceae
Genista monspessulana	Gemo	French broom	No	shrub	Fabaceae
Ribes speciosum	Risp	fucshia-flowered gooseberry	Yes	shrub	Grossulariaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Tropaeolum majus	**Trmj**	garden nasturtium	No	herb	Tropaeolaceae
Chrysanthemum coronarium	Chco	garland chrysanthemum	No	herb	Asteraceae
Euphorbia terracina	Eute	Geraldton carnation weed	No	herb	Euphorbiaceae
Woodwardia fimbriata	Wofi	giant chain fern	Yes	herb	Blechnaceae
Equisetum telmateia Ehrh.	Eqte	giant horsetail	Yes	herb	Equisetaceae
Arundo donax L.	Ardo	giant reed	No	shrub	Poaceae
Leymus condensatus	Leco	giant wild-rye	Yes	herb	Poaceae
Rumex maritimus L.	**Rumr**	golden dock	Yes	herb	Polygonaceae
Eriophyllym confertifolium	Erco	golden yarrow	Yes	shrub	Asteraceae
Lasthenia glabrata Lindl.	Lagl	goldfields	Yes	herb	Asteraceae
Salix gooddingii Ball	Sago	Goodding's black willow	Yes	tree	Salicaceae
Galium aparine	Gaap	goose grass	Yes	herb	Rubiaceae
Artemisia tridentata	Artr	Great Basin sage	Yes	shrub	Asteraceae
Vinca major	Vima	greater periwinkle	No	herb	Apocynaceae
Eleocharis acicularis	Elac	hairgrass	Yes	herb	Cyperaceae
Grindelia hirsutula var. hirsutula	Grhi	hairy gumweed	Yes	herb	Asteraceae
Marsilea vestita	Mave	hairy pepperwort	Yes	herb	Marsileaceae
Veronica peregrina L.	Vepe	hairy purslane/speedwell	Yes	herb	Scrophulariaceae
Epilobium ciliatum Raf.	Epci	hairy willow-herb	Yes	herb	Onagraceae
Phalaris aquatica	Phaq	Harding grass	No	herb	Poaceae
Avena sativa	Avsa	hay	No	herb	Poaceae
Calystegia sepium (L.) R. Br.	Case	hedge bindweed	Yes	herb	Convovulaceae
Tsuga heterophylla	Tshe	hemlock	Yes	tree	Pinaceae
Rubus discolor	Rudi	Himalaya blackberry	No	shrub	Rosaceae
Hesperevax caulescens	Heca	hogwallow starfish	Yes	herb	Asteraceae
Prunus ilicifolia	Pril	holly-leaved cherry	Yes	tree	Rosaceae
Najas marina	Nama	holly-leaved water-nymph	Yes	herb	Hydrocharitaceae
Viola adunca	Viad	hookedspur violet	Yes	herb	Violaceae
Marrubium vulgare L.	Mavu	horehound	No	herb	Lamiaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Suaeda calceoliformis	**Sucl**	horned sea-blite	Yes	herb	Chenopodiaceae
Zannichellia palustris L.	Zapa	horned-pondweed	Yes	herb	Zannichelliaceae
Conyza bonariensis	Cobo	horseweed	No	herb	Asteraceae
Conyza canadensis (L.) Cronq.	Coca	horseweed	Yes	herb	Asteraceae
Isoetes howellii Engelm.	Isho	Howell's quillwort	Yes	herb	Isoetaceae
Carpobrotus edulis	Caed	iceplant	No	herb	Aizoaceae
Calocedrus decurrens	Cade	incense cedar	Yes	tree	Cupressaceae
Apocynum cannabinum	Apca	indian hemp	Yes	shrub	Apocynaceae
Allenrolfea occidentalis	Aloc	iodine bush	Yes	shrub	Chenopodiaceae
Lolium multiflorum	Lomu	Italian ryegrass	No	herb	Poaceae
Carduus pycnocephalus	Capy	Italian thistle	No	herb	Asteraceae
Pinus jeffryi	Pije	Jeffrey pine	Yes	tree	Pinaceae
Poa pratensis	Popr	Kentucky bluegrass	No	herb	Poaceae
Pennisetum clandestinum	Pecl	kikuyu grass	No	herb	Poaceae
Paspalum distichum	Padi	knot grass	Yes	herb	Poaceae
Kyllinga brevifolia	Kybr	kyllinga	No	herb	Cyperaceae
Carex lenticularis	Cale	lakeshore sedge	Yes	herb	Cyperaceae
Chenopodium album	Chal	lamb's quarters	No	herb	Chenopodiaceae
Malosma laurina	Mala	laurel sumac	Yes	shrub	Anacardiaceae
Potamogeton foliosus Raf.	Pofo	leafy pondweed	Yes	herb	Potamogetonaceae
Lemna minuta	**Lemu**	least duckweed	Yes	herb	Lemnaceae
Quercus durata	Qudu	leather oak	Yes	tree	Fagaceae
Phalaris lemmonii	Phle	Lemmon's canary grass	Yes	herb	Poaceae
Salix lemmonii	Sale	Lemmon's willow	Yes	shrub	Salicaceae
Rhus intergrifolia	Rhin	lemonadeberry	Yes	shrub	Anacardiaceae
Lemna minor L.	Lemi	lesser duckweed	Yes	herb	Lemnaceae
Sisymbrium irio	Siir	London rocket	No	herb	Brassicaceae
Erodium botrys	Erbo	long-beaked filaree	No	herb	Geraniaceae
Juncus longistylus	Julo	long-beaked rush	Yes	herb	Juncaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Potamogeton nodosus Poir.	Pono	long-leaved pondweed	Yes	herb	Potamogetonaceae
Lythrum hyssopifolium	Lyhy	loosestrife	No	herb	Lythraceae
Gnaphalium palustre Nutt.	Gnpa	lowland cudweed	Yes	herb	Asteraceae
Rubus villosus	Ruvi	low-running blackberry	No	shrub	Rosaceae
Carex lyngbyei	Caly	Lyngbyei's sedge	No	herb	Cyperaceae
Malacothrix californica	Maca	malacothrix	Yes	herb	Asteraceae
Baccharis douglasii	Bado	marsh baccharis/Douglas' false-willow	Yes	shrub	Asteraceae
Grindelia stricta	Grst	marsh gum-plant	Yes	shrub	Asteraceae
Jaumea carnosa (Less.) Gray	Jaca	marsh jaumea/salty Susan	Yes	herb	Asteraceae
Caltha palustris	Capa	marsh marigold	No	herb	Ranunculaceae
Rorippa palustris (L.) Bess.	Ropa	marsh yellow-cress	Yes	herb	Brassicaceae
Lilaeopsis masonii	Lima	Mason's lilaeopsis	Yes	herb	Apiaceae
Rubus rosaefolius	Ruro	Mauritius raspberry	No	shrub	Rosaceae
Hordeum secalinum	Hose	meadow barley	No	herb	Poaceae
Hordeum geniculatum/H. marinum gussonianum	Hoge	Mediterrenean barley	No	herb	Poaceae
Taeniatherum caput-medusae	Taca	medusa-head	No	herb	Poaceae
Sambucus mexicana K. Presl ex DC.	Same	Mexican elderberry/blue elderberry	Yes	shrub	Caprifoliaceae
Juncus mexicanus	Jume	Mexican rush	Yes	herb	Juncaceae
Leptochloa uninervia (J. Presl)	Leun	Mexican sprangletop	Yes	herb	Poaceae
Chenopodium ambrosioides	Cham	Mexican tea	No	herb	Chenopodiaceae
Cardamine californica	Caca	milk maids, tooth wort	Yes	herb	Brassicaceae
Silybum marianum	Sima	milk thistle	No	herb	Asteraceae
Calystegia macrostegia	Cama	morning-glory	Yes	herb	Convovulaceae
Alnus incana	Alin	mountain alder	Yes	shrub	Betulaceae
Cercocarpus betuloides	Cebe	mountain mahogany	Yes	shrub	Rosaceae
Myosurus minimus L.	Mymi	mouse tail	Yes	herb	Ranunculaceae
Myoporum laetum	Myla	mousehole tree	No	tree	Myoporaceae
Artemisia douglasiana Bess.	**Ardg**	mugwort	Yes	shrub	Asteraceae
Baccharis salicifolia	Basa	mule fat	Yes	shrub	Asteraceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Mimulus moschatus	Mimo	musk monkeyflower	Yes	herb	Scrophulariaceae
Plantago subnuda	Plsu	naked plantain	Yes	herb	Plantaginaceae
Typha angustifolia	Tyan	narrow-leaved cattail	Yes	herb	Typhaceae
Tetragonia tetragonioides	Tete	New Zealand spinach	No	herb	Aizoaceae
Solanum xantii	Soxa	nightshade	Yes	herb	Solanaceae
Cyperus esculentus	Cyes	nutsedge	Yes	herb	Cyperaceae
Cyperus involucratus	Cyin	nutsedge	No	herb	Cyperaceae
Isoetes nuttallii A. Braun ex Engelm.	Isnu	Nuttall's quillwort	Yes	herb	Isoetaceae
Holodiscus discolor	Hodi	oceanspray	Yes	shrub	Rosaceae
Olea europaea	Oleu	olive	No	tree	Oleaceae
Salsola soda L.	Saso	oppositeleaf Russian thistle	No	herb	Chenopodiaceae
Fraxinus latifolia	Frla	Oregon ash	Yes	tree	Oleaceae
Quercus garryana	Quga	Oregon oak	Yes	tree	Fagaceae
Cortaderia selloana	Cose	pampas grass	No	herb	Poaceae
Salicornia subterminalis	Sasu	Parish's glasswort	Yes	herb	Chenopodiaceae
Eleocharis parishii	Elpa	Parish's spikerush	Yes	herb	Cyperaceae
Myriophyllum aquaticum	Myaq	parrot's feather	No	herb	Haloragaceae
Mentha pulegium	Mepu	pennyroyal	No	herb	Lamiaceae
Lepidium nitidum	Leni	peppergrass	Yes	herb	Brassicaceae
Mentha piperita	Mepi	peppermint	No	herb	Lamiaceae
Lepidium latifolium L.	**Lelf**	perennial pepperweed	No	herb	Brassicaceae
Lolium perenne L.	Lope	perennial ryegrass	No	herb	Poaceae
Schinus molle	Scmo	Peruvian pepper tree	No	tree	Anacardiaceae
Euphorbia peplus	Eupe	petty spurge	No	herb	Euphorbiaceae
Phacelia distans	Phdi	phacelia	Yes	herb	Hydrophyllaceae
Phoenix canariensis	Phca	Phoenix date palm	No	tree	Arecaceae
Salicornia bigelovii Torr.	Sabi	pickleweed	Yes	herb	Chenopodiaceae
Tolmiea menziesii	Tome	pig-a-back plant	Yes	herb	Saxifragaceae
Matricaria suaveolens	Masu	pineapple weed	No	herb	Asteraceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Conium maculatum L.	Coma	poison hemlock	No	herb	Apiaceae
Toxicodendron diversilobum	Todi	poison oak	Yes	shrub	Anacardiaceae
Pinus ponderosa	Pipo	ponderosa pine	Yes	tree	Pinaceae
Lactuca serriola L.	Lase	prickly lettuce	No	herb	Asteraceae
Sonchus asper (L.) Hill	Soas	prickly sow-thistle	No	herb	Asteraceae
Tribulus terrestris	Trte	puncturevine	No	herb	Zygophyllaceae
Cyperus rotundus L.	Cyro	purple nutsedge	No	herb	Cyperaceae
Chrysothamnus nauseosus	Chna	rabbit brush	Yes	shrub	Asteraceae
Alnus rubra	Alru	red alder	Yes	tree	Betulaceae
Spergularia rubra	Spru	red sand-spurrey	No	herb	Carophyllaceae
Salix laevigata Bebb	Sala	red willow	Yes	tree	Salicaceae
Erodium cicutarium	Erci	red-stem filaree	No	herb	Geraniaceae
Agrostis gigantea	Aggi	redtop	No	herb	Poaceae
Sequoia sempervirens	Sese	redwood	Yes	tree	Taxodiaceae
Phalaris arundinacea	Phar	reed canary grass	Yes	herb	Poaceae
Stachys albens Gray	Stal	rigid hedgenettle/marsh hedgenettle	Yes	herb	Lamiaceae
Bromus diandrus	Brdi	ripgut brome	No	herb	Poaceae
Casuarina equisetifolia	Caeq	river she-oak	No	tree	Casuarinaceae
Eleocharis radicans	Elra	rooted spikerush	Yes	herb	Cyperaceae
Juncus occidentalis	Juoc	rush	Yes	herb	Juncaceae
Salsola tragus	Satr	Russian thistle/tumbleweed	No	herb	Chenopodiaceae
Cordylanthus maritimus ssp. maritimus	**Comr**	salt marsh bird's beak	Yes	herb	Scrophulariaceae
Pluchea odorata	Plod	salt marsh fleabane	Yes	herb	Asteraceae
Juncus lesueurii	Jule	salt rush	Yes	herb	Juncaceae
Atriplex triangularis	Attr	saltbush	Yes	herb	Chenopodiaceae
Tamarix ramosissima Ledeb.	Tara	saltceder	No	shrub/tree	Tamaricaceae
Distichlis spicata (L.) Greene	Disp	saltgrass	Yes	herb	Poaceae
Spergularia marina	Spma	saltmarsh sand-spurrey	Yes	herb	Carophyllaceae
Spartina patens (Ait.) Muhl.	Sppa	salt-meadow cordgrass	No	herb	Poaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Spartina alterniflora Loisel.	Spal	salt-water cordgrass	No	herb	Poaceae
Batis maritima L.	Bama	saltwort, beachwort	Yes	shrub	Bataceae
Carex spissa Bailey	Casp	San Diego sedge	Yes	herb	Cyperaceae
Eryngium aristulatum var. parishii	Erar	San Diego-button celery	Yes	herb	Apiaceae
Eleocharis montevidensis	Elmo	sand spikerush	Yes	herb	Cyperaceae
Salix exigua Nutt.	Saex	sandbar willow/narrow-leaved willow	Yes	shrub	Salicaceae
Verbena scabra Vahl	Vesc	sandpaper vervain	Yes	herb	Verbenaceae
Spergularia macrotheca	**Spmc**	sand-spurrey	Yes	herb	Carophyllaceae
Carex barbarae	Caba	Santa Barbara sedge	Yes	herb	Cyperaceae
Lepidospartum squamatum	Lesq	scalebroom	Yes	shrub	Asteraceae
Mimulus cardinalis Dougl. ex Benth.	Mica	scarlet monkeyflower	Yes	herb	Scrophulariaceae
Anagallis arvensis L.	Anar	scarlet pimpernel	No	herb	Primulaceae
Carex schottii	Casc	Schott's sedge	Yes	herb	Cyperaceae
Salix scouleriana	Sasc	Scouler willow	Yes	shrub	Salicaceae
Phyllospadix scouleri Hook.	Phsc	Scouler's surfgrass	Yes	herb	Zosteraceae
Quercus berberidifolia	Qube	scrub oak	Yes	shrub	Fagaceae
Limonium californicum	Lica	sea lavender/marsh rosemary	Yes	herb	Plumbaginaceae
Suaeda californica	Suca	sea-blite	Yes	shrub	Chenopodiaceae
Glaux maritima	Glma	sea-milkwort	Yes	herb	Primulaceae
Triglochin maritima	Trma	seaside arrow-grass	Yes	herb	Juncaginaceae
Zostera pacifica L.	Zopa	seawrack/eelgrass	Yes	herb	Zosteraceae
Carex Whitneyi	Cawh	sedge	Yes	herb	Cyperaceae
Crypsis vaginiflora (Forsk.) Opiz	Crva	sharp-leaved Timothy	No	herb	Poaceae
Salix lucida Muhl.	Salu	shining willow	Yes	shrub/tree	Salicaceae
Alopecurus aequalis	Alae	shortawn foxtail	Yes	herb	Poaceae
Elatine brachysperma Gray	Elbr	shortseed waterwort	Yes	herb	Elatinaceae
Parapholis incurva	Pain	sickle grass	No	herb	Poaceae
Juncus nevadensis	June	Sierra rush	Yes	herb	Juncaceae
Lupinus chamissonis	Luch	silver dune lupine	Yes	shrub	Fabaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)

Plant Species	Code[1]	Common Name	Native	Growth Habit	Family
Lotus argophyllus	Loar	silver lotus	Yes	herb	Fabaceae
Artemisia ludoviciana	Arlu	silver wormwood	Yes	shrub	Asteraceae
Salix sitchensis	Sasi	Sitka willow	Yes	shrub/tree	Salicaceae
Aster subulatus Michx.	Assu	slender aster	Yes	herb	Asteraceae
Salicornia europea (S. rubra)	Saeu	slender glasswort	Yes	herb	Chenopodiaceae
Plantago elongata Pursh	Plel	slender plantain	Yes	herb	Plantaginaceae
Avena barbata	Avba	slender wild oat	No	herb	Poaceae
Mesembryanthemum nodiflorum	Meno	slender-leaved iceplant	No	herb	Aizoaceae
Orizopsis mileaceum	Ormi	smilo grass	No	herb	Poaceae
Piptatherum miliaceum	Pimi	smilo grass	No	herb	Poaceae
Equisetum laevigatum	Eqla	smooth scouring rush	Yes	herb	Equisetaceae
Epilobium pygmaeum (Speg.)	Eppy	smooth willow-herb	Yes	herb	Onagraceae
Cordylanthus mollis ssp. mollis	Como	soft bird's beak	Yes	herb	Scrophulariaceae
Bromus mollis	Brmo	soft brome	No	herb	Poaceae
Melilotus indica	Mein	sourclover	No	herb	Fabaceae
Typha domingensis	Tydo	southern cattail	Yes	herb	Typhaceae
Hemizonia parryi var. australis	**Hepr**	southern tarplant	Yes	herb	Asteraceae
Andropogon glomeratus (Walt.) B.S.P.	Angl	southwestern bushy bluestem	Yes	herb	Poaceae
Juncus acutus	Juac	southwestern spiny rush/sharp rush	Yes	herb	Juncaceae
Pulicaria paludosa Link	Pupa	Spanish sunflower	No	herb	Asteraceae
Mentha spicata L.	Mesp	spearmint	No	herb	Lamiaceae
Xanthium spinosum L.	Xasp	spiny cocklebur	Yes	herb	Asteraceae
Ribes divaricatum	Ridi	spreading gooseberry	Yes	shrub	Grossulariaceae
Elymus elymoides	Elel	squirreltail	Yes	herb	Poaceae
Ribes visicosissimum	Rivi	sticky currant	Yes	shrub	Grossulariaceae
Ageratina adenophora	Agad	sticky eupatorium	No	herb	Asteraceae
Urtica dioica L.	Urdi	stinging nettle	Yes	herb	Urticaceae
Plagiobothrys stipitatus	Plst	stipitate popcorn flower	Yes	herb	Boraginaceae
Rhus ovata	Rhov	sugar bush	Yes	shrub	Anacardiaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Hirschfeldia incana	Hiin	summer mustard	No	herb	Brassicaceae
Crypsis schoenoides	Crsc	swamp pickle-grass	No	herb	Poaceae
Lobularia maritima	Loma	sweet alyssum	No	herb	Brassicaceae
Foeniculum vulgare P. Mill.	Fovu	sweet fennel	No	herb	Apiaceae
Tamarix parviflora	Tapa	tamarisk	No	shrub/tree	Tamaricaceae
Lithocarpus densiflorus	Lide	Tanbark oak	Yes	tree	Fagaceae
Eucalyptus globulus	Eugl	Tasmanian blue gum	No	tree	Mytaceae
Heterotheca grandiflora	Hegr	telegraph weed	No	herb	Asteraceae
Bergia texana (Hook.) Seub. ex Walp.	Bete	Texas bergia	Yes	herb	Elatinaceae
Rubus parviflorus	Rupa	thimbleberry	Yes	shrub	Rosaceae
Scirpus americanus Pers.	Scam	three-square bulrush	Yes	herb	Cyperaceace
Juncus bufonius L.	Jubu	toadrush	Yes	herb	Juncaceae
Ammannia coccinea Rottb.	Amco	tooth-cup	Yes	herb	Lythraceae
Downingia cuspidata	Docu	toothed calicoflower	Yes	herb	Campanulaceae
Malacothrix torreyi	Mato	Torrey's desertdandelion	Yes	herb	Asteraceae
Phyllospadix torreyi S. Wats.	Phto	Torrey's surfgrass	Yes	herb	Zosteraceae
Heteromeles arbutifolia	Hear	toyon	Yes	shrub	Rosaceae
Ailanthus altissima (P. Mill.) Swingle	Aial	tree of heaven	No	tree	Simaroubaceae
Nicotiana glauca Graham	Nigl	tree tobacco	No	shrub	Solanaceae
Deschampsia cespitosa	Dece	tufted hairgrass	Yes	herb	Poaceae
Lathryus jepsonii var. jepsonii	Laje	tule pea	Yes	herb	Fabaceae
Amaranthus albus	Amal	tumbleweed	No	herb	Amaranthaceae
Lonicera involucrata	Loin	twinberry honeysuckle	Yes	vine ("shrub")	Caprifoliaceae
Cyperus eragrostis Lam.	Cyer	umbrella sedge	Yes	herb	Cyperaceae
Salicornia utahensis	Saut	Utah pickleweed	Yes	herb	Chenopodiaceae
Quercus lobata	Qulo	valley oak	Yes	tree	Fagaceae
Ehrharta erecta	Eher	veldt grass	No	herb	Poaceae
Fraxinus velutina Torr.	Frve	velvet ash	Yes	tree	Oleaceae
Holcus lanatus	Hola	velvet grass	No	herb	Poaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Hordeum intercedens Nevski	Hoin	vernal barley	Yes	herb	Poaceae
Acer circinatum	Acci	vine maple	Yes	shrub	Aceraceae
Clematis ligusticifolia	Clli	virgin's bower	Yes	shrub	Ranunculaceae
Agrostis viridis	Agvi	water bentgrass	No	herb	Poaceae
Ranunculus aquatilis L.	Raaq	water buttercup	Yes	herb	Ranunculaceae
Rorippa nasturtium-aquaticum	Rona	water cress	Yes	herb	Brassicaceae
Alisma plantago-aquatica	Alpl	water plantain	Yes	herb	Alismataceae
Crassula aquatica (L.) Schoenl.	Craq	water pygmyweed	Yes	herb	Crassulaceae
Polygonum amphibium L.	Poam	water smartweed	Yes	herb	Polygonaceae
Polygonum punctatum	Popu	water smartweed	Yes	herb	Polygonaceae
Veronica anagallis-aquatica L.	Vean	water speedwell	No	herb	Scrophulariaceae
Callitriche heterophylla Pursh	Cahe	water starwort	Yes	herb	Callitrichaceae
Wolffia columbiana Karst.	Woco	watermeal	Yes	herb	Lemnaceae
Hydrocotyle umbellata L.	Hyum	water-pennywort	Yes	herb	Apiaceae
Hydrilla verticillata (L. f.) Royle	Hyve	waterthyme	No	herb	Hydrocharitaceae
Atriplex wattsonii	Atwa	Watson's saltbush	Yes	shrub	Chenopodiaceae
Salix babylonica	Saba	weeping willow	No	tree	Chenopodiaceae
Rhododendron occidentalis	Rhoc	western azalea	Yes	shrub	Ericaceae
Lilaeopsis occidentalis	Lioc	western grasswort	Yes	herb	Apiaceae
Hesperocnide tenella	Hete	western nettle	Yes	herb	Urticaceae
Ambrosia psilostachya DC.	Amps	western ragweed	Yes	herb	Asteraceae
Platanus racemosa	Plra	western sycamore	Yes	tree	Platanaceae
Cicuta douglasii	Cido	western waterhemlock	Yes	herb	Apiaceae
Emmenanthe penduliflora	Empe	whispering bells	Yes	herb	Hydrophyllaceae
Alnus rhombifolia	Alrh	white alder	Yes	tree	Betulaceae
Trifolium repens L.	Tre	white clover	No	herb	Fabaceae
Abies concolor	Abco	white fir	Yes	tree	Pinaceae
Salvia apiana	Saap	white sage	Yes	shrub	Lamiaceae
Melilotus alba	Meal	white sweetclover	No	herb	Fabaceae

Appendix 2-B: List of California Plant Species (alphabetized by common name)					
Plant Species	**Code[1]**	**Common Name**	**Native**	**Growth Habit**	**Family**
Solanum douglasii	Sodo	white-flowered nightshade	Yes	herb	Solanaceae
Hydrocotyle verticillata Thunb.	**Hyvr**	whorled marsh pennywort	Yes	herb	Apiaceae
Beta vulgaris	Bevu	wild beet	No	herb	Chenopodiaceae
Avena fatua	Avfa	wild oat	No	herb	Poaceae
Raphanus sativus L.	Rasa	wild radish	No	herb	Brassicaceae
Polygonum lapathifolium L.	Pola	willow weed	Yes	herb	Polygonaceae
Monanthochloe littoralis	Moli	wiregrass/shoregrass	Yes	herb	Poaceae
Cuscuta salina	Cusa	witch's hair/dodder	Yes	herb	Cuscutaceae
Dryopteris arguta	Drar	wood fern	Yes	herb	Dryopteridaceae
Rosa gymnocarpa	Rogy	wood rose	Yes	shrub	Rosaceae
Rosa woodsii	Rowo	Wood's rose	Yes	shrub	Rosaceae
Verbascum thapsus	Veth	woolly mullein	No	herb	Scrophulariaceae
Suaeda taxifolia	Suta	woolly sea-blite	Yes	shrub	Chenopodiaceae
Psilocarphus brevissimus Nutt.	Psbr	wooly marbles	Yes	herb	Asteraceae
Nemacaulis denudata var. denudata	Nede	wooly-heads	Yes	herb	Polygonaceae
Juncus rugulosus Engelm.	Juru	wrinkled rush	Yes	herb	Juncaceae
Lupinus arboreus	Luar	yellow bush lupine	Yes	shrub	Fabaceae
Centaurea solstitialis	Ceso	yellow starthistle	No	herb	Asteraceae
Iris pseudacorus	Irps	yellow water iris/yellow flag	No	herb	Iridaceae
Salix lutea Nutt.	**Salt**	yellow willow	Yes	shrub/tree	Salicaceae
Anemopsis californica (Nutt.)	Anca	yerba mansa	Yes	herb	Saururaceae

[1]In general, code names consist of the first two letters of the genus and the first two letters of the species. For species in which this formula produces duplicate code names within the list, the final letter in the code is changed for one of the two species. In all such cases, the resulting code names of both species are presented in **bold** as a "flag" to warn the observer about the potential for an error of duplication (CalEPPC, 1999).

APPENDIX 3: EXPECTED OR POSSIBLE DOMINANT VERNAL POOL PLANT SPECIES

Plant Species	Native/Non-native
Agrostis hendersonii	native
Alopecurus saccatus (A. howellii)	native
Bergia texana	native
Blennosperma nanum	native
Briza minor	native
Epilobium cleistogamum (Boisduvalia cleistogama)	native
Castilleja campestris (Orthocarpus campestris)	native
Dichelostemma capitatum ssp. capitatum (Brodiaea lacuna-vernalis)	native
Callitriche marginata	native
Centunculus minimus	native
Cicendia quadrangularis	native
Cuscuta howelliana	native
Deschampsia danthonioides	native
Downingia bella	native
Downingia bicornuta	native
Downingia cuspidata	native
Downingia ornatissima	native
Downingia pusilla	native
Eleocharis acicularis	native
Eryngium pinnatisectum	native
Eryngium spinosepalum	native
Eryngium vaseyi	native
Gratiola embracteata	native
Gratiola heterosepela	native
Isoetes howellii	native
Isoetes orcuttii	native
Juncus unicalis	native
Juncus leiospermus var. leiospermus	native
Juncus leiospermus var. ahartii	native
Lasthenia chrysantha	native
Lasthenia conjugens	native
Lasthenia fremontii	native
Lasthenia glaberrima	native
Lasthenia glabrata	native
Layia fremontii	native

Plant Species	**Native/Non-native**
Legenere limosa	native
Lilaea scilloides	native
Limnanthes alba	native
Limnanthes douglasii	native
Limnanthes flocossa ssp. californica	native
Mimulus tricolor	native
Montia fontana	native
Myosurus minimus	native
Navarretia leucocephala	native
Naverretia intertexta ssp. intertexta	native
Naverretia myersii	native
Naverretia nigelliformis	native
Naverretia tagetina	native
Neostapfia colusana	native
Orcuttia tenuis	native
Orcuttia viscida	native
Pilularia americana	native
Plagiobothrys austinae	native
Plagiobothrys acanthocarpus	native
Plagiobothrys bracteatus	native
Plagiobothrys greenei	native
Plagiobothrys humistratus	native
Plagiobothrys hystriculus (presumed extinct)	native
Plagiobothrys leptocladus	native
Plagiobothrys stipitatus	native
Plagiobothrys undulatus	native
Pogogyne zizyphoroides	native
Psilocarphus brevissimus	native
Psilocarphus oregonus	native
Psilocarphus tenellus var. globiferus	native
Ranunculus bonariensis var. trisepalus	native
Sagina decumbens ssp. occidentalis	native
Tuctoria greenei	native
Tuctoria mucronata	native

APPENDIX 4: GLOSSARY

aggradation – filling and raising of the level of the bed of a stream by deposition of sediment; the opposite of degradation

alluvial – refers to natural, channelized runoff from terrestrial terrain and the material borne or deposited by such runoff.

anthropogenic – arising from human activity

assessment area (AA) – the portion of a wetland or riverine system that is the subject of the CRAM evaluation.

attribute – attributes constitute the obvious, universal aspects of wetland condition; CRAM recognizes a total of four attributes of condition within a wetland: (1) buffer and landscape context; (2) hydrology; (3) physical structure; and (4) biotic structure.

avulsion – sudden movement of fluvial flow entirely or in part from one channel to another, less sinuous and steeper channel, usually during flood flows.

bankfull – height of fluvial flow corresponding to the floodplain.

bar – an alluvial or tidal deposit of sand, gravel, cobble, or other material within a channel. that directs flow and is often exposed during low-water periods

barrier beach – a natural area of sand or gravel along a lacustrine, marine or estuarine shore that blocks the landward action of tides or waves.

benthic – pertaining to the sea bed, river bed, or lake floor

braided – a stream that forms an interlacing network of branching and recombining channels separated by floodplains, channel bars, or islands

buffer – for the purposes of CRAM, the area extending from the immediate edge of the AA that is in a natural, or semi-natural, state and protects the AA from stressors

catchment – synonymous with watershed. An area of land, bounded by a drainage divide that drains to a fluvial channel or water body.

condition – condition is defined as the ability of a wetland to maintain its complexity and capacity for self-organization with respect to species composition, physico-chemical characteristics, and functional processes, relative to healthy wetlands of the same class

confinement – the degree to which levee, terraces, or hillsides prevent the later migration of a fluvial channel

debris jam – a conglomeration of material, organic or inorganic, floating or submerged, that has been lodged into place by the action of a flowing stream

deciduous – plants (trees and shrubs) that shed all of their leaves annually, such that there is a time each year at which individuals of the species are essentially devoid of leaves

deposition – the settlement of materials out of moving water and onto the bed, banks, or floodplain of a wetland or riverine channel.

degradation – the long-term lowering of a fluvial channel due to erosion of its bed

detritus – deposition of newly dead or decaying organic matter

disturbance – the consequence of natural changes in forcing functions, or controlling factors, through space and over time; disturbance is natural, regardless of its frequency, persistence, or magnitude

duff – a spongy layer of decaying leaves, branches, and other organic materials along a wetland shore or in a riparian area

ecological services – the services, or beneficial uses, for which a wetland can be managed; Key ecological services for many types of wetland include flood control, groundwater recharge, water filtration, conservation of cultural values, aesthetics, and the support of special-status species

emergent vegetation - plant species typically growing on saturated soils or on soils covered with water for most of the growing season; the leaves of emergent aquatic species are partly or entirely borne above the water surface; examples of such species include *Rorippa nasturtium-aquaticum* (watercress), *Scirpus californicus* (tule, bulrush), *Veronica anagallis-aquatica* (water speedwell), Polygonum amphibium (water knotweed), *Typha angustifolia* (narrow-leaved cattail), *Mimulus guttatus* (common monkeyflower)

entrenchment – the degree to which fluvial flood flows are confined to channel banks without access to the effective valley

effective valley width – the portion of a valley within which its fluvial channel is able to migrate without cutting into hillslopes, terraces, man-made levees, etc.

forb – a plant with a soft, rather than permanent, woody stem that is not a grass or grass-like

floodplain – the bench or broader flat area of a fluvial channel that corresponds to the height of the bankfull flow.

flood prone - land susceptible to inundation by extreme flood events. The height of the flood prone area approximately corresponds to twice bankfull height.

fluvial – of, relating to, or happening in, a river or stream

free-floating – plants that float at or just beneath the water surface without attachment to the substrate; free-floating aquatic species are transported freely by wind and water currents

herbaceous – a plant having stems that are not secondarily thickened and that die down annually

hummock – a mound composed of organic materials

interfluve – the region of higher land between two fluvial channels or swales on a floodplain or in a braided channel system

invasive – species that have been introduced from other regions by the actions of people and that exhibit a tendency to significantly displace native species

littoral zone – the nearshore area of a water body, where it is sufficiently shallow to allow light to penetrate to the bottom and reach rooted vegetation; corresponds with the limit of submerged aquatic vegetation

meander – the curves of a fluvial or tidal channel as viewed from above; a meander cutoff is a new, shorter channel across the narrow neck of a meander

metric – a measurable component of a CRAM attribute

natural levee – a low ridge landward of the active floodplain of a channel that forms by deposition during flood events.

nick point – the point where the stream is actively eroding the streambed to a new base level; nick points tend to migrate upstream

organic – pertaining to, or derived from, living organisms, or to compounds containing carbon as an essential component

panne – a shallow pond or pool, inundated or exposed, that forms on a fluvial floodplain or tidal marsh plain.

patch – a spatially distinct structural element pf a wetland or riparian system large enough to serve as habitat for wildlife, or to serve as an indicator of spatial variations in hydrological or edaphic conditions within a wetland

periphyton – benthic algae that grow attached to surfaces such as rocks or larger plants

POTW – Publicly Owned Treatment Works

rating – for a CRAM metric, represents it's state relative to the full range of possible states, from worst possible state to best

reach – a length of stream, lacustrine shore, or estuarine shore that has generally consistent physical and biological characteristics

riffle – a submerged, topographical high area in a channel created by the accumulation of relatively coarse-grained sediment causing turbulent flow indicated by standing waves

riparian – a transitional area between terrestrial and aquatic ecosystems, distinguished by gradients in biophysical conditions, ecological processes and biota; areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands, including those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems; riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes and estuarine-marine shorelines (National Research Council, 2001)

run – a reach of straight, smooth, fast-moving fluvial flow between riffles; also called a glide

scour – concentrated erosive action of flowing water in streams that removes and carries away material from the bed and banks

sediment – organic or inorganic material that has been transported and/or deposited by wind or water action

slough – a large tidal channel, or a large fluvial channel lacking an obvious terminal water body, cam also refer to an abandoned fluvial channel within the effective valley.

snag – a standing, dead tree or shrub at least 12 feet tall

stress – the consequence of unnatural, anthropogenic changes in forcing functions or controlling factors; key stressors are anthropogenic actions that tend to modify the quantity and/or quality of physical or biological habitat, sediment supplies, and/or water supplies upon which the desired functions of the wetland depend

stressor – an agent that inflicts stress on a wetland or riparian area

submergent vegetation - plant species that are adapted to spending their lifespan, from germination to fruiting, completely or nearly completely under water; examples of such species include *Ruppia cirrhosa* (ditchgrass), *Zannichellia palustris* (horned pondweed)

swale – gentle, elongated depression in which shallow water collects or flows during heavy rains, floods, etc.

thalweg – the middle of the chief navigable channel of a waterway that forms the boundary line between states

wetlands – lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water; wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil;

and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin *et al*., 1979)

wrack or wrackline – kelp, plastic debris, wood, and similar material left along the shore of a river, lake, tidal marsh, or other water body by high water levels

zonation – distribution of plants or animals arranged in zones or bands, caused by gradations of abiotic and/or biotic factors