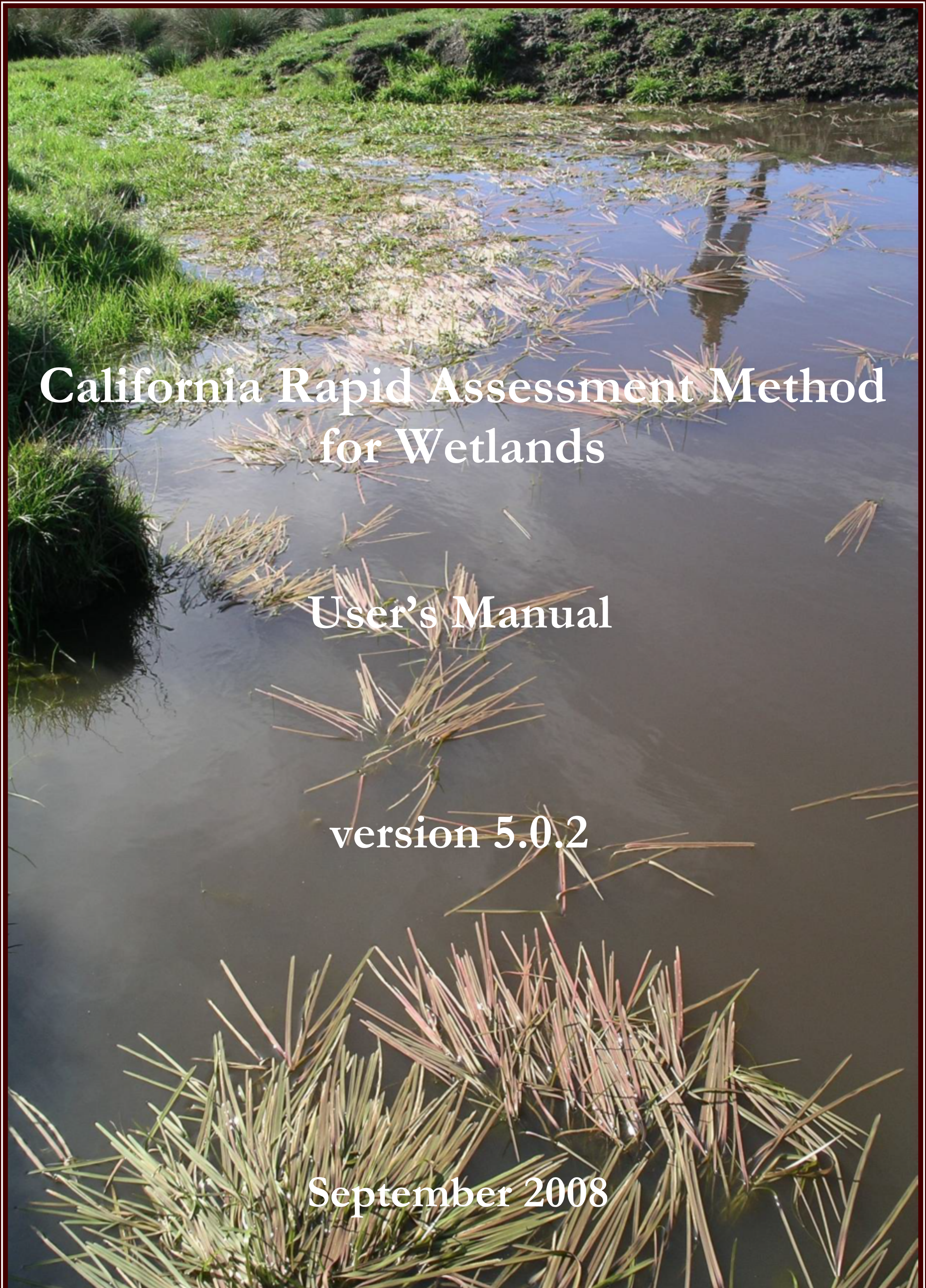

California Rapid Assessment Method for Wetlands

User's Manual

version 5.0.2

September 2008

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Cover Photograph: Joshua N. Collins

California Rapid Assessment Method (CRAM) For Wetlands

User's Manual

Version 5.0.2
September 2008

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Volume Two: Worksheets and Data sheets for assembling hardcopy field books, and CRAM Software 1.0.0 (an electronic version of CRAM 5.0.2) are available at www.cramwetlands.org

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CRAM Core Team and Regional Team members

VERSION HISTORY OF CRAM METHODOLOGY

Version 5.0.2 released 9/30/08
Changes in this version:

- Added section on version history of CRAM methodology and fixed typos
- Added paragraph in Section 2.3.1 to explain separation of assessments of condition and stress
- Added note to Section 3.2.2.2 that the depressional module was primarily based on perennial depressional wetlands and caution should be applied in the interpretation of scores in seasonal depressional wetlands
- Corrected text in various Sections to eliminate inconsistencies in terminology
- Updated figures in Chapter 3
- Revised the ratings for scoring Structural Patch Richness for Estuarine wetlands

Version 5.0.1 released 10/17/07
Changes in this version:

- Minor wording changes for clarification

Version 5.0.0 released 9/18/07
Changes in this version:

- Version numbering changed from 4.6 to 5.0—no other changes

Version 4.6 released 9/10/07
Changes in this version:

- Substantial changes in nearly all areas
- Changes to metrics included:
    - Wording changes for clarification
    - Added a second "B" rating for scoring Landscape Connectivity for Riverine wetlands
    - Revised the "C" and "D" ratings for scoring Number of Plant Layers Present for Slope and Confined Riverine wetlands

Versions 4.3 - 4.5

- Internal development versions

Version 4.2.3 released 11/1/06
Changes in this version:

- Reorganized volume 2 into three sections: Assessment Forms, Narratives, Tables & Figures; typos fixed

Version 4.2.2 released 8/17/06
Changes in this version:

- Added citation to title page and fixed typos

Version 4.2.1 released 8/10/06
Changes in this version:

- Vol 1, p. 15: Table 2.2, added new metric name Plant Community and bulleted its four component submetrics
- Vol 1, p. 36: Added language prescribing the calculation of mean submetric score in order to arrive at Plant Community metric value; in Table 3.8, changed expected maximum value of Biotic Structure attribute from 84 to 36 for Playas and Vernal Pools and 48 for all other wetland classes
- Vol 1, pp. 68-71: Changed “metric” to “submetric” for discussion of the four submetrics of the Plant Community metric
- Vol 2, pp.145-6: removed wrackline or organic debris in channel or on floodplain from worksheet 2 since this patch type is not expected in playas
- Vol 2, p. 55: Revised “D” narrative for number of plants layers present from "No layers are present" to "0-1 layer is present"
- Vol 2, pp. 133, 149, 166: Removed shading from scoring sheet for Interspersion and Zonation since this metric is assessed for vernal pools and playas
- Vol 2: Revised scoring forms to incorporate Plant Community metric

Version 4.2.0 released 8/4/06
Changes in this version:

- Split into two volumes: main manual and assessment forms
- Created separate volume for assessment forms - all supporting documents included with each class
- Updated entrenchment ratio and hydrologic connectivity metric bins
- Revised bins for percent co-dominant species that are non-native
- Added confined v. unconfined diagram
- Revised scoring to a 1-12 scale for all metrics

Version 4.1 released 7/11/06
Changes in this version:

- Separated estuarine class into two sub-classes: saline and non-saline

Version 4.0 released 5/25/06

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Organization Codes			
CCC	Ca Coastal Commission	OCPFRD	Orange County Public Facilities & Resources Dept
CCWGIS	Central Coast Wetlands GIS Project	PCR	PCR Services Corporation
CDFG	Ca Department of Fish and Game	PRBO	Point Reyes bird Observatory
CDPR	CA Department of Parks and Recreation	RCDSMM	Resource Conservation District of the Santa Monica Mountains
CDWR	Ca Department of Water Resources	RMC	San Gabriel & Lower Los Angeles Rivers and Mountains Conservancy
CMVCA	Ca Mosquito & Vector Control Assoc.	RWQCB	Regional Water Quality Control Board
CPI	Ca Polytech Institute	SCC	South Coast Ca Coastal Conservancy
CSU	Ca State University	SCCRPP	Southern. Ca Coastal Water Research Project
EBRPD	East Bay Regional Park District	SCVWD	Santa Clara Valley Water District
HBHRCD	Humboldt Bay Harbor, Recreation and Conservation District	SELC	Southern Environmental Law Center
LASGRWC	Los Angeles & San Gabriel Rivers Watershed Council	SFEI	San Francisco Estuary Institute
MBNMS	Monterey Bay National Marine Sanctuary	SWRCB	Ca State Water Resources Control Board
MLML	Moss Landing Marine Laboratory	UC	University of California
NEP	National Estuary Program	USACOE	US Army Corps of Engineers
NERR	National Estuary Research Reserve	USEPA	US Environmental Protection Agency
NWI	National Wetland Inventory	USF	University of San Francisco
OCWD	Orange County Water District	USFWS	US Fish and Wildlife Service
OSU	Oregon State University	USNPS	US National Park Service

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Joshua N. Collins

Seasonal estuarine wetland, Abbotts Lagoon, Point Reyes National Seashore

EXECUTIVE SUMMARY

Large amounts of public funds and human resources are being invested in the protection, restoration, creation, and enhancement of wetlands 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 wetland areas and how are they doing? This need is clearly indicated by the California State Wetlands Conservation Policy.

A consortium of local, state and federal authorities has been developing new tools to increase the State's capacity to monitor its wetlands. The effort is guided by the three-level framework for surface water monitoring and assessment recently issued to the state by the USEPA (USEPA 2006). Level 1 consists of habitat inventories and landscape profiles based on the statewide wetland inventory as mandated by California Assembly Bill 2286, the statewide riparian inventory as planned by the Riparian Habitat Joint Venture, and the Wetland Trackers of the Regional Data Centers being developed by the State Water Resources Control Board and others as part of the California Environmental Data Exchange Network. Level 2 consists of rapid assessment of wetland condition in relation to the broadest suite possible of ecological and social services and beneficial uses. Level 3 consists of standardized protocols for intensive-quantitative assessment of selected services and to validate and explain Level 1 and Level 2 methods and results. All three levels are to be supported by data management systems that enable the State to compile local and regional Level 1-3 data into statewide summary reports. Level 1 and Level 2 methods are supported by open-source, web-based information systems (wetlandtracker.org and cramwetlands.org) that are consistent with existing state and federal environmental databases. Level 3 protocols and results will be added to these information systems as they are developed.

This manual focuses on the California Rapid Assessment Method. CRAM is being developed as a cost-effective and scientifically defensible Level 2 method for monitoring the conditions of wetlands throughout California. The CRAM web site (www.cramwetlands.org) provides access to an electronic version of this manual, training materials, eCRAM (the downloadable software that eliminates the need for taking a hardcopy version of CRAM into the field), and the CRAM database. CRAM results can be uploaded to the database, viewed, and retrieved via the CRAM web site. CRAM, eCRAM, and the supporting web sites are public and non-proprietary.

CRAM development has focused on the wetlands of coastal watersheds from Mexico to Oregon. These watersheds in aggregate encompass almost as much variation in climate, geology, and land use as the State as a whole. A special effort has been made, however, to involve environmental scientists and managers who are familiar with inland arid montane environments that are not well represented in the coastal watersheds. Seasoned staff from natural resource management and regulatory agencies, NGO science institutions, the private sector, and academia have worked together through four coastal Regional Teams and a statewide Core Team to provide the breadth and depth of technical and administrative experience necessary to help assure statewide applicability of CRAM.

CRAM development has incorporated aspects of other approaches to habitat assessment used 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.

In essence, CRAM enables two or more trained practitioners working together in the field for one half day or less to assess the overall health of a wetland by choosing the best-fit set of narrative descriptions of observable conditions ranging from the worst commonly observed to the best achievable for the type of wetland being assessed. There are four alternative descriptions of condition for each of fourteen metrics that are organized into four main attributes: (landscape context and buffer, hydrology, physical structure, and biotic structure) for each of six major types of wetlands recognized by CRAM (riverine wetlands, lacustrine wetlands, depressional wetlands, slope wetlands, playas, and estuarine wetlands). To the extent possible, CRAM has been standardized across all these wetland types. The differences in metrics and narrative descriptions between wetland types have been minimized.

CRAM yields an overall score for each assessed area based on the component scores for the attributes and their metrics. The alternative narrative description for each metric has a fixed numerical value. An attribute score is calculated by first summing the values of the chosen narrative descriptions for the attribute's component metrics, and then converting the sum into a percentage of the maximum possible score for the attribute. The overall score for an area is calculated by first summing the attribute scores, and then converting this sum into the maximum possible score for all attributes combined. The maximum possible score represents the best condition that is likely to be achieved for the type of wetland being assessed. The overall score for a wetland therefore indicates how it is doing relative to the best achievable conditions for that wetland type in the state. Local conditions can be constrained by unavoidable land uses that should be considered when comparing wetlands from different land use settings.

CRAM also provides guidelines for identifying stressors that might account for low scores. Evident stressors are characterized as probably insignificant or strongly influencing an attribute score. The stressor checklist allows researchers and managers to explore possible relationships between condition and stress, and to identify actions to counter stressor effects.

CRAM is a cost-effective ambient monitoring and assessment tool that can be used to assess condition on a variety of scales, ranging from individual wetlands to watersheds and larger regions. Applications could include preliminary assessments to determine the need for more intensive analysis; supplementing information during the evaluation of wetland condition to aid in regulatory review under Section 401 and 404 of the Clean Water Act or other wetland regulations; and assisting in the assessment of restoration or mitigation projects by providing a rapid means of checking progress along a particular restoration trajectory. CRAM is not intended to replace any existing tools or approaches to monitoring or assessment, and will be used at the discretion of each individual agency to complement preferred approaches. Quality assurance and control practices are being designed to ensure that CRAM is appropriately applied in ambient and regulatory applications.

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

1.0 Introduction

This document is the User's Manual for the California Rapid Assessment Method (CRAM) for wetlands. CRAM is intended to assess all types of wetlands in California. The current version of CRAM can be used to assess all types of wetlands but cannot be used to assess riparian areas except in relation to riverine systems. The version of CRAM for assessing the riparian areas of other wetland types is not yet ready for implementation.

Chapter 1 presents the rationale for CRAM, including why it's needed, its primary goal, its strategic context, intended uses, and the geographic scope of its applicability. Chapter 2 covers key terms, the conceptual framework for CRAM, and its development process. Chapter 3 describes the basic steps of the methodology. Chapter 4 provides detailed instructions with worksheets and datasheets for assessing a wetland 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 areas 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 can 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 high costs of conventional assessment methods; and (3) the lack of an information management system to support regional or statewide wetland assessments. The USEPA has developed a 3-tiered framework for comprehensive assessment and monitoring of surface waters that can guide efforts to overcome these obstacles (USEPA 2006).

> *Level 1*. Level 1 consists of map-based inventories and landscape profiles of wetlands and related habitats in a Geographic Information System (GIS). Inventories are essential for locating wetlands and for describing their geographic distribution and abundance. 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. The statewide is inventory can be 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 regional wetland scientists, managers, and regulators. In addition to the inventory of wetlands, the State is supporting the development of web-based inventories of wetland

projects (www.wetlandtracker.org) that can be used to assess the cumulative effect of projects on the extent and overall ambient condition of wetlands. The State Wetland Inventory, Riparian Inventory, and the Wetland Trackers will aid wetland conservation planning by showing each wetland in the context of all others. They will also serve as sample frames for objective, probabilistic surveys of the ambient condition of wetlands and for assessing the effects of projects and other management actions on the ambient wetland condition at various scales ranging from local watersheds to the State as a whole. Through the statewide Level 1 inventory and the Wetland Tracker, the State can overcome the obstacle of not having an adequate inventory of wetlands and related projects to track changes in their extent and condition.

Level 2. Level 2 methods assess the existing condition of a wetland relative to its broadest suite of suitable functions, services, and beneficial uses, such as flood control, groundwater recharge, pollution control, and wildlife support, based on the consensus of best professional judgment. In this regard, a level 2 assessment represents the overall functional capacity of a wetland. To be valid, rapid assessments must be strongly correlated to Level 3 measures of actual functions or services. Once validated, Level 2 assessments can be used where Level 3 data are lacking or too expensive to collect. Level 2 assessments can thus lessen the amount and kinds of data needed to monitor wetlands across large areas over long periods. CRAM is the most completely developed and tested Level 2 method for California at this time.

Level 3. Level 3 provides quantitative data about selected functions, services, or beneficial uses of wetlands. Such data are needed to develop indicators, to develop standard techniques of data collection and analysis, to explore mechanisms that account for observed conditions, to validate Level 1 and 2 methods, and to assess conditions when the results of Level 1 and Level 2 efforts are too general to meet the needs of wetland planners, managers, or regulators.

CRAM is based on a growing body of scientific literature and practical experience in the rapid assessment of environmental conditions. 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, Carletti *et al.* 2004, Fennessy *et al.* 2004). Most methods differ more in the details of data collection than in overall approach. In general, the most useful approaches 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 Level 3 studies that show relationships between the indicators, high-priority functions or ecological services of wetlands, and anthropogenic 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 projects, to watersheds and regions of various sizes. 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 the Hydrogeomorphic Method (HGM; Smith *et al.* 1995, Smith 2000) or the Index of Biotic Integrity (IBI; Karr 1981). Each scale of wetland assessment provides different information.

Furthermore, assessments at different scales can be used for cross-validation, thereby increasing confidence in the approach being used. A comprehensive wetland monitoring program might include a variety of methods for assessing wetlands at different scales.

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 other than CRAM 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 and lakes. 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. Trial applications of rapid assessment methods developed for other states, including 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 developing CRAM.

1.3 Goal and Intended Use

The overall goal of CRAM is to:

> *Provide rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and the performance of related policies, programs and projects throughout California.*

CRAM is being developed as a rapid assessment tool to provide information about the condition of a wetland and the stressors that affect that wetland. CRAM is intended for cost-effective ambient monitoring and assessment that can be performed on different scales, ranging from an individual wetland, to a watershed or a larger region. It can be used to develop a picture of reference condition for a particular wetland type or to create a landscape-level profile of the conditions of different wetlands within a region of interest. This information can then be used in planning wetland protection and restoration activities. Additional applications could include:

- *preliminary* assessments to determine the need for more traditional intensive analysis or monitoring;
- providing *supplemental* information during the evaluation of wetland condition to aid in regulatory review under Section 401 and 404 of the Clean Water Act, the Coastal Zone Management Act, Section 1600 of the Fish and Game code, or local government wetland regulations; and
- *assisting* in the monitoring and assessment of restoration or mitigation projects by providing a rapid means of checking progress along restoration trajectories.

CRAM is *not* intended to replace any existing tools or approaches to monitoring or assessment, and will be used at the discretion of each individual agency to complement preferred approaches. Wetland impact analysis and compensatory mitigation planning and monitoring for larger wetland areas that exhibit more complex physical and biological functions will typically require more information than CRAM will be able to provide.

1.4 Related Rapid Assessment Efforts in California and Other States

Development of 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 of wetlands throughout California. Although centered on coastal watersheds, CRAM development to date has 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. Validation efforts have indicated that CRAM is broadly applicable throughout the range of conditions commonly encountered. However, since CRAM emphasizes the functional benefits of structural complexity, it may yield artificially low scores for wetlands that do not naturally appear to be structurally complex. CRAM should therefore be used with caution in such wetlands. This can include riverine wetlands in the headwater reaches of very arid watersheds, montane depressional wetlands above timberline, and vernal pools on exposed bedrock. Future CRAM results will be used to adjust CRAM metrics as needed to remove any systematic bias against any particular kinds of wetlands or their settings.

1.6 Supporting Information Systems

Information management is an essential part of a successful program of environmental monitoring and assessment. CRAM is supported by a public web site (cramwetlands.org) that provides downloadable versions of this User's Manual, training materials, an electronic version of CRAM (eCRAM) that eliminates the need to take hardcopies of worksheets and datasheets in to the field, and access to an open-source database that allows registered CRAM practitioners to upload, view, and download CRAM results. The CRAM website and database are being developed in the context of a broad initiative in California to improve data and information sharing throughout the community of environmental scientists, managers, and the concerned public. At this time, the CRAM database is being built into the information management system of the State's Surface Water Ambient Monitoring Program (SWAMP) through the coastal Regional Information Centers of the California Environmental Data Exchange Network (CEDEN). The CRAM website is being integrated with the Wetland Tracker website to provide easy access to information about the extent as well as the condition of wetlands. However, as of this writing, the CRAM database is only publicly accessible through the CRAM website (cramwetlands.org).

1.7 Organization and Coordination to Develop CRAM

An organization was created to foster collaboration and coordination among the regional CRAM developers. 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 (CRAM) and information management. The Principal Investigators (PIs) 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 begin implementing CRAM.

1.7.1 Core Team

The Core Team fostered collaboration and coordination among the regions to produce a rapid assessment method that is consistent for all kinds of wetlands throughout California. The Core Team consists of the PIs plus technical experts in government agencies, non-governmental 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.

1.7.2 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 ecological service. The members of each Regional Team are listed in the acknowledgments at the front of this document. Members of the Regional Teams have assisted in the verification and validation of CRAM, and have 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 having experience with assessment methodologies, Core Team members who work within the region, and technical representatives from potential user groups.

Joshua N. Collins

Depressional wetland, Gualala River watershed, Mendocino County

CHAPTER 2: KEY TERMS, CONCEPTS, ASSUMPTIONS, AND DEVELOPMENTAL PROCESS

2.0 Overview

CRAM uses standardized definitions for key terms, including "wetland," "disturbance," "stress," and "condition." CRAM is based on basic assumptions about functional relationships between condition and function or ecological service, and about the spatial relationships between stress and condition, as explained below.

2.1 Key Terms

Assessment Area (AA). An AA is the portion of a wetland that is the subject of a CRAM assessment. Multiple AAs might be needed to assess large wetlands. Rules for delineating an AA are presented in Section 3.5.

Stress. Stress is the consequence of anthropogenic events or actions that measurably affect conditions in the field. The key stressors tend to reduce the amount of wetlands, or they significantly decrease the quantity and/or quality of sediment supplies and/or water supplies upon which the wetlands depend. Gradients of stress result from spatial variations in the magnitude, intensity, or frequency of the stressors.

Disturbance. Disturbance is the consequence of natural phenomena, such as landslides, droughts, floods, wildfires, and endemic diseases that measurably affect conditions in the field.

Condition. The condition of a wetland is the states of its physical and biological structure and form relative to their best achievable states.

Buffer. The buffer for a wetland consists of its adjoining lands including other wetland areas that can reduce the effects of stressors on the wetland's condition.

Landscape Context. The landscape context of a wetland consists of the lands, waters, and associated natural processes and human uses that directly affect the condition of the wetland or its buffer.

Ecological Services or Beneficial Uses. These are the benefits to society that are afforded by the conditions and functions of a wetland. Key ecological services for many types of wetlands in California include flood control, shoreline and stream bank protection, groundwater recharge, water filtration, conservation of cultural and aesthetic values, and support of endemic biological diversity.

Attribute. Attributes are categories of metrics used to assess wetland condition as well as buffer and landscape context. There are four CRAM attributes: Buffer and Landscape Context, Hydrology, Physical Structure, and Biotic Structure.

Metric. 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 distinguished from natural variation across a stressor gradient (Barbour *et al.* 1995).

Narrative Descriptions of Alternative States. For each type of wetland, the narrative descriptions of alternative states represent the full range of possible condition from the worst conditions that are commonly observed to the best achievable conditions, for each metric of each attribute in CRAM.

Indicators. These are visible clues or evidence about field conditions used to select the best-fit narrative description of alternative states for CRAM metrics.

Metric Score. The score for a CRAM metric is the numerical value associated with the narrative description of an alternative state that is chosen because it best-fits the condition observed at the time of the assessment.

Attribute Score. An attribute score is the percent of the maximum possible sum of the metric scores for the attribute.

CRAM Score or AA Score. A CRAM score or AA score indicates the overall condition of an Assessment Area. It is calculated as the percent of the maximum possible sum of the attribute scores for the Assessment Area.

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 best framework for managing wetlands, the driving forces that account for their condition, and the spatial relationships 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, Pinter *et al.* 1999). 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 condition or *state* of natural resources. The human *responses* to these changes include any organized behavior that aims to reduce, prevent or mitigate undesirable stresses or state changes. Natural resource protection depends on monitoring and assessment to understand the relationships between stress, state, and management responses. The managers' concerns guide the monitoring efforts, and the results of the monitoring should influence the managers' actions and concerns.

Assessment approaches vary in that they may evaluate any or all aspects of the pressure-state-response model. Pressure indicators describe the variables that directly cause (or may cause) wetland problems, such as discharges of fill or urban encroachment. State indicators evaluate the current condition of the wetland, such as plant diversity or concentration of a particular contaminant in the water. Response indicators demonstrate the efforts of managers to address the wetland problem, such as the implementation of best management practices. The approach used by CRAM is to focus on *condition* or *state*. A separate stressor checklist is then used to note which, if any, stressors appear to be exerting *pressure* affecting condition. It is assumed that managers with knowledge of pressures and states will exact more effective *responses*.

The PSR framework is a simple construct that can help organize the monitoring components of adaptive management. It can be elaborated to better represent complex systems involving interactions and nonlinear relations among stressors, states and management responses (e.g., Rissik *et al*. 2005) For the purposes of CRAM the PSR model is simply used to clarify that CRAM is mainly intended to described state conditions of wetlands.

2.2.2 Rapid Assessment

CRAM embodies the basic assumption of most other rapid assessment methods that ecological conditions vary predictably along gradients of stress, and that the conditions can be evaluated based on a fixed set of observable indicators. CRAM metrics were built on this basic assumption according to the following three criteria common to most wetland rapid assessment methods (Fennessy *et al*. 2004):

> *the method should assess existing conditions* (see Section 2.1 above), without regard for past, planned, or anticipated future conditions;
>
> *the method should be truly rapid,* meaning that it requires two people no more than one half day of fieldwork plus one half day of subsequent data analysis to complete; and
>
> *the method is a site assessment* based on field conditions and does not depend largely on inference from Level 1 data, existing reports, opinions of site managers, etc.

2.2.3 Forcing Functions, Stress, Buffer, and Condition

The condition of a wetland is determined by interactions among internal and external hydrologic, biologic (biotic), and physical (abiotic) processes (Brinson, 1993). CRAM is based on a series of assumptions about how these processes interact through space and over time. First, CRAM assumes that the condition of a wetland is mainly determined by the quantities and qualities of water and sediment (both mineral and organic) that are either processed on-site or that are exchanged between the site and its immediate surroundings. Second, the supplies of water and sediment are ultimately controlled by climate, geology, and land use. Third, geology and climate govern natural disturbance, whereas land use accounts for anthropogenic stress. Fourth, biota (especially vegetation) tend to mediate the effects of climate, geology, and land use on the quantity and quality of water and sediment (Figure 2.1). For example, vegetation can stabilize stream banks and hillsides, entrap sediment, filter pollutants, provide shade that lowers temperatures, reduce winds, etc. Fifth, stress usually originates outside the wetland, in the surrounding landscape or encompassing watershed. Sixth, buffers around the wetland can intercept and otherwise mediate stress (Figure 2.2).

2.2.4 Condition, Ecological Service, and CRAM Scores

Three major assumptions govern how wetlands are scored using CRAM. First, it is assumed that the societal value of a wetland (i.e., its ecological services) matters more than whatever intrinsic value it might have in the absence of people. This assumption does not preclude the fact that the support of biological diversity is a service to society. Second, it is assumed that the value depends more on the diversity of services than the level of any one service. Third, it is assumed that the diversity of services increases with structural complexity and size. CRAM therefore favors large, structurally complex examples of each type of wetland.

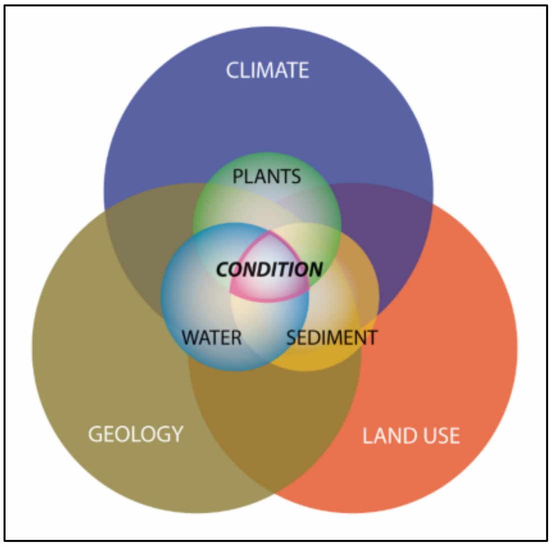


Figure 2.1: Spatial hierarchy of factors that control wetland conditions, which are ultimately controlled by climate, geology, and land use.

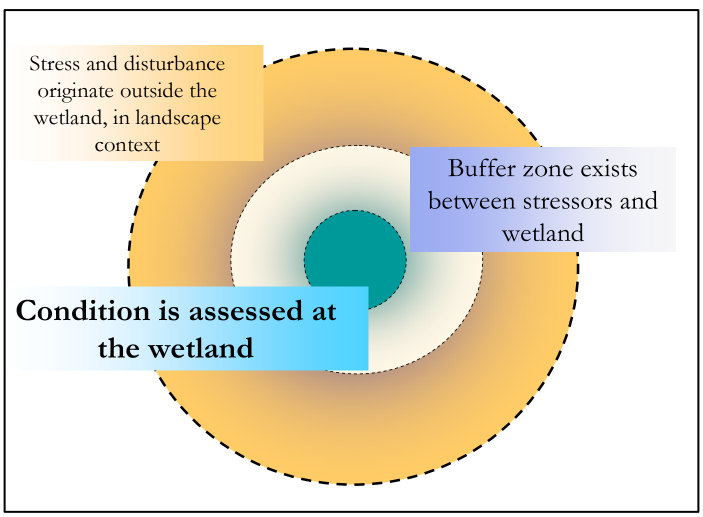


Figure 2.2: Spatial hierarchy of stressors, buffers, and wetland condition. Most stressors originate outside the wetland. The buffer exists between the wetland and the sources of stress, and serves to mediate the stress.

2.3 Developmental Framework

The CRAM developmental process consists of nine steps with distinct products organized into three phases: basic design, calibration, and validation (Table 2.1).

Table 2.1: Basic outline of CRAM development.

<table>
<tr><td rowspan="4">Core Team</td><td rowspan="4">Basic Design Phase</td><td>Develop conceptual models of wetland form and function</td></tr>
<tr><td>Identify universal Attributes of wetland condition</td></tr>
<tr><td>Nominate Metrics of the Attributes</td></tr>
<tr><td>Nominate descriptions of alternative states for each Metric</td></tr>
<tr><td rowspan="7">Core and Regional Teams</td><td rowspan="4">Calibration Phase</td><td>Clarify and revise the Metrics and narrative descriptions of alternative states based on regional team input and inter- and intra-team comparisons</td></tr>
<tr><td>Develop a checklist to identify stressors</td></tr>
<tr><td>Test and select methods of scaling and weighting Attributes and Metrics</td></tr>
<tr><td>Test and select formulas for calculating Attribute scores and AA scores</td></tr>
<tr><td rowspan="3">Validation Phase</td><td>Validate Metrics and Attributes using Level 3 data</td></tr>
<tr><td>Conduct independent peer review</td></tr>
<tr><td>Provide outreach and training</td></tr>
</table>

2.3.1 Basic Design

This phase of CRAM development involved creating conceptual models of wetland form and function, defining key terms, developing the wetland typology, identifying the attributes, and formulating metrics that describe each attribute. The basic design work was done primarily through initial field-testing and feedback by Regional Teams and the Core Team. Version 2.0 of CRAM marked the completion of the basic design phase.

Each CRAM attribute is represented by a set of metrics (Table 2.2 below), and each metric is represented by a set of mutually exclusive narrative descriptions of alternative states. In aggregate, the alternative states of all the metrics for any type of wetland represent its full range of visible form and structure.

An effort was made to separate assessments of condition from assessments of stress. This was done to explore correlations between stress and condition. For example, CRAM AAs can be grouped according to their associated stressors, and the groups can be compared based on their CRAM scores. The separation has been difficult to achieve, however, For example, the Plant Community metric of the Biotic Structure attribute includes a sub-metric about the relative abundance of non-native plant species, although biological invasion is usually considered a significant stressor. Some autocorrelation can therefore be expected between stress and condition as assessed using the current version of CRAM

2.3.2 Calibration

The calibration phase was used to determine if the draft wetland classification scheme, the attributes, the metrics, and the narrative descriptions of alternative states were (1) clear and understandable; (2) comprehensive and appropriate; (3) sensitive to obvious variations in condition; (4) able to produce similar scores for areas subject to similar levels of the same kinds of stress; and (5) tended to foster repeatable results among different practitioners. The calibration phase was also used to test and select methods of calculating, scaling, and weighting scores for metrics, attributes, and AAs.

Calibration has involved iterative adjustments to the classification system and the metrics during multiple field tests by each Regional Team. The amount of revision has declined steadily, but minor changes are expected to continue as the number of CRAM users and the amount of its use increases. For the CRAM version used in the Validation Phase, all the regional teams were able to meet the targeted within-team and between-team QAQC standards of 10% and 20%, respectively, for each metric.

Table 2.2: CRAM Site Attributes and Metrics.

<table>
<tr><th colspan="2">Attributes</th><th>Metrics</th></tr>
<tr><td colspan="2" rowspan="5">Buffer and Landscape Context</td><td>Landscape Connectivity</td></tr>
<tr><td>Buffer:</td></tr>
<tr><td>Percent of AA with Buffer</td></tr>
<tr><td>Average Buffer Width</td></tr>
<tr><td>Buffer Condition</td></tr>
<tr><td colspan="2" rowspan="3">Hydrology</td><td>Water Source</td></tr>
<tr><td>Hydroperiod or Channel Stability</td></tr>
<tr><td>Hydrologic Connectivity</td></tr>
<tr><td rowspan="8">Structure</td><td rowspan="2">Physical</td><td>Structural Patch Richness</td></tr>
<tr><td>Topographic Complexity</td></tr>
<tr><td rowspan="6">Biotic</td><td>Plant Community:</td></tr>
<tr><td>Number of Plant Layers Present
or Native Species Richness (vernal pools only)</td></tr>
<tr><td>Number of Co-dominant Species</td></tr>
<tr><td>Percent Invasion</td></tr>
<tr><td>Horizontal Interspersion and Zonation</td></tr>
<tr><td>Vertical Biotic Structure</td></tr>
</table>

2.3.3 Validation

The purpose of the validation phase was to assess the overall performance of CRAM by regressing metric scores and attribute scores on Level 3 data representing expected relationships between condition and function or service (Table 2.3). The same models were used to guide alternative approaches for weighting and combining scores. CRAM performed best using the simplest combination rules without any weighting. The level of performance was adequate for the functions and services represented by the selected Level 3 data. The validation phase for estuarine wetlands and riverine/riparian systems was completed with CRAM version 4.0. The other types of wetlands will be validated as CRAM is implemented. A full report of the validation efforts to date is available at www.cramwetlands.org.

Table 2.3: Expected relationships among CRAM attributes, metrics, and key services.

KEY SERVICES	**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	Number of Plant Layers	Number of Co-dominant Species and Native Species Richness	Percent Invasion	Horizontal 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					
Moderation of groundwater flow or discharge	X	X									
Dissipation of energy					X	X	X			X	X
Cycling of nutrients	X		X	X	X	X	X	X	X		X
Removal of elements and compounds	X		X	X		X	X			X	
Retention of particulates			X	X	X	X	X	X		X	
Export of organic carbon			X	X			X		X	X	X
Maintenance of plant and animal communities	X		X	X	X	X	X	X	X	X	X

Joshua N. Collins

Vernal pool in oak woodland, Vina Plain, Butte County

CHAPTER 3:
PROCEDURES FOR USING CRAM

3.0 Summary

The general procedure for using CRAM consists of eight (8) steps (Table 3.1).

Table 3.1: Steps for using CRAM.

Step 1	Assemble background information about the management of the wetland.
Step 2	Classify the wetland using this manual (see Section 3.2 and Figure 3.2).
Step 3	Verify the appropriate season and other timing aspects of field assessment.
Step 4	Estimate the boundary of the AA (subject to field verification).
Step 5	Conduct the office assessment of stressors and on-site conditions of the AA.
Step 6	Conduct the field assessment of stressors and on-site conditions of the AA.
Step 7	Complete CRAM assessment scores and QA/QC Procedures.
Step 8	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 of background materials.

- USGS topographic quadrangles, National Wetlands Inventory (NWI), State Wetlands Inventory, road maps, and other maps of geology, soils, vegetation, land uses, etc.
- Air photos and other imagery, preferably geo-rectified with 1-3 m. pixel resolution.
- 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 and Riparian Areas

Wetland classification requires the application of a standard wetland definition followed by the application of a standard wetland typology or classification system.

3.2.1 General Definitions of Wetlands and Riparian Areas

CRAM employs the following wetland definition provided by the National Wetland Inventory (NWI) of the US Fish and Wildlife Service (USFWS). The NWI definition might be replaced with the proposed California State definition when it is promulgated.

> *"**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).*

CRAM is designed to assess vegetated wetlands, meaning wetlands that support at least 5% cover of vegetation during the peak growing season. Therefore, for the purposes of CRAM, a wetland is further defined as the vegetated portion of a discrete area of wetland habitat (as defined by NWI) that is large enough to contain one or more CRAM Assessment Areas (AAs). A wetland may be the same size as an AA or larger than multiple AAs, but it is never smaller than an AA (see AA delineation guidelines in Section 3.5 and AA size recommendations in Table 3.7 below). This modification of the NWI definition is necessary to convert a Level 1 wetland inventory based on the NWI definition into a sample frame for ambient surveys of wetland condition using CRAM. A sample frame is a list or map of every wetland or potential CRAM AA) within the population of wetlands to be surveyed (Särndal *et al.* 1992).

CRAM recognizes that all wetlands have some amount of adjacent riparian area, as defined by the NRC. However, for the purposes of wetland assessment, the riparian areas adjacent to lacustrine wetlands, depressional wetlands, vernal pools, playas, slope wetlands, and estuarine wetlands are considered part of the wetland buffers, and not part of the wetlands. In contrast, riverine wetlands include the portions of the adjacent riparian areas with which the riverine wetlands are inextricably and obviously connected through various ecological and hydrological processes. The reason for treating riverine riparian areas differently than other riparian areas is more fully explained in Sections 3.2.2.1 and 3.5.4 below. CRAM employs the riparian definition provided by the US National Research Council (NRC):

> *"**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).*

The approximate boundaries of a wetland can be determined from the State Wetland Inventory, NWI, an existing Jurisdictional Delineation (JD), by using the State Inventory or NWI mapping methods, or by using the JD manual (USACE 1987). A JD is especially useful for determining the boundaries of a wetland when assessing impacted sites or mitigation sites as defined under Section 404 of the US Clean Water Act. When using the State Inventory, NWI, or the JD manual to identify a wetland, it is important to limit the wetland to the vegetated area, as described above.

If the wetland cannot be identified from an existing inventory or a JD, then its boundaries should be sketched on the base imagery for the CRAM assessment, using the general guidelines in Table 3.3 and Figure 3.1 below. A sketch map based on these guidelines cannot replace a JD, the State Wetland Inventory or NWI.

Table 3.3: Guidelines to delineate a wetland for the purpose of CRAM.

Delineating Feature	Description of Features
Backshore	The backshore of a wetland is the boundary between the wetland and the adjoining upland, where the upland is at least 5m wide. The high-water contour of the wetland is a good proxy for its backshore boundary.
Foreshore	The foreshore of a wetland is the boundary between the vegetated wetland and any adjoining semi-aquatic, non-wetland area, such as an intertidal flat or a non-vegetated riverine channel bar, or a fully aquatic area such as the open water area of a lake or estuary that is at least 30m wide.
Adjoining Wetland	Any wetland that is mostly less than 5m distant from the wetland being assessed is an adjoining wetland.

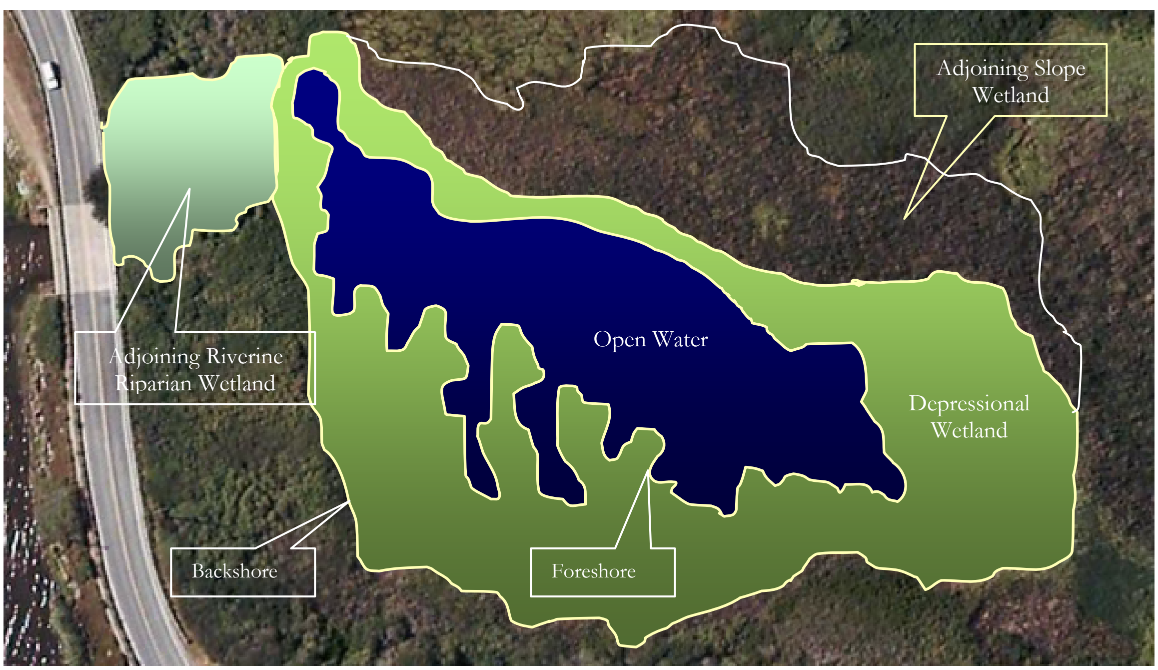


Figure 3.1: Using the backshores, foreshores, and the boundaries between wetland types to delineate a wetland.

3.2.2 Wetland Typology

In determining the appropriate wetland typology for CRAM, the Core Team considered the ecological typology used by NWI, the hydro-geomorphic (HGM) classification used by the USACE, and typologies used in state policy. The NWI typology emphasizes the habitat functions of wetlands. The HGM typology emphasizes wetland hydrology and landscape position. While the Core Team considered the need to be consistent with both of these typologies, it also considered the need to recognize the kinds of wetlands named in California wetland protection policies. The hierarchical CRAM typology reflects all of these considerations, but it favors the HGM classification system overall, with sub-types that reflect State policy.

The CRAM typology consists of six major wetland types, four of which have sub-types (Table 3.4 and Figure 3.2). Additional sub-types can be added in the future as needed.

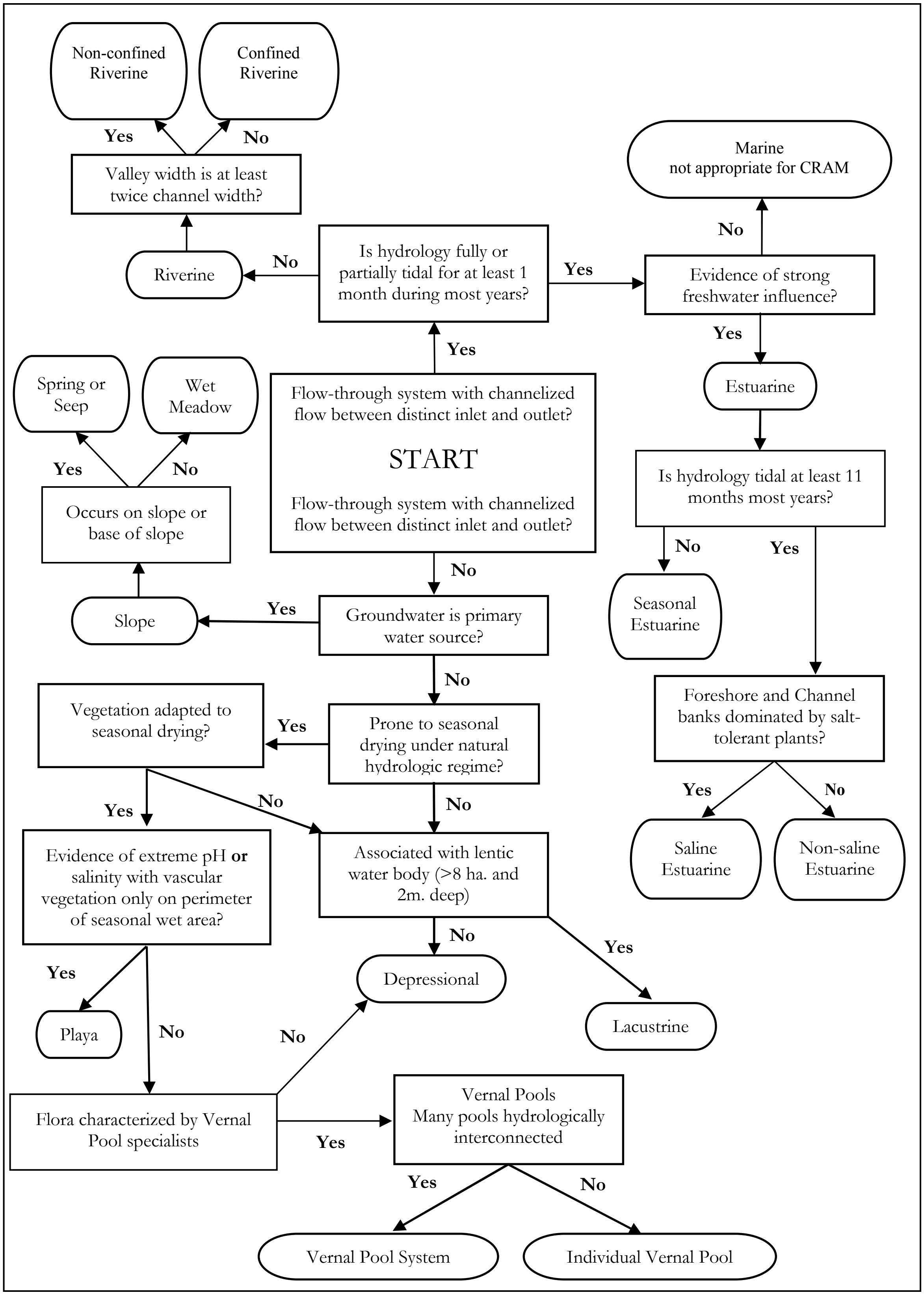
Table 3.4: The CRAM Wetland Typology.

CRAM Wetland Types	**CRAM Sub-types (these are recognized for some but not all metrics)**
Riverine Wetlands	Confined Riverine Wetlands
	Non-confined Riverine Wetlands
Depressional Wetlands	Individual Vernal Pools
	Vernal Pool Systems
	Other Depressional Wetlands
Playas	no sub-types
Estuarine Wetlands	Perennial Saline Estuarine Wetlands
	Perennial Non-saline Estuarine Wetlands
	Seasonal Estuarine Wetlands
Lacustrine Wetlands	no sub-types
Slope Wetlands	Seeps and Springs
	Wet Meadows

Some wetlands will have undergone a conversion from one type to another due to either natural or anthropogenic events. For example, a channel avulsion may capture a depressional wetland 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 type and condition. 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 historical type as well as the existing type should be noted. The stressor checklist enables the user to document if the wetland is currently being stressed by the conversion (i.e., if the process of conversion is continuing and a significant source of stress).

Figure 3.2: Flowchart to determine wetland type and sub-type.



3.2.2.1 Riverine (Including Closely Associated Riparian Areas)

A riverine wetland consists of the riverine channel and its active floodplain, plus any portions of the adjacent riparian areas that are likely to be strongly linked to the channel or floodplain through bank stabilization and allochthanous inputs (see Section 3.5.3 below). An active floodplain is defined as the relatively level area that is periodically flooded, as evidenced by deposits of fine sediment, wrack lines, vertical zonation of plant communities, etc. The water level that corresponds to incipient flooding can vary depending on flow regulation and whether the channel is in equilibrium with water supplies and sediment supplies. Under equilibrium conditions, the usual high water contour that marks the inboard margin of the floodplain (i.e., the margin nearest the thalweg of the channel) corresponds to the height of bankfull flow, which has a recurrence interval of about 1.5 to 2.0 years. The active floodplain can include broad areas of vegetated and non-vegetated bars and low benches among the distributaries of deltas and braided channel systems. Vegetated wetlands can develop along the channel bottoms of intermittent and ephemeral streams during the dry season. Dry season assessment in these systems therefore includes the channel beds. However, the channel bed is excluded from the assessment when it contains non-wadeable flow.

There may be a limit to the applicability of CRAM in low order (i.e., headwater) streams in very arid environments that tend not to support species-rich plant communities with complex horizontal and vertical structure. CRAM may be systematically biased against such naturally simple riverine systems. Therefore, while the current version of CRAM can be used in these systems, the results will be tracked carefully. If warranted, the riverine CRAM module will be revised based on past experience and additional field work during FY 2008-10.

Riverine wetlands are further classified as confined or non-confined, based on the ratio of valley width to channel width (see Figure 3.2 above). Channels can also be entrenched, based on the ratio of flood-prone width to bankfull width (Figure 3.3 below). Entrenchment impacts hydrologic connectivity and is discussed more fully in Section 4.2.3.

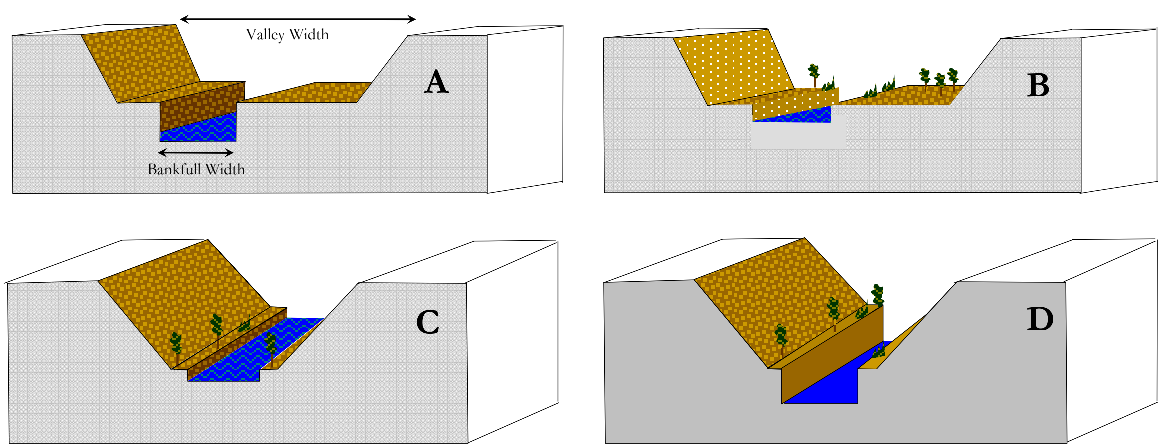


Figure 3.3: Illustrations of riverine confinement and entrenchment.
(A) non-confined entrenched, (B) non-confined not entrenched, (C) confined not entrenched, and (D) confined entrenched riverine sub-types.

3.2.2.1.1 Non-confined Riverine Sub-type

In non-confined riverine systems, the width of the valley across which the system can migrate without encountering a hillside, high terrace, or other feature that is likely to resist migration is at least twice the average bankfull width of the channel. Non-confined riverine systems typically occur on alluvial fans, deltas in lakes, and along broad valleys. A channel can be confined by substantial artificial levees if the average distance across the channel at bankfull is more than half the distance between the levees. This assumes that the channel would not be allowed to migrate past the levees, and that levee breaches will be repaired. Confinement is unrelated to the channel entrenchment. Entrenched channels can be confined or non-confined (Figure 3.3).

3.2.2.1.2 Confined Riverine Sub-type

In confined riverine systems, the width of the valley across which the system can migrate without encountering a hillside, terrace, or substantial man-made levee is less than twice the average bankfull width of the channel. A channel can be confined by artificial levees and urban development if the average distance across the channel at bankfull is more than half the distance between the levees or more than half the width of the non-urbanized lands that border the stream course. This assumes that the channel would not be allowed to migrate past the levees and that levee breaches will be repaired. Confinement is unrelated to channel entrenchment. Entrenched channels can be confined or non-confined (Figure 3.3).

3.2.2.2 Depressional Wetlands

Depressional wetlands exist in topographic lows that do not usually have outgoing surface drainage except during extreme flood events or heavy rainfall. Precipitation is their main source of water. 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 vernal pool system 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, cutoff ox-bows on floodplains, and water hazards on golf courses.

3.2.2.2.1 Vernal Pool Wetlands

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 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 undergo four distinct annual 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 succumb to extreme dry conditions (Zedler 1987). Vernal pools typically support a minimum of 30% cover of native plant species during the aquatic or drying phase. Vernal pools in disturbed areas or ones that are subjected to abnormal rainfall patterns might not meet this criterion due to invasion by non-native plants (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 Systems

Vernal pools often occur together and with vernal swales as vernal pool systems (Figure 3.6). These can have many pools of various sizes and shapes, varying floral and faunal composition, and various hydroperiods (Witham 2006). Water can move between adjacent pools and swales through the thin soils above the underlying impervious substrate. The lack of surface flow between pools does not necessarily indicate that they are not hydrologically inter-connected.

3.2.2.2.3 Other Depressional Wetlands

Depressional wetlands other than vernal pools can be seasonal or perennial, but their flora and fauna are mostly not characteristic of vernal pools, and they lack the impervious substrate that controls vernal pool hydrology. They differ from lacustrine wetlands by lacking an adjacent area of open water (at least 2 m deep and 8 ha total area). They differ from playas by lacking an adjacent area larger than the wetland of either alkaline or saline open water less than 2 m deep or non-vegetated, fine-grain sediments. Unlike slope wetlands (i.e., springs and seeps), depressional wetlands depend more on precipitation than groundwater as their water source.

There may be a limit to the applicability of CRAM in seasonal depressional wetlands that tend not to support species-rich plant communities with complex horizontal and vertical structure. CRAM may be systematically biased against such naturally simple depressional systems. Therefore, while the current version of CRAM can be used in these systems, the results will be tracked carefully. If warranted, the depressional wetlands CRAM module will be revised based on past experience and additional field work during FY 2008-09.

3.2.2.3 Playa Wetlands

The central feature of a playa is a seasonal or perennial body of very sodic (i.e., strongly alkaline) or saline water less than 2m deep that is larger than the adjacent, fringing wetland. The benthic sediments of a playa are mostly very fine-grain clays and silts. The fringing wetlands are characterized by grasses and herbaceous plants tolerant of the soluble salts that accumulate along the margins of the playas (Gustavson *et al.* 1994, Rocchio 2006). Playas differ from vernal pools by having little or no vascular vegetation within the area that is seasonally saturated or inundated. 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). The shallowness of playas and their high salinity or alkalinity distinguishes them from lacustrine systems.

3.2.2.4 Estuarine Wetlands

An estuary consists of aquatic (i.e., sub-tidal) and semi-aquatic (i.e., intertidal) environments that are strongly influenced by mixtures of ocean water and upland runoff due to tidal processes operating through an ocean inlet. Estuaries are mostly enclosed by land. Their inlets may be natural or unnatural. Typical sources of freshwater include rivers, streams, lakes and reservoirs, point discharges (e.g., effluent from sewage treatment facilities), and storm drains.

An estuarine wetland consists of the vegetated marsh plain, its pannes, potholes, hummocks, and other habitat elements of the plain, as well as the natural levees, shell beds, submerged plant beds, and other habitat elements created or supported by tidal processes and associated with tidal channels that tend to dewater at low tide or that are less than 30m wide. Tidal channels that do not tend to dewater at low tide or that are wider than 30m are not considered to be part of the wetland and can serve to separate one estuarine wetland from another.

3.2.2.4.1 Perennial Saline Estuarine Wetland Sub-type

For the purposes of CRAM, saline estuarine wetlands are distinguished from non-saline estuarine wetlands by the obvious dominance of salt-tolerant species of emergent vascular vegetation, such as cordgrass (*Spartina* spp.), pickleweed (*Salicornia* spp.), and salt grass (*Distichlis* spp.) along the foreshore of the wetland and along the immediate banks of the larger tidal channels that tend to dewater at low tide.

3.2.2.4.2 Perennial Non-saline Estuarine Wetland Sub-type

In non-saline wetlands (i.e., brackish or freshwater estuarine wetlands), the plant community along the foreshore of the wetland and along the immediate banks of the larger tidal channels that tend to dewater at low tide is dominated by species that don't tolerate high salinities, such as cattails (*Typha* spp.), rushes (*Scirpus species),* and willows (*Salix* spp.).

3.2.2.4.3 Seasonal Estuarine Wetland Sub-type

Seasonal estuaries are the reaches of coastal rivers and streams that are ecologically influenced by seasonal closures of their tidal inlets. The frequency and duration of inlet closure can be natural or managed. The tidal regime can be muted or not (i.e., the tidal range can be the same or less than that of the adjacent marine or estuarine system when the tidal inlet is open). The salinity regime of a seasonal estuary can be highly variable. It can be fresh throughout very wet years or hypersaline during extended droughts. Some seasonal estuaries are locally referred to as lagoons.

3.2.2.5 Lacustrine Wetlands

Lacustrine systems are lentic water bodies that usually exceed 8 hectares in total area during the dry season and that usually have a maximum dry season depth of at least 2m. They are deeper and larger than depressional wetlands or vernal pools or playas. Some lacustrine systems are separated from estuarine or marine systems by barrier beaches, dunes, or other natural or artificial barriers that are occasionally but irregularly breached. Some of these coastal lacustrine systems are locally referred to as lagoons. Here they are regarded as lacustrine systems because they resemble other lacustrine systems based on CRAM attributes and metrics.

3.2.2.6 Slope Wetlands

Slope wetlands form due to seasonal or perennial emergence of groundwater into the root zone or across the ground surface. Their hydroperiods are mainly controlled by unidirectional subsurface flow.

3.2.2.6.1 Seeps and Springs

These are slope wetlands that occur on hillsides or at the bases of dunes, hills, alluvial fans, etc. Springs are indicated by groundwater emerging and flowing across the ground surface or through indistinct or very small rivulets, runnels, and other features that are too small to be called a creek or riverine system. They often lack the features of riverine channels, such as a thalweg or floodplain. Seeps are similar to springs but lack a single-dominant origin of surface flow. Most of the flow is confined to the root zone and is not evident on the ground surface.

3.2.2.6.2 Wet Meadows

Wet meadows include bogs, fens, and alpine meadows where the hydrology is controlled mainly by fluctuations in ground water levels. They are associated with broad, gentle topographic gradients along which the near-surface ground water moves advectively, albeit slowly, in one dominant direction. If the hydroperiod of a wetland that looks like a wet meadow mainly depends on direct precipitation, then it is a depressional wetland (see Sections 3.2.2.2 and 3.2.2.3 above). Channels can lead into and from a wet meadow, but not all the way through it. If surface water moves through the wetland in a well-defined channel, then the wetland is riverine.

3.4 Step 4: Verify the Appropriate Assessment Window

The Assessment Window is the period of time each year when assessments of wetland condition based on CRAM should be conducted. One Assessment Window exists for all attributes and metrics of each wetland type, but different types of wetlands can have different Assessment Windows. For example, the window is not the same for vernal pools and estuarine wetlands.

In general, the CRAM Assessment Window falls within the growing season for the characteristic plant community of the wetland type to be assessed. For wetlands that are not subject to snowfall and that are non-tidal, the main growing season usually extends from March through September, although it may begin earlier at lower latitudes and altitudes. The growing season tends to start earlier and last longer in tidal wetlands than adjoining non-tidal wetlands due to the seasonal variations in tidal inundation. 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 snow pack. For seasonal wetlands (e.g., vernal pools, playas, and some seeps), the growing season will generally be March through June, although it can be much shorter for vernal pools.

Since the timing of the growing season varies with altitude 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 any given wetland types. For example, the assessment of seasonal depressional wetlands might begin after the start of the growing season (the window is opening) but before summertime desiccation of the wetland soils (the window is closing). Some experts can reconstruct conditions for the Assessment Window after it closes based on forensic botany and other field techniques. It should be clearly noted on the CRAM data sheets, however, if an assessment is being done outside the designated Assessment Window.

Note that the assessment of estuarine wetlands should occur at low tide, when most of the smaller intertidal channels of the wetland are dewatered and associated benthic indicators of conditions are visible.

Also note that riverine wetlands should not be assessed during high water, not only because some important indicators of channel condition 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)

The Assessment Area (AA) is the portion of the Wetland that is assessed using CRAM. An AA might include a small wetland in its entirety. But, in most cases the wetland will be larger than the AA. Rules are therefore needed to delineate the AA.

Establishing a proper AA is a critical step in correctly performing a rapid assessment using CRAM. As explained below, the use of an incorrect AA can yield results that are not reproducible, and that are not likely to relate to stressors or management actions. The delineation of the boundary of an AA must adhere to the following guidelines.

It is assumed that different wetlands, even neighboring wetlands of the same type, can be managed differently, or for different purposes, and can be subject to different stressors. Therefore, each AA must not encompass or involve more than one wetland, as defined in the Level 1 inventory.

Since CRAM metrics vary between wetland types, each AA must only represent one type of wetland. Different types of wetlands can be contiguous with each other, or even nested one within the other, but each AA must only represent one wetland type.

The wetland AA must be classified using the typology provided in Section 3.2.2 and it must be assessed using the metrics designed for its wetland type. Misclassification of wetlands can lead to using the wrong CRAM module, which in turn will lead to spurious assessments.

Each of the additional considerations outlined below, if applied alone, could lead to defining a different AA for the same wetland. The delineation of an AA is therefore an optimization among these considerations. Experience has shown, however, that for the purpose of standardizing the AAs for any wetland type, the overriding considerations are hydro-geomorphic integrity and size.

3.5.1 Hydro-geomorphic Integrity

Wetland managers need to be able to distinguish between the effects of management actions and the natural variability within and among wetlands of any given type based on CRAM scores. In effect, the AA should help maximize the CRAM signal-to-noise ratio.

Each AA must therefore encompass most if not all of the natural spatial variability in the visible form and structure of its encompassing wetland, and the AA should also encompass most of the internal workings of the wetland that account for its homeostasis – its tendency to maintain a certain overall condition or return to it during or after significant stress or disturbance.

For an AA to have this desired level of integrity, it should be bounded by obvious physical changes in topography, hydrology, or infrastructure that significantly control the sources, volumes, rates, or general composition of sediment supplies or water supplies within the AA at the time of the field assessment. In essence, the boundaries of an AA should not extend beyond any features that represent or cause a major spatial change in water source or sediment source.

One way to visualize the AA is to identify the spatial scale at which the structure and form of the wetland seem to repeat themselves (i.e., the scale at which self-similarity becomes evident). This is assumed to be the scale at which the internal workings of the wetland yield the least variability in form and structure. For example, the s-shaped curve created by two consecutive river bends tends to have a wave length equal to 10x the average width of the river through the bends (Leopold 1994). Also, large estuarine wetlands tend to consist of a number of drainage networks of very similar length and drainage area for any given drainage order (Collins *et al.* 1987, Collins and Grossinger 2004). Shorelines can be characterized by alternating reaches of erosion and deposition that repeat themselves at certain spatial scales relating to wave fetch and shoreline geology (e.g., Philips 1986). Observing the patterns of self-similarity for a given wetland type can help identify the dimensions of the appropriate AA.

3.5.2 AA Size

For any given wetland type, larger AAs might tend to yield higher CRAM scores. This is because CRAM is especially sensitive to wetland structural complexity, and larger AAs can afford more opportunity to encounter variability in structure. For any given wetland type, having AAs of very different sizes can introduce variability into CRAM scores.

As stated above, one of the primary considerations for delineating an AA is its hydro-geomorphic integrity. The boundaries of the AA should be established based on clear breaks in surface hydrology, sediment supply, or geomorphology (see Tables 3.5 and 3.6 below). Experience has shown, however, that most of the AAs of each wetland type that are delineated according to indicators of hydro-geomorphic integrity fall within a narrow range of size, although their shapes are more variable. This suggests that size guidelines can be applied to the process of establishing an AA without necessarily violating the criterion for the hydro-geomorphic integrity of the AA.

Furthermore, in some cases the self-similar, self-organizing, integral area of a wetland is not clearly evident. For example, some wet meadows, brackish estuarine wetlands, large riverine systems, and fringing wetlands of playas and lacustrine systems lack obvious hydrological breaks or other features that clearly demarcate changes in water supplies or sediment supplies. In these cases, overall size may be the dominant criterion for delineating the AA.

The preferred AA size is generally greater for types of wetlands that tend to have broad, level planes than for wetlands fringing steep terrain. The size-frequency distribution of wetlands for each wetland type (a Level 1 analysis) was also considered when the recommendations for AA sizes were being developed.

Examples of features that should be used to delineate an AA, and other features that should not be used, are listed in Tables 3.5 and 3.6 below. The preferred and minimum AA sizes for each wetland type are presented below in Table 3.7.

To the degree possible, the delineation of an AA should first be based on the hydro-geomorphic considerations presented in Tables 3.5 and 3.6. But, if these considerations are not applicable, or if the resulting AA is more than about 25% larger than the preferred size presented in Table 3.7, then the AA delineation should rely only on the size guidelines. The number of AAs per wetland will depend on the purpose of the assessment, as outlined in Table 3.8.

Table 3.5: Examples of features that *should* be used to delineate AA boundaries.

Flow-Through Wetlands	**Non Flow-Though Wetlands**	
Riverine, Estuarine and Slope Wetlands	**Lacustrine, Wet Meadows, Depressional, and Playa Wetlands**	**Vernal Pools and Vernal Pool Systems**
• diversion ditches • end-of-pipe large discharges • grade control or water height control structures • major changes in riverine entrenchment, confinement, degradation, aggradation, slope, or bed form • major channel confluences • water falls • open water areas more than 30 m wide on average or broader than the wetland • transitions between wetland types • foreshores, backshores and uplands at least 5 m wide • weirs, culverts, dams, levees, and other flow control structures	• above-grade roads and fills • berms and levees • jetties and wave deflectors • major point sources or outflows of water • open water areas more than 30 m wide on average or broader than the wetland • foreshores, backshores and uplands at least 5 m wide • weirs and other flow control structures	• above-grade roads and fills • major point sources of water inflows or outflows • weirs, berms, levees and other flow control structures

Table 3.6: Examples of features that should *not* be used to delineate any AAs.

- at-grade, unpaved, single-lane, infrequently used roadways or crossings
- bike paths and jogging trails at grade
- bare ground within what would otherwise be the AA boundary
- equestrian trails
- fences (unless designed to obstruct the movement of wildlife)
- property boundaries
- riffle (or rapid) – glide – pool transitions in a riverine wetland
- spatial changes in land cover or land use along the wetland border
- state and federal jurisdictional boundaries

Table 3.7: Preferred and minimum AA sizes for each wetland type.
Note: Wetlands smaller than the preferred AA sizes can be assessed in their entirety.

<table>
<tr><th>Wetland Type</th><th>Recommended AA Size</th></tr>
<tr><td colspan="2">Slope</td></tr>
<tr><td>Spring or Seep</td><td>Preferred size is 0.50 ha (about 75m x 75m, but shape can vary); there is no minimum size (least examples can be mapped as dots).</td></tr>
<tr><td>Wet Meadow</td><td>Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); minimum size is 0.1 ha (about 30m x 30m).</td></tr>
<tr><td colspan="2">Depressional</td></tr>
<tr><td>Vernal Pool</td><td>There are no size limits (see Section 3.5.6 and Table 3.8).</td></tr>
<tr><td>Vernal Pool System</td><td>Preferred size is 1.0 km (about 300m x 300m, but shape can vary); There is no minimum size (see Section 3.5.6 and Table 3.8).</td></tr>
<tr><td>Other Depressional</td><td>Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.1 ha (about 30m x 30m).</td></tr>
<tr><td colspan="2">Riverine</td></tr>
<tr><td>Confined and Non-confined</td><td>Preferred length is 10x average bankfull channel width; maximum length is 200m; minimum length is 100m.
AA should extend laterally (landward) to encompass all the vegetation (trees, shrubs vines, etc) that probably provide woody debris, leaves, insects, etc. directly to the channel and its floodplain (Figure 3.4); minimum width is 2m.</td></tr>
<tr><td>Lacustrine</td><td>Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.5 ha (about 75m x 75m).</td></tr>
<tr><td>Playa</td><td>Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.5 ha (about 75m x 75m).</td></tr>
<tr><td colspan="2">Estuarine</td></tr>
<tr><td>Perennial Saline</td><td rowspan="3">Preferred size and shape for estuarine wetlands is a 1.0 ha circle (radius about 55m), but the shape can be non-circular if necessary to fit the wetland and to meet hydro-geomorphic and other criteria as outlined in Sections 3.5.1 through 3.5.3. The minimum size is 0.1 ha (about 30m x 30m).</td></tr>
<tr><td>Perennial Non-saline</td></tr>
<tr><td>Seasonal</td></tr>
</table>

3.5.3 Assessment Purpose

There are two primary purposes for using CRAM. It is used to assess the ambient condition of a population of wetlands or to assess the condition of an individual wetland or wetland project.

The same guidelines for delineating AAs (see Tables 3.5 through 3.7 above) pertain to project assessments and ambient assessments using CRAM.

However, the number of AAs per wetland can vary between ambient surveys and individual wetland assessments. Multiple AAs might be required to assess the average condition of a wetland project that is many times larger than one AA, whereas just one AA would be required in the same wetland if it were only being assessed as part of an ambient survey (see Table 3.8).

Table 3.8: Guidelines for determining the number of AAs per wetland.

	Assessment Scenario
Single AA	If the size of the wetland is within the size limits given in Table 3.7, then the entire wetland constitutes the AA, regardless of the purpose of the assessment. Or If the wetland is one in a population of wetlands to be assessed as part of an ambient survey, then delineate one AA around each point randomly selected within the wetland as part of the sample draw from the ambient sample frame. For more information about ambient sampling design go to http://epa.gov/nheerl/arm/designing/design_intro.htm.
Multiple AAs	If the wetland is about twice as large as the preferred size AA from Table 3.7, and if the purpose is to assess the average condition of the wetland, then assess the second AA and report the results for both AAs. Or If the wetland is at least thrice as large as the preferred size AA from Table 3.7, and if the purpose is to assess the average condition of the wetland, then randomly select and assess three AAs from the array of all possible AAs for the wetland. If the overall score for the third AA differs from the average of the first two scores by more than 15%, then assess a randomly selected fourth AA; if its score differs from the average of the first three by more than 15%, then assess a randomly selected fifth AA. Repeat this procedure until the overall score for the latest AA is no more than 15% different than the average of all previous scores, or until the array of possible AAs is exhausted. For more detailed instructions on assessing multiple AAs per wetland, see Section 3.5.8 and Appendix I).
Reporting	The final boundaries of all the AAs of a wetland should be mapped using either the eCRAM software mapping tool or by drawing a heavy pencil line on a hardcopy of the site imagery. Hardcopy maps will need to be digitized using the online version of eCRAM as part of the process of entering CRAM results into the online CRAM database.

3.5.4 Special Considerations for Riverine Wetlands Including Riparian Areas

For a riverine wetland, the AA should begin at a hydrological or geomorphic break in form or structure of the channel that corresponds to a significant change in flow regime or sediment regime, as guided by Tables 3.5 and 3.6. If no such break exists, then the AA can begin at any point near the middle of the wetland. For ambient surveys, the AA should begin at the point drawn at random from the sample frame (for more information about ambient survey designs go to http://epa.gov/nheerl/arm/designing/design_intro.htm). From this beginning, the AA should extend upstream for a distance ten times (10x) the average channel width, but at least 100m, and no further than 200m. In any case, the AA should not extend upstream of any confluence that obviously increases the downstream sediment supply or flow, or if the channel in the AA is obviously larger below the confluence than above it. The AA should include both sides of wadeable channels, but only one side of channels that can't be safely crossed by wading.

All types of wetlands can have adjacent riparian areas. However, riparian areas play a larger role in the overall form and function of riverine wetlands than other wetland types. Riverine wetlands are generally more dependent on the allochthanous riparian input to support their food webs. Also, the large woody debris provided by riparian areas can be essential to maintain riverine geomorphology, such as pools and riffles, as well as the associated ecological services, such the support of anadromous fishes.

Therefore, the riverine AA should extend landward from the backshore of the floodplain to include the adjacent riparian area that probably accounts for bank stabilization and most of the direct allochthanous inputs of leaves, limbs, insects, etc. into the channel including its floodplain. Any trees or shrubs that directly contribute allochthanous material to the channel should be included in the AA in their entirety (Figure 3.4). The AA can include topographic benches, interfluves, paleo-channels, terraces, meander cutoffs, and other features that are at least semi-regularly influenced by fluvial processes associated with the main channel of the AA or that support vegetation that is likely to directly provide allochthanous inputs.

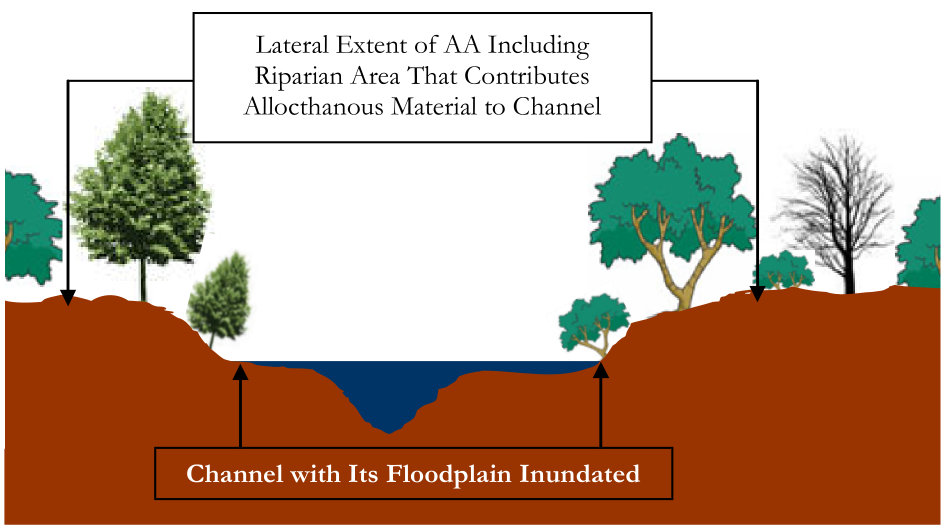


Figure 3.4: Cross-section of riverine AA including portion of riparian area that affects channel bank stability and allochthanous inputs.

In some cases, the lateral limit of allochthanous input is not readily discernable. The vegetation along riverine channels in grasslands, croplands, or urban areas might seem too short or sparse to provide direct allochthanous input. In such cases, the lateral extent of the riparian portion of the AA is calculated as twice (2x) the height of the dominant plant cover along the channel, or 2m, which ever is wider. The opposing sides (different banks) of a riverine AA can have different riparian widths, based on differences in plant architecture.

3.5.5 Special Considerations for Estuarine Wetlands

The boundary of an estuarine wetland AA should be determined during low tide. If possible, the AA should be circular, but it can be non-circular as required to fit the wetland and to conform to the size and hydro-geomorphic criteria outlined in Sections 3.5.1-3. It should not extend above the backshore, as indicated by wrack lines, transitions from intertidal to upland vegetation, etc., and it should not extend more than 10m across a non-vegetated tidal flat that adjoins the foreshore. The AA should not extend across any tidal channel that is wider than 30m or that cannot be safely crossed at low tide. The boundary of the AA can extend along the midline of such channels but not across them. The AA can incorporate any smaller channels that can be safely crossed on the ground. 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 can be crossed, plus the exposed banks and beds of channels that border the AA. But, the AA should not extend further than 10m onto any tidal flat that adjoins the foreshore (Figure 3.5).

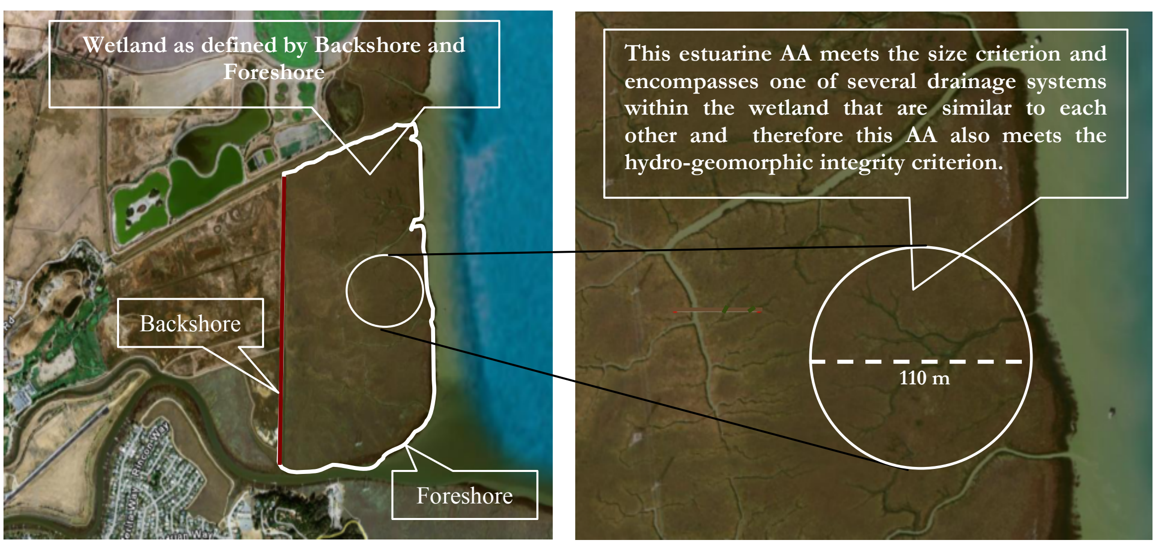


Figure 3.5: Example of an estuarine wetland and a characteristic Assessment Area.

3.5.6 Special Considerations for Vernal Pool Systems

Vernal pool systems consist of multiple, hydrologically interconnected vernal pools and vernal swales plus their surrounding upland matrix or riparian area. The larger systems consist of tributaries that converge downslope and are separated in their headward reaches by subtle topographic divides. The drainage divides are apparent in aerial imagery and in the field as corridors of relatively high ground covered by upland vegetation and lacking many vernal pools.

Delineating a vernal pool system requires careful examination of aerial imaging and field reconnaissance to identify the pathways of surface flow that links pools together. Once the flow path of a system has been traced, then the large pools and small pools are separately coded on the site imagery (Figure 3.6). There are no fixed numerical criteria for distinguishing large pools from small pools; large pools are simply much larger than small pools.

Table 3.9: Steps to delineate a vernal pool system and its component large and small pools.

Step	Vernal Pool System Delineation Task
1	On the site imagery, trace the interconnected pathways of surface flow for one pool system up to 10 ha in size (see Table 3.7).
2	Delineate and number all large pools within the pool system from Step 1.
3	Delineate and number all small pools within each pool system from Step 1.
4	The pools delineated in Steps 2 and 3 comprise the AA.
5	Randomly select three small pools and three large pools from the AA. These pools will be assessed individually and their scores will be averaged.

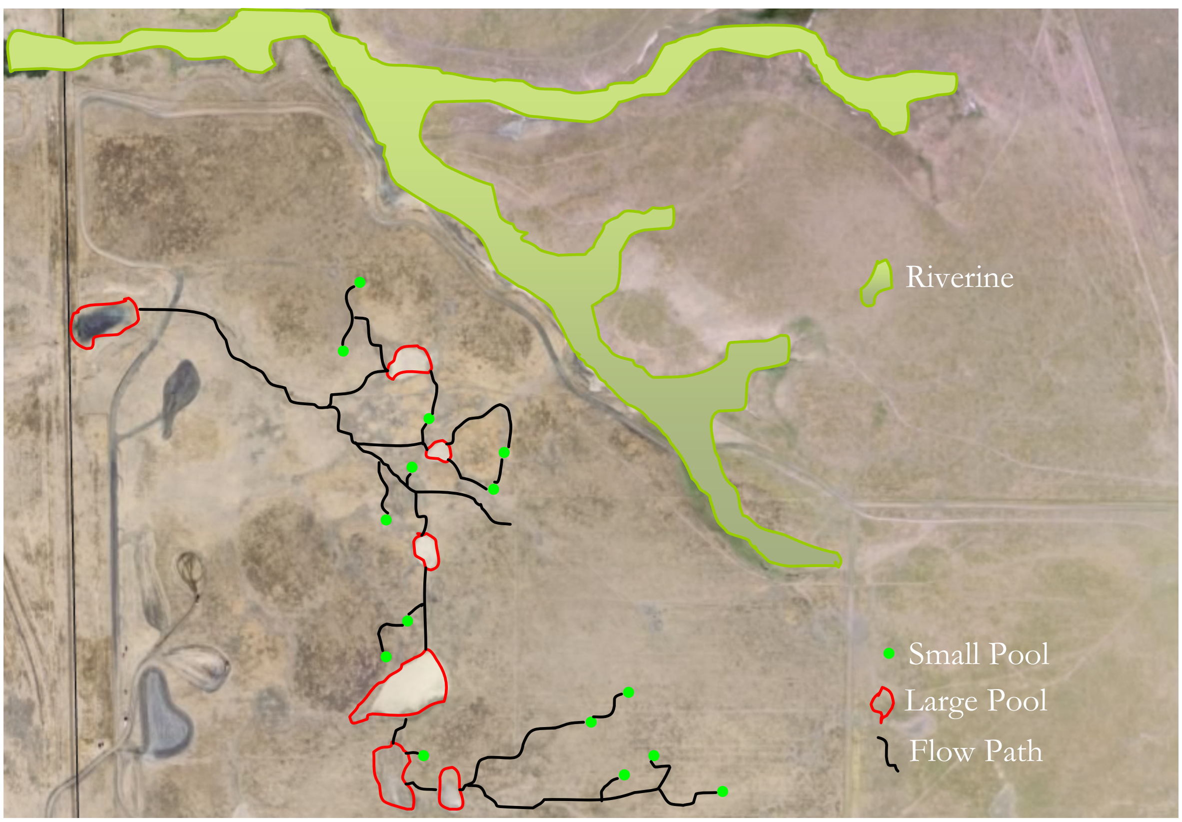


Figure 3.6: Example map of one vernal pool system and its component elements.

3.5.7 Special Considerations for Post-assessment Analysis

For CRAM scores to be comparable they must be standardized in terms of time (i.e., scores should represent comparable amounts of assessment effort during comparable years and times of year), and in terms of space (i.e., for any given wetland type, the scores should represent comparable amounts of wetlands, and these should have hydrological and ecological integrity; see Section 3.5.2 above).

For a variety of reasons, scores that do not meet these standards cannot be compared and cannot be combined into datasets. For example, assessments that take longer or that involve larger areas are likely to encounter more structural complexity and therefore yield higher scores.

The use of Assessment Windows (see Section 3.4 above), fixed assessment times (i.e., no assessment should take longer than one half day in the field), recommended AA sizes, and guidelines for assembling data of varying vintage will achieve more consistent assessment results.

To achieve the spatial standards, each AA for each wetland type should fall within a standard size range that is large enough to incorporate the natural processes of homeostasis that characterize the wetland (see discussion of AA integrity in Section 3.5.2), but small enough to meet the time constraints (see Table 3.7).

An additional spatial consideration for ambient surveys is that the probability of any wetland within a given area being selected for assessment increases with its size, and weighting CRAM scores for the inclusion probabilities of their associated AAs depends on having a standard AA size range for each wetland type. For more information about ambient sampling design go to http://epa.gov/nheerl/arm/designing/design_intro.htm.

Standardizing the shape of AAs (e.g., having all AAs be circles or squares of fixed size) may increase the ease with which they are delineated, but may also lead to a disregard of features such as water control structures that affect AA integrity. Standardizing the shapes of AAs is less important than standardizing their sizes.

3.5.8 Special Considerations for Assessing Projects

For the purposes of CRAM, a "project" is an area of wetland that is subject to physical change as authorized under Section 404 of the US Clean Water Act, under the State's 401 Certification Program, or under Section 1600 of the State's Fish and Game Code. Such projects are often at least partly delimited by property lines or other administrative or legal boundaries. Wetland restoration projects, mitigation projects, mitigation banks, and wetlands that are targeted for development (i.e., impacted wetlands) are often delimited by property lines.

Property lines, jurisdictional limits, and other administrative or legal boundaries should not automatically be used to delineate AAs, except for the assessment of a project, in which case the wetland and its AA(s) are confined to the project boundaries. A formal wetland Jurisdictional Delineations (JD) in good standing for a project can be used in the absence of any other wetland map to define the wetland and to help delimit the AA(s). If the project is much larger than one AA, then the process outlined in Appendix I should be used to assess multiple AAs.

The best achievable condition of a project might be unavoidably constrained by adjacent or nearby land uses. In these situations, the expected or target level of performance of a project might be adjusted for the land use constraints. In other words, although a project is assessed relative to the best achievable conditions for its wetland type throughout the State, what is expected or deemed acceptable for any particular project might reflect its land use setting. For example, stream restoration projects in urban landscapes need not be held to the same standards of high performance as projects in rural or non-developed landscapes. As CRAM scores accumulate throughout the State, their relationship to land use setting can be analyzed to guide local adjustments in project performance criteria that are based on CRAM.

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

For each CRAM assessment, there is 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 (e.g., aerial photography, reports, etc.), prior to conducting any 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 3.10 below.

Table 3.10: CRAM metrics suitable for pre-site visit draft assessment.

<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="8">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="6">Biotic</td><td>Number of Plant Layers Present</td><td>No</td></tr>
<tr><td>Number of Co-dominant Species</td><td>No</td></tr>
<tr><td>Native Plant Species Richness</td><td>No</td></tr>
<tr><td>Percent Invasion</td><td>No</td></tr>
<tr><td>Horizontal Interspersion and Zonation</td><td>No</td></tr>
<tr><td>Vertical Biotic Structure</td><td>No</td></tr>
</table>

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 $9m^2$ 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 from the National Agriculture Imagery Program (NAIP) for the entire state. The eCRAM software is designed to work with any geo-rectified imagery that can be loaded into the image directory and then used with a tablet computer or laptop in the field to map AAs and to conduct the assessment using CRAM.

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 the 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 validation exercises. Letter scores for each metric (A, B, C, D) are simply converted into whole integer scores (12, 9, 6, 3, respectively; see Step 1 in Table 3.11).

For the Hydrology and Physical Structure attributes, the attribute scores are simply calculated as the sum of the component metric scores (see Step 2 in Table 3.11).

For the Buffer and Landscape Context attribute, the submetric scores relating to buffer are combined into an overall buffer score that is added to the score for the Landscape Connectivity metric, using the formula in Step 2 in Table 3.11.

For the Biotic Structure attribute, the Plant Community metric consists of three submetrics (Number of Plant Layers Present; Number of Co-dominant Species; and Percent Invasion). Prior to calculating the Biotic Structure attribute score, the values for these submetrics must be averaged. Then the Biotic Structure attribute score can be calculated as described in Table 3.11.

Each raw attribute score is then converted into a percentage of the maximum possible score (see Step 3 in Table 3.11). 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.

An overall AA score is calculated by averaging the attribute scores. All scores are rounded to the nearest whole percentage value (see Step 4 in Table 3.11).

Different wetlands are likely to have different functions and ecological services due to differences in wetland form, structure, geomorphic setting, climatic regime, evolutionary stage, stressor regime, etc. It is therefore unlikely that the same CRAM score represents the same level of function or even the same set of functions for different wetlands. CRAM scores cannot be used to infer wetland function except in the context of correlations between CRAM scores and actual functional levels, as measured using Level 3 methods. Validation efforts to date indicate that CRAM scores are strongly correlated to a variety of wetland functions and services.

It is expected that the same scores for different wetlands of the same type probably represent the same overall condition and functional capacity. CRAM can therefore be used to track the progress of restoration efforts over time, to compare impacted sites to their in-kind mitigation sites, or to compare an individual wetland to the status and trends in ambient condition of its wetland type.

CRAM scores can also be used to compare the status and trends of different types of wetlands. This is because all wetlands are assessed relative to their best achievable condition. For example, separate ambient surveys of lacustrine and estuarine wetlands might reveal that one type is doing better than the other, relative to their particular overall best achievable conditions.

Table 3.11: Steps to calculate attribute scores and AA scores.

Step 1: Calculate Metric Score	For each Metric, convert the letter score into the corresponding numeric score: A=12, B=9, C=6 and D=3.
Step 2: Calculate Raw Attribute Score	For each Attribute, calculate the Raw Attribute Score as the sum of the numeric scores of the component Metrics, except in the following cases: • For Attribute 1 (Buffer and Landscape Context), the submetric scores relating to buffer are combined into an overall buffer score that is added to the score for the Landscape Connectivity metric, using the following formula: $\left(\text{Buffer Condition} \times \left(\text{\% AA with Buffer} \times \text{Average Buffer} \right)^{1/2} \right)^{1/2} + \text{Landscape Connectivity}$ • Prior to calculating the Biotic Structure Raw Attribute Score, average the three Plant Community sub-metrics. • For vernal pool systems, first calculate the average score for all three Plant Community sub-metrics for each replicate pool, then average these scores across all six replicate pools; calculate the average Topographic Complexity score for all six replicates.
Step 3: Calculate final Attribute Score	For each Attribute, divide its Raw Score by its maximum possible score, which is 24 for Buffer and Landscape Context, 36 for Hydrology, 24 for Physical Structure, and 36 for Biotic Structure.
Step 4: Calculate the AA Score	Calculate the AA score by averaging the final attribute scores. Round the average to the nearest whole integer.

There are many possible ways to graphically present CRAM scores. The choice should depend on the information to be conveyed and the intended audience. It will not usually be necessary to present metric scores except in the context of validation efforts and to explain attribute scores. The metric scores can be presented effectively, however, as a circular graph that depicts the contribution of each metric to the overall score (e.g., Figure 3.7A). Site-specific and ambient scores can be compared in bar charts (Figure 3.7B). The progress of a restoration or mitigation project can be shown as the change in average overall score relative to performance standards (Figure 3.7C). The ambient conditions of two different types of wetlands can be compared based on the frequency distributions of the overall scores (Figure 3.7D). The ambient condition of any given wetland type can be displayed as the cumulative frequency of overall scores (Figure 3.7E). The graphs pertaining to ambient condition or to any population of wetlands can be produced for a variety of spatial scales, from watersheds or regions to the State as a whole.

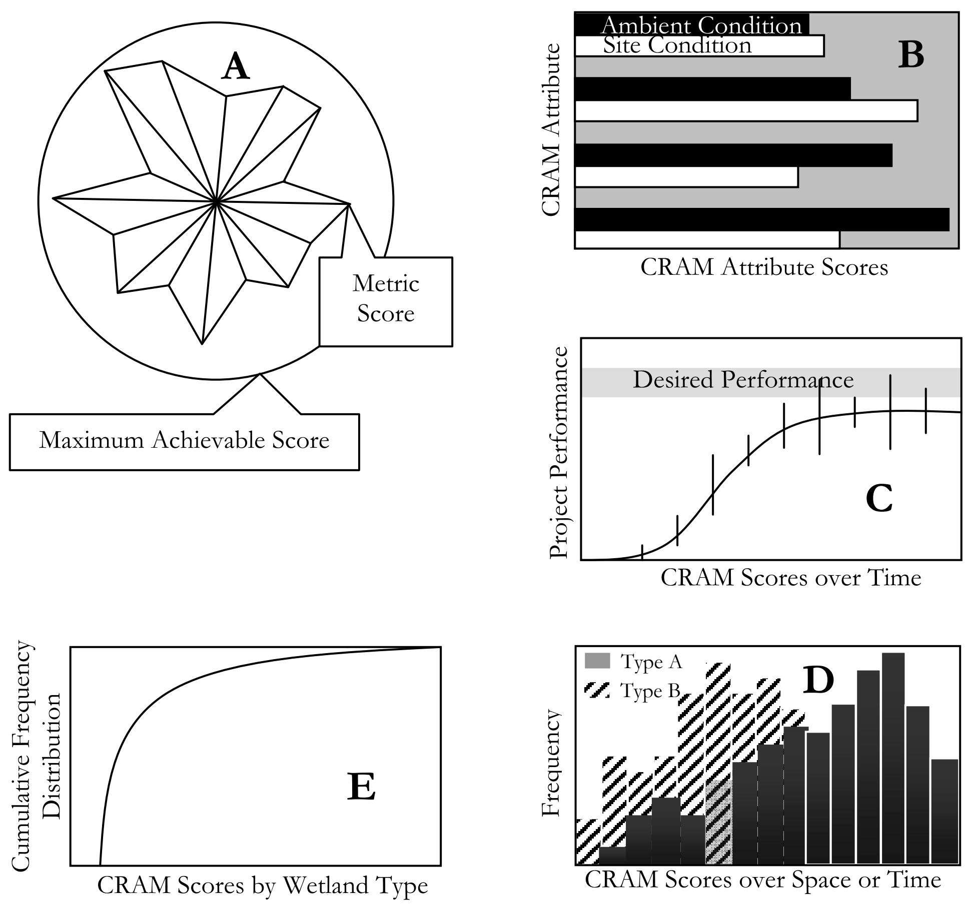


Figure 3.7: Example graphs for displaying CRAM results.

Figure shows (A) "spider plot" of metric scores for one or more AAs (multiple areas would be represented by average scores) (see Ambrose *et al.* 2006); (B) site-specific attribute scores compared to ambinet conditions or reference conditions; (C) changes in AA scores over time for a wetland an project; (D) comparison of two different populations of wetlands based on the frequency distribution of their AA scores; and (E) cummulative frequency distribution of scores for one population of wetlands.

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 conducting CRAM assessments. For large wetland projects having numerous AAs and for ambient assessments involving multiple wetlands, it is recommended that at least 10% of the AAs be revisited by an independent CRAM assessment team and compared to the original assessments for the same AAs. The replicate scores should be within 10% of the original scores for each attribute.

Beginning in 2008, CRAM Training Courses will be offered through the Extension Service of the University of California at Davis (http://extension.ucdavis.edu/). Each three-day courses provides an introductory lecture, training on 2-3 wetland types, and training on eCRAM.

In addition to taking on or more CRAM training courses through UC Davis Extension, 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 User's 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 control procedures for any assessment involve a basic review of the AA map and the summary scoring sheet. The recommended topics for the initial quality control are listed in Table 3.12 below.

Table 3.12: 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 type, 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 Quality Control 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 and resource managers. Procedures described in this User's 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 followed.

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

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 regional Information Center of the California Environmental Data Exchange Network (CEDEN). Expansion of data management to include other regional data centers is expected. The eCRAM software, the CRAM database, and its supporting web sites are open source. No aspect of CRAM programming is proprietary. The CRAM database incorporates numerous measures to assure accurate data entry and processing, including the following.

- Each database field that requires a value is checked for null or missing values.
- Standard codes are provided in look-up lists for 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 one record set is related to another, it is checked for orphan records (parent records have child records and 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 are password-protected; data authors can only access and edit their own data.
- All data are time-stamped and automatically assigned to a unique site code.
- Database users are automatically 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 for hardcopy versions of CRAM must be transcribed into the electronic version on the web site. Results obtained by using eCRAM 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. All results can be viewed and downloaded by the public through interactive maps at the CRAM web site.

Joshua N. Collins

Riverine and riparian wetland, Carriger Creek, Sonoma 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 types and regions of the State. The wetland types 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 adjusting any metric for regional differences in any wetland type.

A full set of data sheets and worksheets for each wetland type is provided on the CRAM website (www.cramwetlands.org) as a basic hardcopy field book 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 and its surrounding environment that is likely to help protect the wetland from anthropogenic stress (see Figure 2.2). Areas adjoining wetlands that probably do not provide protection are not considered buffers.

Buffers can protect wetlands by filtering pollutants, providing refuge for wetland wildlife during times of high water levels, acting as barriers to disruptive incursions by people and pets into wetlands, and moderating predation by ground-dwelling terrestrial predators. Buffers can also reduce the risk of invasion by non-native plants and animals, by either obstructing terrestrial corridors of invasion or by helping to maintain the integrity and therefore the resistance of wetland communities to invasions.

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

4.1.1 Landscape Connectivity

A. Definition: The landscape connectivity of an Assessment Area is assessed in terms of its spatial association with other areas of aquatic resources, such as other wetlands, lakes, streams, etc. 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. 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: 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.

All wetlands except riverine: On digital or hardcopy site imagery, draw a straight line extending 500 m from the AA boundary in each of the four cardinal compass directions. The lines should intercept the approximate centroid of the AA. Along each transect line, estimate the percentage of the segment that passes through wetland or aquatic habitat of any kind, including open water. Vernal pool systems should be considered aquatic habitat. Use the worksheet below to record these estimates.

Worksheet 4.1: Landscape Connectivity Metric for All Wetlands Except Riverine

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

Table 4.1: Rating for Landscape Connectivity for all wetlands except Riverine.

Rating	Alternative States
A	An average of 76 – 100 % of the transects is wetland habitat of any kind.
B	An average of 51 – 75 % of the transects is wetland habitat of any kind.
C	An average of 26 – 50 % of the transects is wetland habitat of any kind.
D	An average of 0 – 25 % of the transects is wetland habitat of any kind.

Riverine wetlands: For riverine wetlands, landscape connectivity is assessed as the continuity of the riparian corridor over a distance of about 500 m upstream and 500 m downstream of the AA. Of special concern is the ability of wildlife to enter the riparian area from outside of it at any place within 500 m of the AA, and to move easily through adequate cover along the riparian corridor through the AA from upstream and downstream. The landscape connectivity of riverine wetlands is assessed as the total amount of non-buffer land cover (as defined in Table 4.4) that interrupts the riparian corridor within 500m upstream or downstream of the AA. Non-buffer land covers less than 10m wide are disregarded in this metric.

Note that, for riverine wetlands, this metric considers areas of open water to provide landscape connectivity. For the purpose of assessing buffers, open water is considered a non-buffer land cover. But for the purpose of assessing landscape connectivity for riverine wetlands, open water is considered part of the riparian corridor. This acknowledges the role that riparian corridors have in linking together aquatic habitats and in providing habitat for anadromous fish and other wildlife.

Table 4.2: Steps to assess Landscape Connectivity for riverine wetlands.

Step 1	Extend the AA 500 m upstream and downstream, regardless of the land cover types that are encountered (see Figure 4.1).
Step 2	Using the site imagery, identify all the places where non-buffer land covers (see Table 4.4) at least 10 m wide interrupt the riparian area on at least one side of the channel in the extended AA. Disregard interruptions of the riparian corridor that are less than 10m wide. Do not consider open water as an interruption.
Step 3	Estimate the length of each non-buffer segment identified in Step 2, and enter the estimates in the worksheet for this metric.

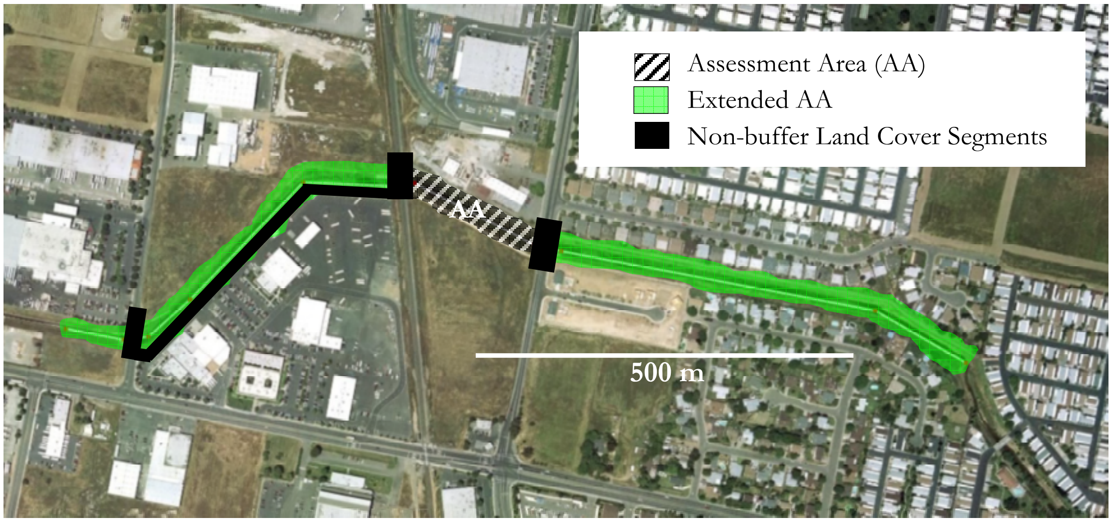


Figure 4.1: Diagram of method to assess Landscape Connectivity of riverine wetlands. This example shows that about 400 m of non-buffer cover crosses at least one half of the buffer corridor within 500 m downstream of the AA, and about 10 m crosses the corridor upstream of the AA.

Worksheet 4.2: Landscape Connectivity Metric for Riverine Wetlands

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

Table 4.3: Rating for Landscape Connectivity for Riverine wetlands.

Notes:

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

b. Assume that open water areas serve as buffer (only for this metric as it applies to riverine wetlands).

c. The minimum length for any non-buffer segment (measured parallel to the channel) is 10 m.

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

e. For wadeable systems, assess both sides of the channel upstream and downstream of the AA.

f. For systems that cannot be waded, only assess the accessible side of the channel, upstream and downstream of the AA.

Table 4.3 (Continued): Rating for Landscape Connectivity for Riverine wetlands.

Rating	For Distance of 500 m Upstream of AA:	For Distance of 500 m Downstream of AA:
A	The combined total length of all non-buffer segments is less than 100 m for wadeable systems ("2-sided" AAs); 50 m for non-wadeable systems ("1-sided" AAs).	The combined total length of all non-buffer segments is less than 100 m for wadeable systems ("2-sided" AAs); 50 m for non-wadeable systems ("1-sided" AAs).
B	The combined total length of all non-buffer segments is less than 100 m for "2-sided" AAs; 50 m for "1-sided" AAs.	The combined total length of all non-buffer segments is between 100 m and 200 m for "2-sided" AAs; 50 m and 100 m for "1-sided" AAs.
OR		
B	The combined total length of all non-buffer segments is between 100 m and 200 m for "2-sided" AAs; 50 m and 100 m for "1-sided" AAs.	The combined total length of all non-buffer segments is less than 100 m for "2-sided" AAs; is less than 50 m for "1-sided" AAs.
C	The combined total length of all non-buffer segments is between 100 m and 200 m for "2-sided" AAs; 50 m and 100 m for "1-sided" AAs.	The combined total length of all non-buffer segments is between 100 m and 200 m for "2-sided" AAs; 50 m and 100 m for "1-sided" AAs.
D	The combined total length of non-buffer segments is greater than 200 m for "2-sided" AAs; greater than 100 m for "1-sided" AAs.	any condition
OR		
D	any condition	The combined total length of non-buffer segments is greater than 200 m for "2-sided" AAs; greater than 100 m for "1-sided" AAs.

4.1.2 Percent of AA with Buffer

A. Definition: The buffer is the area adjoining the AA that is in a natural or semi-natural state and currently not dedicated to anthropogenic uses that would severely detract from its ability to entrap contaminants, discourage visitation into the AA by people and non-native predators, or otherwise protect the AA from stress and disturbance.

B. Rationale: The ability of buffers to protect a wetland increases with buffer extent along the wetland perimeter. For some kinds of stress, such as predation by feral pets or disruption of plant communities by cattle, small breaks in buffers may be adequate to nullify the benefits of an existing buffer. However, for most stressors, small breaks in buffers caused by such features as trails and small, unpaved roadways probably do not significantly disrupt the buffer functions.

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 visually estimating the total percentage of the perimeter of the

AA that adjoins land cover types that usually provide buffer functions (see Table 4.3). To be considered as buffer, a suitable land cover type must be at least 5 m wide and extend along the perimeter of the AA for at least 5 m. The maximum width of the buffer is 250 m. At distances beyond 250 m from the AA, the buffer becomes part of the landscape context of the AA.

Any area of open water at least 30 m wide that is adjoining the AA, such as a lake, large river, or large slough, is not considered in the assessment of the buffer. Such open water is considered to be neutral, neither part of the wetland nor part of the buffer. There are three reasons for excluding large areas of open water (i.e., more than 30 m wide) from Assessment Areas and their buffers. First, assessments of buffer extent and buffer width are 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 of stress (i.e., promotes human visitation, encourages intensive use by livestock looking for water, provides dispersal for non-native plant species), or it can be a source of benefits to a wetland (e.g., nutrients, propagules of native plant species, water that is essential to maintain wetland hydroperiods, etc.). However, any area of open water at least 30 m wide that is within 250 m of the AA but is not adjoining the AA is considered part of the buffer.

In the example below (Figure 4.2), most of the area around the AA (outlined in white) consists of non-buffer land cover types. The AA adjoins a major roadway, parking lot, and other development that is a non-buffer land cover type. There is a nearby wetland but it is separated from the AA by a major roadway and is not considered buffer. The open water area is neutral and not considered in the estimation of the percentage of the AA perimeter that has buffer. In this example, the only areas that would be considered buffer is the area labeled "Upland Buffer".

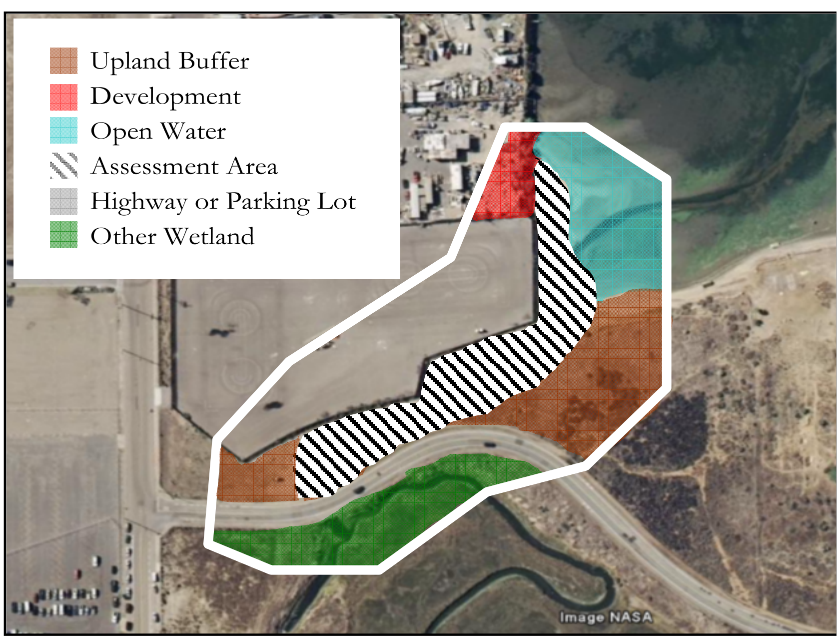


Figure 4.2: Diagram of buffer and non-buffer land cover types.

Table 4.4: Guidelines for identifying wetland buffers and breaks in buffers.

Examples of Land Covers Included in Buffers	**Examples of Land Covers Excluded from Buffers** Notes: Buffers do not cross these land covers; areas of open water adjacent to the AA are not included in the assessment of the AA or its buffer.
• bike trails • dry-land farming areas • foot trails • horse trails • links or target golf courses • natural upland habitats • nature or wildland parks • open range land • railroads • roads not hazardous to wildlife • swales and ditches • vegetated levees	• commercial developments • fences that interfere with the movements of wildlife • intensive agriculture (row crops, orchards and vineyards lacking ground cover and other BMPs) • paved roads (two lanes plus a turning lane or larger) • lawns • parking lots • horse paddocks, feedlots, turkey ranches, etc. • residential developments • sound walls • sports fields • traditional (intensely manicured) golf courses • urbanized parks with active recreation • pedestrian/bike trails (i.e., nearly constant traffic)

Table 4.5: Rating for Percent of AA with Buffer.

Rating	**Alternative States (not including open-water areas)**
A	Buffer is 75 - 100% of AA perimeter.
B	Buffer is 50 – 74% of AA perimeter.
C	Buffer is 25 – 49% of AA perimeter.
D	Buffer is 0 – 24% of AA perimeter.

4.1.3 Average Buffer Width

A. Definition: The average width of the buffer adjoining the AA is estimated by averaging the lengths of straight lines drawn at regular intervals around the AA from its perimeter outward to the nearest non-buffer land cover at least 10 m wide, or to a maximum distance of 250 m, whichever is first encountered. The maximum buffer width is 250 m. The minimum buffer width is 5 m, and the minimum buffer length along the AA perimeter is also 5 m. Any area that is less than 5 m wide and 5 m long is assumed to be too small to provide buffer functions. See Table 4.4 above for more guidance regarding the identification of AA buffers land covers.

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: This procedure can be performed initially in the office using the site imagery, and then revised based on the field visit. The procedure has four steps as presented in Table 4.6 below. There are special considerations for riverine wetlands explained below in Figure 4.4.

Table 4.6: Steps to estimate Buffer Width for all wetlands except Riverine, for which these steps are modified according to Figure 4.4.

Step 1	Identify areas in which open water is within 5 m of the AA. These areas are excluded from buffer calculations.
Step 2	Draw straight lines 250 m in length perpendicular to the AA through the buffer area at regular intervals along the portion of the perimeter of the AA that has a buffer. For one-sided riverine AAs, draw four lines; for all other wetland types, draw eight lines (see Figures 4.3 and 4.4 below).
Step 3	Estimate the buffer width of each of the lines as they extend away from the AA. Record these lengths on the worksheet below.
Step 4	Estimate the average buffer width and record it on the worksheet below.

Figure 4.3: Examples of method used to estimate Buffer Width. It is based on the lengths of eight lines A-H that extend at regular intervals though the buffer areas, whether they are not extensive (A) or all encompassing (B).

Worksheet 4.3: Calculating Average Buffer Width of AA

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

Riverine wetlands: For Riverine wetlands, conduct the steps of Table 4.6 with the following modifications. If the AA includes both sides of the channel (i.e., if the channel is wadeable), then draw four lines through the buffer areas on each side (see Figure 4.4 below). If the AA only exists on one side of the channel, then draw four lines through the buffer on one side (Figure 4.4). No lines should extend from the downstream or upstream ends of the riverine AA. Use worksheet 4.3 to record the data for buffer width.

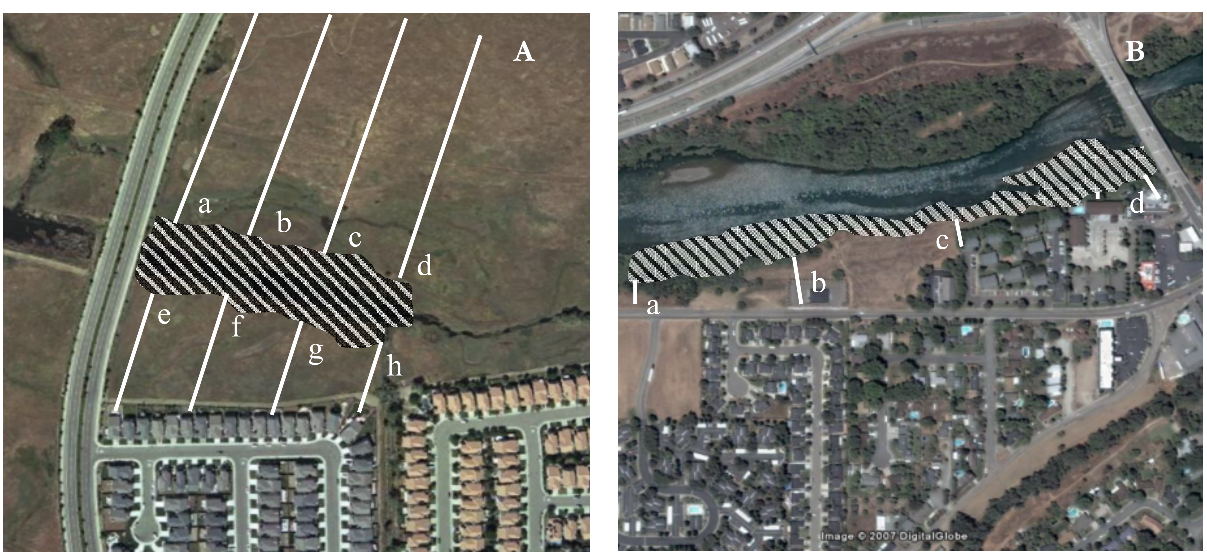


Figure 4.4: Diagram of approach to estimate Buffer Width for Riverine AAs. Widths are measured along lines a-h on both sides of a wadeable channel (A), and along lines a-d on one side of a non-wadeable channel (B).

Table 4.7: Rating for Average Buffer Width (based worksheet 4.3).

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

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 method is the same across all wetland types. 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 4.8. If there is no buffer, assign a score of D.

Table 4.8: Rating for Buffer Condition.

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

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 include inputs of water into the AA as well as any diversions of water from the AA. Diversions are considered a water source because they affect the ability of the AA to function as a source of water for other habitats while also directly affecting the hydrology of the AA.

Inputs of water affecting conditions during the dry season are especially important because they strongly influence the structure and composition of wetland plant and animal communities. The Water Source metric therefore focuses on conditions that affect dry season hydrology.

Natural water sources include precipitation, ground water discharge, and flooding of the AA due to high tides or naturally high riverine flows. Examples of unnatural sources include stormdrains that empty into the AA or into an immediately adjacent area. For seeps and springs that occur at the toes of earthen dams, the reservoirs behind the dams are water sources. Large reservoirs and lakes that do not drain directly into the AA should not be considered water sources, although they can have systemic, ubiquitous, effects on the condition of the AA. For example, although the salinity regimes of some estuarine wetlands in San Francisco Bay are indirectly affected by dams in the Sierra Nevada, others are directly affected by nearby discharges from sewage treatment facilities. This metric focuses on the more direct water sources. Engineered hydrological controls, such as pumps, weirs, and tide gates can serve to demarcate the boundary of an AA (see Section 3.5), but they are not considered water sources.

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

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

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

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

> **Estuarine:** This metric is focused on the non-tidal water sources that account for the aqueous salinity regime of the AA during the early and middle months of the dry season, regardless of the time of year when these sources exist. The focus is usually on the tidal water that enters and exits the AA across the associated foreshore, as well as any local freshwater seeps or artificial sources of non-saline water that enter the site across its backshore. To assess the water source, the plant species composition of the wetland should be compared to what is expected, in terms of the position of the wetland along the salinity gradient of the estuary, as adjusted for the overall wetness of the water year. In general, altered sources are indicated by vegetation that is either more tolerant of saline conditions or less tolerant than would be expected. If the plant community is unexpectedly salt-tolerant, then an unnatural decrease in freshwater supply is indicated. Conversely, if the community is less salt-tolerant than expected, than an unnatural increase in freshwater is indicated.
>
> **Slope Wetlands:** Ground water is the source of water for seeps and springs (i.e., 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).
>
> **Riverine, Depressional, Lacustrine, and Playas:** The natural sources of water for these wetlands are mainly direct rainfall, groundwater discharge, runoff, and riverine flows. 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 can be subtle, multi-directional, and difficult to assess, but significant during wet years. The effects of changes in water sources can be assessed according to the distribution, abundance, and size of individual pools and pool systems, as well as the pattern of plant zonation and interspersion.

Table 4.9: Rating for Water Source.

Rating	Alternative States
A	Freshwater sources that affect the dry season condition of the AA, such as its flow characteristics, hydroperiod, or salinity regime, are precipitation, groundwater, and/or natural runoff, or natural flow from an adjacent freshwater body, or the AA naturally lacks water in the dry season. There is no indication that dry season conditions are substantially controlled by artificial water sources.
B	Freshwater sources that affect the dry season condition of the AA are mostly natural, but also obviously include occasional or small effects of modified hydrology. Indications of such anthropogenic inputs include developed land or irrigated agricultural land that comprises less than 20% of the immediate drainage basin within about 2 km upstream of the AA, or that is characterized by the presence of a few small stormdrains or scattered homes with septic systems. No large point sources or dams control the overall hydrology of the AA.
C	Freshwater sources that affect the dry season conditions of the AA are primarily urban runoff, direct irrigation, pumped water, artificially impounded water, water remaining after diversions, regulated releases of water through a dam, or other artificial hydrology. Indications of substantial artificial hydrology include developed or irrigated agricultural land that comprises more than 20% of the immediate drainage basin within about 2 km upstream of the AA, or the presence of major point source discharges that obviously control the hydrology of the AA. OR Freshwater sources that affect the dry season conditions of the AA are substantially controlled by known diversions of water or other withdrawals directly from the AA, its encompassing wetland, or from its drainage basin within 2 km of the AA.
D	Natural, freshwater sources that affect the dry season conditions of the AA have been eliminated based on the following indicators: impoundment of all possible wet season inflows, diversion of all dry-season inflow, predominance of xeric vegetation, etc.

4.2.2 Hydroperiod or Channel Stability

A. Definition: Hydroperiod is the characteristic frequency and duration of inundation or saturation of a wetland during a typical year. The natural hydroperiod for estuarine wetlands is governed by the tides, and includes predictable variations in inundation regimes over days, weeks, months, and seasons. Depressional, lacustrine, playas, and riverine wetlands typically have daily variations in water height that are governed by diurnal increases in evapotranspiration and seasonal cycles that are governed by rainfall and runoff. Seeps and springs that depend on groundwater may have relatively slight seasonal variations in hydroperiod.

Channel stability only pertains to riverine wetlands. It's assessed as the degree of channel aggradation (i.e., net accumulation of sediment on the channel bed causing it to rise over time), or degradation (i.e., net loss of sediment from the bed causing it to be lower 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: 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 than hydroperiod. The patterns of flow, in conjunction with the kinds and amounts of sediment that the flow carries or deposits, 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 in cross-section, plan view, and longitudinal profile 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, 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 of these factors 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 types 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 types. This metric focuses on changes that have occurred in the last 2-3 years.

Table 4.10: Field Indicators of Altered Hydroperiod.

Direct Engineering Evidence	Indirect Ecological Evidence
Reduced Extent and Duration of Inundation or Saturation	
• Upstream spring boxes • Impoundments • Pumps, diversions, ditching that move water *out of* 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 • Pumps, diversions, ditching that move water ***into*** the wetland	• Late-season vitality of annual vegetation • Recently drowned riparian vegetation • Extensive fine-grain deposits

Depressional, Lacustrine, Playas, and Slope Wetlands: Field indicators for altered hydroperiod in t6hese kinds of wetlands include pumps, spring boxes, ditches, hoses and pipes, and encroachment of terrestrial vegetation (see Table 4.10 above). Tables 4.11a and 4.11b provide narratives for rating Hydroperiod for depressional, lacustrine, and seep and spring wetlands.

Table 4.11a: Rating of Hydroperiod for Depressional, Lacustrine, Playas, and Slope wetlands.

Rating	Alternative States (based on Table 4.10 above)
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 inundation and drawdown of the AA deviate from natural conditions (either increased or decreased in magnitude and/or duration).

Table 4.11b: Rating of Hydroperiod for Individual Vernal Pools and Pool Systems.

Rating	Alternative States (based on Table 4.10 above)
A	Hydroperiod of the AA is characterized by natural patterns of filling, inundation, or saturation as well as natural patterns of drying or drawdown with no indication of hydro-modification. There are no artificial controls on the hydroperiod.
B	The filling, inundation, or saturation patterns in the AA are of greater magnitude or longer duration than would be expected under natural condition (or compared to comparable natural wetlands), but thereafter, the AA is subject to natural processes and patterns of drawdown or drying.
C	The patterns of filling, inundation or saturation of the AA as well as the patterns of drawdown or drying of the AA are naturalistic but controlled by unnatural processes due to hydromodification.
D	The patterns of filling, inundation or saturation of the AA as well as the patterns of drawdown or drying of the AA significantly deviate from natural patterns due to hydromodification.

Perennial Estuarine: The volume of water that flows into and out of an estuarine wetland is termed the "tidal prism."

The tidal prism consists of inputs from both tidal (i.e., marine or estuarine) and non-tidal (e.g., fluvial or upland) sources. The timing, duration, and frequency of inundation of the wetland by these waters are collectively referred to as the tidal hydroperiod.

Under natural conditions, increases in tidal prism tend to cause increases in inorganic sedimentation, which raises the tidal elevation of the wetland and thus reduces its hydroperiod. If the sediment supply is adequate, estuarine marshes tend to build upward in quasi-equilibrium with sea level rise.

A change in the hydroperiod of an estuarine wetland (i.e., a change in the tidal prism) can be inferred from changes in channel morphology, drainage network density, and the relative abundance of plants indicative of either high or low tidal marsh. A preponderance of shrink-swell cracks or dried pannes on the wetland plain 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, mosquito control, etc. Table 4.12 provides narratives for rating Hydroperiod for perennial estuarine wetlands.

Seasonal Estuarine: The hydroperiod of a seasonal estuarine wetland can be highly variable due to inter-annual variations in freshwater inputs and occasional breaching of the tidal barrier. Assessing hydroperiod for seasonal estuaries requires knowing its recent history of inlet closure and opening.

Hydroperiod alteration can be inferred from atypical wetting and drying patterns along the shoreline (e.g., a preponderance of shrink-swell cracks or dried pannes). 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, mosquito control, boating, etc. Table 4.13 provides narratives for rating Hydroperiod for seasonal estuarine wetlands.

Table 4.12: Rating of Hydroperiod for Perennial 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.

Table 4.13: Rating of Hydroperiod for Seasonal Estuarine wetlands.

Rating	Alternative States
A	AA is subject to natural inter-annual tidal fluctuations (range may be severely muted or vary seasonally), and episodically has tidal inputs by natural breaching due to either fluvial flooding or storm surge.
B	AA is subject to tidal inputs more often than would be expected under natural circumstances, because of artificial breaching of the tidal inlet.
C	AA is subject to tidal inputs less often than would be expected under natural circumstances due to management of the inlet to prevent its opening.
D	AA is rarely subject to natural tidal inputs.

Riverine: The hydroperiod of a riverine wetland can be assessed based on a variety of statistical parameters, including the frequency and duration of flooding (as indicated by the local relationship between stream depth and time spent at depth over a prescribed period), and flood frequency (i.e., how often a flood of a certain height is likely to occur). These characteristics, plus channel form in cross-section and plan view, steepness of the channel bed, material composition of the bed, sediment loads, and the amount of woody material entering the channel all interact to create the physical structure and form of the channel at any given time.

The data needed to calculate hydroperiod is not available for most riverine systems in California. Rapid assessment must therefore rely on field indicators of hydroperiod. For a broad spectral diagnosis of overall riverine wetland condition, the physical stability or instability of the system is especially important. Whether a riverine system is stable (i.e., sediment supplies and water supplies are in dynamic equilibrium with each other and with the stabilizing qualities of riparian vegetation), or if it is degrading (i.e., subject to chronic incision of the channel bed), or aggrading (i.e., the bed is being elevated due to in-channel storage of excess sediment) can have large effects on downstream flooding, contaminant transport, riparian vegetation structure and composition, and wildlife support. CRAM therefore translates the concept of riverine wetland hydroperiod into riverine system physical stability.

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. An increase in the supply of sediment can cause a channel to aggrade. Aggradation might simply increase the duration of inundation for existing wetlands, or might cause complex changes in channel location and morphology through braiding, avulsion, burial of wetlands, creation of new wetlands, sediment splays and fan development, etc. An increase in discharge might cause a channel to incise (i.e., cut-down), leading to bank erosion, headward erosion of the channel bed, floodplain abandonment, and dewatering of riparian areas.

There are many well-known field indicators of equilibrium conditions for assessing the degree to which a channel is stable enough to sustain existing wetlands. To score this metric, visually survey the AA for field indicators of aggradation or degradation (listed in the following worksheet). After reviewing the entire AA and comparing the conditions to those described in worksheet 4.4, decide whether the AA is in equilibrium, aggrading, or degrading, then assign a rating score using the alternative state descriptions in Table 4.14.

Worksheet 4.4: Assessing Hydroperiod for Riverine Wetlands

Condition	Field Indicators (check all existing conditions)
Indicators of Channel Equilibrium	☐ The channel (or multiple channels in braided systems) has a well-defined bankfull contour that clearly demarcates an obvious active floodplain in the cross-sectional profile of the channel throughout most of the AA. ☐ Perennial riparian vegetation is abundant and well established along the bankfull contour, but not below it. ☐ There is leaf litter, thatch, or wrack in most pools. ☐ The channel contains embedded woody debris of the size and amount consistent with what is naturally available in the riparian area. ☐ There is little or no active undercutting or burial of riparian vegetation. ☐ There are no mid-channel bars and/or point bars densely vegetated with perennial vegetation. ☐ Channel bars consist of well-sorted bed material. ☐ There are channel pools, the bed is not planar, and the spacing between pools tends to be regular. ☐ The larger bed material supports abundant mosses or periphyton.
Indicators of Active Degradation	☐ The channel is characterized by deeply undercut banks with exposed living roots of trees or shrubs. ☐ There are abundant bank slides or slumps, or the lower banks are uniformly scoured and not vegetated. ☐ Riparian vegetation is declining in stature or vigor, or many riparian trees and shrubs along the banks are leaning or falling into the channel. ☐ An obvious historical floodplain has recently been abandoned, as indicated by the age structure of its riparian vegetation. ☐ The channel bed appears scoured to bedrock or dense clay. ☐ Recently active flow pathways appear to have coalesced into one channel (i.e. a previously braided system is no longer braided). ☐ The channel has one or more nick points indicating headward erosion of the bed.
Indicators of Active Aggradation	☐ There is an active floodplain with fresh splays of coarse sediment. ☐ There are partially buried living tree trunks or shrubs along the banks. ☐ The bed is planar overall; it lacks well-defined channel pools, or they are uncommon and irregularly spaced. ☐ There are partially buried, or sediment-choked, culverts. ☐ Perennial terrestrial or riparian vegetation is encroaching into the channel or onto channel bars below the bankfull contour. ☐ There are avulsion channels on the floodplain or adjacent valley floor.

Table 4.14: Rating for Riverine Channel Stability.

Rating	Alternative State (based on worksheet above)
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 worksheet).
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 worksheet).
C	There is evidence of severe aggradation or degradation of most of the channel through the AA (based on the field indicators listed in worksheet), or the channel is artificially hardened through less than half of the AA.
D	The channel is concrete or otherwise artificially hardened through most of AA.

4.2.3 Hydrologic Connectivity

A. Definition: Hydrologic Connectivity describes the ability of water to flow into or out of the wetland, or to accommodate rising flood waters without persistent changes in water level that can result in stress to wetland plants and animals. This metric pertains only to Riverine, Estuarine, Vernal Pool Systems, Individual Vernal Pools, Depressional, and Playas.

B. Rationale: Hydrologic connectivity between wetlands and adjacent uplands promotes the exchange of water, sediment, nutrients, and organic carbon. Inputs of organic carbon are of great importance to ecosystem function. Litter and allochthanous 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. Hydrologic connections with shallow aquifers and hyporheic zones influence most wetland functions. 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). Amphibian diversity 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.

This metric is scored by assessing the degree to which the lateral movement of flood waters or the associated upland transition zone of the AA and its encompassing wetland is restricted by unnatural features such as levees, sea walls, or road grades.

For estuarine wetlands, the function of upland transitions as refuge for intertidal wildlife during extreme high tides is especially important

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

D. Field Indicators: Scoring of this metric is based solely on field indicators. Tables 4.14a–14c contain narratives for rating the Hydrologic Connectivity metric.

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

Worksheet 4.5: Riverine Wetland Entrenchment Ratio Calculation

The following 5 steps should be conducted for each of 3 cross-sections located in the AA at the approximate mid-points along straight riffles or glides, away from deep pools or meander bends.				
Steps	**Replicate Cross-sections** →	**1**	**2**	**3**
1 Estimate bankfull width.	This is a critical step requiring familiarity with field indicators of the bankfull contour. Estimate or measure the distance between the right and left bankfull contours.			
2: Estimate max. bankfull depth.	Imagine a level line between the right and left bankfull contours; estimate or measure the height of the line above the thalweg (the deepest part of the channel).			
3: Estimate flood prone depth.	Double the estimate of maximum bankfull depth from Step 2.			
4: Estimate flood prone width.	Imagine a level line having a height equal to the flood prone depth from Step 3; note where the line intercepts the right and left banks; estimate or measure the length of this line.			
5: Calculate entrenchment.	Divide the flood prone width (Step 4) by the bankfull width (Step 1).			
6: Calculate average entrenchment.	Calculate the average results for Step 5 for all 3 replicate cross-sections. Enter the average result here and use it in Tables 4.15 a, b.			

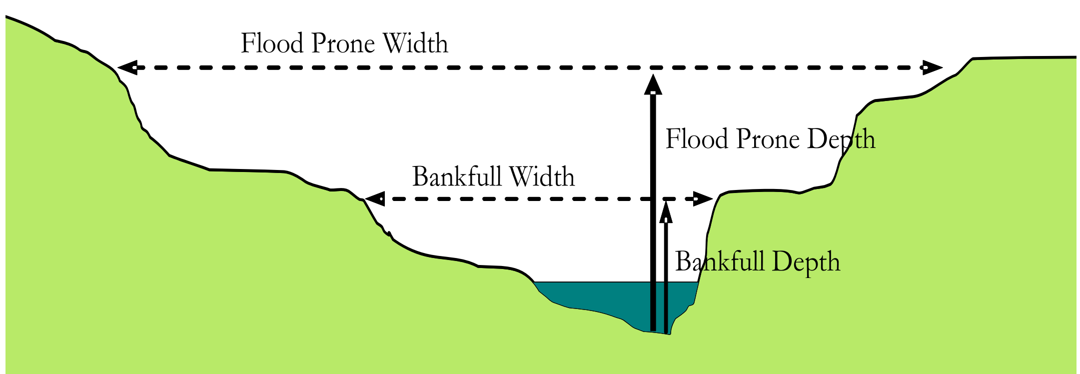


Figure 4.5: Parameters of Channel entrenchment. Flood prone depth is twice maximum bankfull depth. Entrenchment equals flood prone width divided by bankfull width.

Table 4.15a: Rating of Hydrologic Connectivity for Non-confined Riverine wetlands.

Rating	Alternative States (based on the entrenchment ratio calculation worksheet above)
A	Entrenchment ratio is > 2.2.
B	Entrenchment ratio is 1.9 to 2.2.
C	Entrenchment ratio is 1.5 to 1.8.
D	Entrenchment ratio is <1.5.

Table 4.15b: Rating of Hydrologic Connectivity for Confined Riverine wetlands.

Rating	Alternative States (based on the entrenchment ratio calculation worksheet above)
A	Entrenchment ratio is > 2.0.
B	Entrenchment ratio is 1.6 to 2.0.
C	Entrenchment ratio is 1.2 to 1.5.
D	Entrenchment ratio is < 1.2.

Table 4.15c: Rating of Hydrologic Connectivity for Estuarine, Depressional, Lacustrine, and Slope wetlands, Playas, Individual Vernal Pools, and Vernal Pool Systems.

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

4.3 Attribute 3: Physical Structure

Physical structure is defined as the spatial organization of living and non-living surfaces that provide habitat for biota (Maddock 1999). For example, the distribution and abundance of organisms in riverine systems are largely controlled by physical processes and the resulting physical characteristics of habitats (e.g., Frissell *et al.* 1986). Metrics of the Physical Structure attribute in CRAM therefore focus on physical conditions that are indicative of the capacity of a wetland to support characteristic flora and fauna.

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 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 type, 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 type of wetland.

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 4.16 contains narratives for rating the Structural Patch Richness Metric for each wetland type.

4.3.1.1 Patch Type Definitions for All Wetlands Except Vernal Pool Systems

Animal mounds and burrows. Many vertebrates make mounds or holes as a consequence of their foraging, denning, predation, or other behaviors. The resulting soil disturbance helps to redistribute soil nutrients and thus it influences plant species composition and abundance. To be considered a patch type there should be evidence that a population of burrowing animals has occupied the Assessment Area. A single burrow or mound does not constitute a patch.

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

Cobble and boulders. Cobble and boulders are rocks of different size categories. The long axis of cobble ranges from about 6 cm to about 25 cm. A boulder is any rock having a long axis greater than 25 cm. Submerged cobbles and boulders provide abundant habitat for aquatic macroinvertebrates and small fish. Exposed cobbles and boulders provide roosting habitat for birds and shelter for amphibians. They contribute to patterns of shade and light and air movement near the ground surface that affect local soil moisture gradients, deposition of seeds and debris, and overall substrate complexity.

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

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

Hummocks or sediment mounds. Hummocks are mounds created by plants in slope wetlands, depressions, and along the banks and floodplains of riverine and tidal systems. Hummocks are typically less than 1 m high. Sediment mounds are similar to hummocks but lack plant cover.

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

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

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

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

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

Pools in channels. Pools are areas along tidal and fluvial channels that are much deeper than the average depths of their channels and that tend to retain water longer than other areas of the channel during periods of low or no surface flow.

Riffles or rapids. Riffles and rapids are areas of relatively rapid flow and standing waves in tidal or fluvial channels. Riffles and rapids add oxygen to flowing water and provide habitat for many fish and aquatic invertebrates.

Secondary channels on floodplains or along shorelines. Channels confine riverine or estuarine flow. A channel consists of a bed and its opposing banks, plus its floodplain. Estuarine and riverine wetlands can have a primary channel that conveys most flow, and one or more secondary channels of varying sizes that convey flood flows. The systems of diverging and converging channels that characterize braided and anastomosing fluvial systems usually consist of one or more main channels plus secondary channels. 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. For example, short tributaries that are entirely contained within the CRAM Assessment Area (AA) are regarded as secondary channels.

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 substrates for plant and animal life, and playing particularly important roles in the uptake and cycling of nutrients and other water-borne materials.

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

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

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

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

Variegated or crenulated foreshore. As viewed from above, the foreshore of a wetland can be mostly straight, broadly curving (i.e., arcuate), or variegated (e.g., meandering). In plan view, a variegated shoreline resembles a meandering pathway. Variegated shorelines provide greater contact between water and land. Generally shorelines that are not variegated have been artificially straightened.

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.

Worksheet 4.6: Structural Patch Types for All Wetland Types, 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 4.16 below. In the case of riverine wetlands, their status as confined or non-confined must first be determined (see Section 3.2.2.1).

STRUCTURAL PATCH TYPE (check for presence)	**Riverine (Non-confined)**	**Riverine (Confined)**	**All Estuarine**	**Depressional**	**Slope Wetlands**	**Lacustrine**	**Individual Vernal Pools**	**Playas**
Minimum Patch Size	**3 m^2**	**3 m^2**	**3 m^2**	**3 m^2**	**1 m^2**	**3 m^2**	**1 m^2**	**3 m^2**
Secondary channels on floodplains or along shorelines	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**1**
Swales on floodplain or along shoreline	**1**	**0**	**0**	**1**	**1**	**1**	**1**	**1**
Pannes or pools on floodplain	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**1**
Vegetated islands (mostly above high-water)	**1**	**0**	**0**	**1**	**0**	**0**	**1**	**1**
Pools or depressions in channels (wet or dry channels)	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
Riffles or rapids (wet channel) or planar bed (dry channel)	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
Non-vegetated flats or bare ground (sandflats, mudflats, gravel flats, etc.)	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**1**
Point bars and in-channel bars	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
Debris jams	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**
Abundant wrackline or organic debris in channel, on floodplain, or across depressional wetland plain	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**
Plant hummocks and/or sediment mounds	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Bank slumps or undercut banks in channels or along shoreline	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**
Variegated, convoluted, or crenulated foreshore (instead of broadly arcuate or mostly straight)	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**0**
Animal mounds and burrows	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**1**
Standing snags (at least 3 m tall)	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Filamentous macroalgae or algal mats	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Shellfish beds	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**
Concentric or parallel high water marks	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**
Soil cracks	**0**	**0**	**1**	**1**	**0**	**1**	**1**	**1**
Cobble and/or Boulders	**1**	**1**	**0**	**0**	**1**	**1**	**1**	**0**
Submerged vegetation	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**0**
Total Possible	**16**	**11**	**15**	**13**	**10**	**16**	**10**	**10**
No. Observed Patch Types(enter here and use in Table 4.16 below)								

4.3.1.2 Patch Type Definitions for Vernal Pool Systems

Animal mounds and burrows. Many vertebrates make mounds or holes as a consequence of their foraging, denning, predation, or other behaviors. The resulting soil disturbance helps to redistribute soil nutrients and thus it influences plant species composition and abundance. To be considered a patch type there should be evidence that a population of burrowing animals has occupied the Assessment Area. A single burrow or mound does not constitute a patch.

Bare Soil. Areas at least 1m2 that lack at least 5% cover of vegetation are considered bare ground. Patches of bare ground serve as resting sites for passerine birds and foraging sites for predators.

Drainage Branches. Many vernal pool systems consist of low-gradient drainage networks with multiple pathways or branches for surface water flow that provide alternative ways to naturally fill and drain vernal pools.

Mima-mounds. These are regularly spaced, elliptical mounds of soil ranging in height from about 50 cm to 2 m. They provide upland transition zones around vernal pools, perches for ground-dwelling birds, burrowing habitat for small mammals, etc.

Hummocks. In vernal pool systems, hummocks are small mounds created by plants, such as bunch grasses, usually along the upland margins of vernal pools or in the adjacent upland matrix. They are usually less than 10 cm high and less than 10 cm in diameter.

Vernal Pool Types. The component pools of any given vernal pool system tend to vary in size and shape in ways that affect the communities of plants and animals they support.

Large and Small Pools. There are no fixed, numerical criteria to identify large and small pools. Within many vernal pool systems, some pools are obviously larger than others. For any AA, the cutoff in size between large and small pools must result in three replicates of each.

Simply- and Complexly-shaped Pools. Within many systems, some pools will be round in plan form (i.e., simply-shaped), whereas others will be much longer than wide or very irregularly shaped, with variegated shorelines.

Pool Clusters. A cluster of vernal pools is a set of three or more pools that are hydrologically interconnected by swales or other surface flow pathways, with each pool being no more than 10 m away from another pool in the set.

Soil cracks. Repeated wetting and drying of fine grain soil that typifies some vernal pools can cause the soil to crack and form fissures that provide habitat for amphibians and macroinvertebrates. Cracks must be a minimum of 1 inch deep to qualify.

Swale Types. Vernal pool systems consist of vernal pools, vernal swales (and other pathways of surface water flow), subsurface flow, and an upland matrix that surrounds each pool and swale. A swale is an elongate feature, slightly concave in cross-section, that conveys surface flow but lacks a well-defined channel. Swales vary in width and length.

Large and Small Swales. There are no fixed, numerical criteria to identify large and small pools. Within many vernal pool systems, some swales are obviously larger than others. For any AA, the cutoff in size between large and small pools must result in three replicates of each.

Worksheet 4.7: Structural Patch Types 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 4.16 below.

STRUCTURAL PATCH TYPE (check for presence)	**Vernal Pool Systems**
Small individual pools	
Large individual pools	
Small swales	
Large swales	
More than 1 pool cluster (a set of 3 or more interconnected pools with nearest neighbors less than 10 m apart)	
Drainage branches (more than 1 drainage branch)	
Simply-shaped pools (mostly round or oval)	
Complexly-shaped pools (not mostly round or oval)	
Plant hummocks	
Mima-mounds	
Animal burrows	
Bare soil	
Soil cracks	
Total Possible	**13**
No. Observed Patch Types (enter here and use in Table 4.16 below)	

Table 4.16: Rating of Structural Patch Richness (based on results from worksheets).

Rating	Confined Riverine, Playas, Springs & Seeps, Individual Vernal Pools	Vernal Pool Systems and Depressional	Estuarine	Non-confined Riverine, Lacustrine
A	≥ 8	≥ 11	≥ 9	≥ 12
B	6 – 7	8 – 10	6 – 8	9 – 11
C	4 – 5	5 – 7	3 – 5	6 – 8
D	≤ 3	≤ 4	≤ 2	≤ 5

4.3.2 Topographic Complexity

A. Definition: Topographic complexity refers to the micro- and macro-topographic relief within a wetland due to physical, abiotic features and elevations gradients.

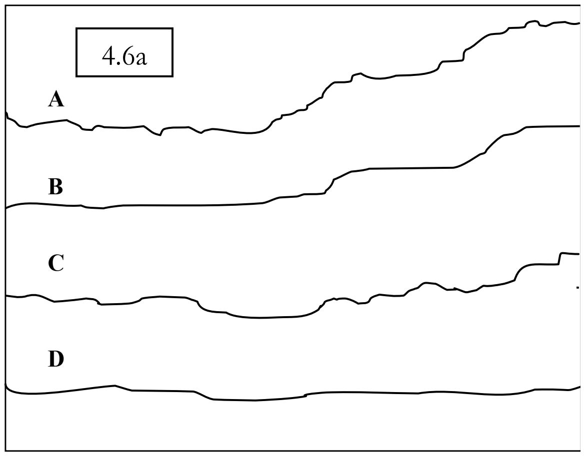
B. Rationale: Topographic complexity promotes variable hydroperiods and concomitant moisture gradients that, in turn, promote ecological complexity by increasing the spatial and temporal variability in energy dissipation, surface water storage, groundwater recharge, particulate matter detention, cycling 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.

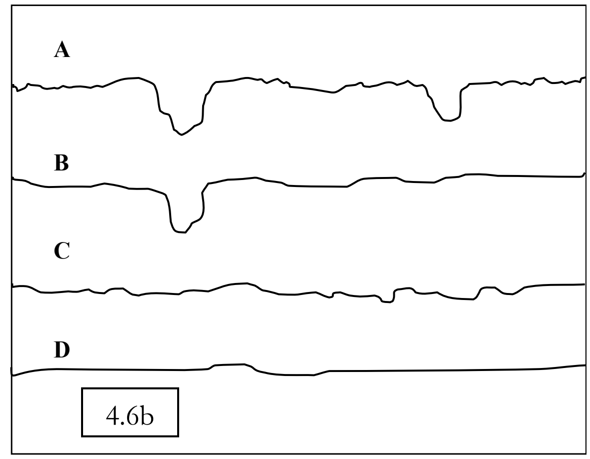
C. Seasonality: This metric is not sensitive to seasonality.

D. Field Indicators: Topographic complexity is assessed by noting the overall variability in physical patches and topographic features (Table 4.17 and Figure 4.6). Care must be taken to distinguish indicators of topographic complexity or habitat features within a wetland from different kinds of wetlands. For each type of wetland, 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, and the amount of micro-topographic relief along the gradients or flow paths. Topographic gradients may be indicated by plant assemblages with different inundation/saturation or salinity tolerances. Tables 4.18a-d provide narratives for rating Topographic Complexity for all wetland types.

Table 4.17: Typical indicators of Macro- and Micro-topographic Complexity for each wetland type.

Type	Examples of Topographic Features
Depressional and Playas	pools, islands, bars, mounds or hummocks, variegated shorelines, soil cracks, partially buried debris, plant hummocks, livestock tracks
Estuarine	channels large and small, islands, bars, pannes, potholes, natural levees, shellfish beds, hummocks, slump blocks, first-order tidal creeks, soil cracks, partially buried debris, plant hummocks
Lacustrine	islands, bars, boulders, cliffs, benches, variegated shorelines, cobble, boulders, partially buried debris, plant hummocks
Riverine	pools, runs, glides, pits, ponds, hummocks, bars, debris jams, cobble, boulders, slump blocks, tree-fall holes, plant hummocks
Slope Wetlands	pools, runnels, plant hummocks, burrows, plant hummocks, cobbles, boulders, partially buried debris, cattle or sheep tracks
Vernal Pools and Pool Systems	soil cracks, "mima-mounds," rivulets between pools or along swales, cobble, plant hummocks, cattle or sheep tracks





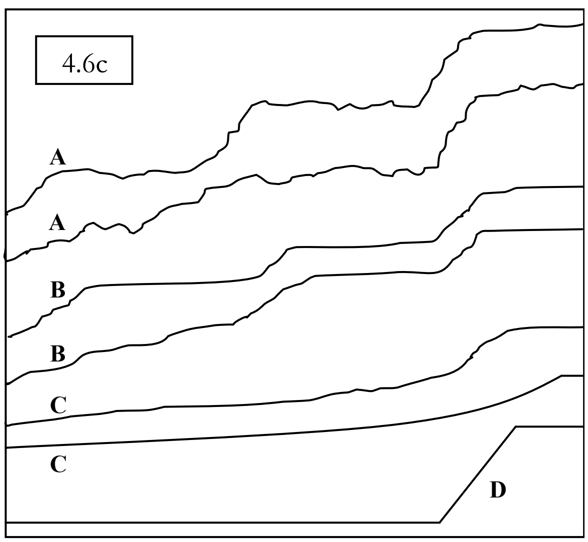


Figure 4.6: Scale-independent schematic profiles of Topographic Complexity.

Each profile A-D represents one-half of a characteristic cross-section through an AA for (4.6a) Slope, Playas, Depressional Wetlands and Individual Vernal Pools, (4.6b) Estuarine Wetlands, and (4.6c) Lacustrine and Riverine Wetlands. The right end of each profile represents one edge of the AA. For vernal pool systems, the right end (4.6a) represents the lower margin of the upland matrix, slightly above the edge of a large or small vernal pool.

Table 4.18a: Rating of Topographic Complexity for Depressional Wetlands, Playas, Individual Vernal Pools, and Slope Wetlands.

Rating	Alternative States (based on diagrams in Figure 4.6 above)
A	AA as viewed along a typical cross-section has at least two benches or breaks in slope, and each of these benches, plus the slopes between them contain physical patch types or features that contribute to abundant micro-topographic relief or variability as illustrated in profile A of Figure 4.6a.
B	AA has at least two benches or breaks in slope above the middle area or bottom zone of the AA, but these benches and slopes mostly lack abundant micro-topographic relief. The AA resembles profile B of Figure 4.6a.
C	AA lacks any obvious break in slope or bench, and is best characterized has a single slope that has at least a moderate amount of micro-topographic complexity, as illustrated in profile C of Figure 4.6a.
D	AA has a single, uniform slope with little or no micro-topographic complexity, as illustrated in profile D of Figure 4.6a.

Table 4.18b: Rating of Topographic Complexity for all Estuarine Wetlands.

Rating	Alternative States (based on diagrams in Figure 4.6 above)
A	The vegetated plain of the AA in cross-section has a variety of micro-topographic features created by plants, animal tracks, cracks, partially buried debris, retrogressing channels (i.e., channels filling-in with sediment and plants), natural levees along channels, potholes and pannes that together comprise a complex array of ups and downs resembling diagram A in Figure 4.6b.
B	The vegetated plain of the AA has a variety of micro-topographic features as described above for "A" but they are less abundant and/or they comprise less variability in elevation overall, as illustrated in diagram B of Figure 4.6b.
C	The vegetated plain of the AA has a variety of micro-topographic features as described above for "A" but lacks well-formed tidal channels that are well-drained during ebb tide. If channels exist, they mostly do not drain well or are filling-in with sediment. The plain overall resembles diagram C of Figure 4.6b.
D	The vegetated plain of the AA has little or no micro-topographic relief and few or no well-formed channels. The plain resembles diagram D of Figure 4.6b.

Table 4.18c: Rating of Topographic Complexity for all Riverine Wetlands.

Rating	Alternative States (based on diagrams in Figure 4.6 above)
A	AA as viewed along a typical cross-section has at least two benches or breaks in slope, including the riparian area of the AA, above the channel bottom, not including the thalweg. Each of these benches, plus the slopes between the benches, as well as the channel bottom area contain physical patch types or features such as boulders or cobbles, animal burrows, partially buried debris, slump blocks, furrows or runnels that contribute to abundant micro-topographic relief as illustrated in profile A of Figure 4.6c.
B	AA has at least two benches or breaks in slope above the channel bottom area of the AA, but these benches and slopes mostly lack abundant micro-topographic complexity. The AA resembles profile B of Figure 4.6c.
C	AA has a single bench or obvious break in slope that may or may not have abundant micro-topographic complexity, as illustrated in profile C of Figure 4.6c.
D	AA as viewed along a typical cross-section lacks any obvious break in slope or bench. The cross-section is best characterized as a single, uniform slope with or without micro-topographic complexity, as illustrated in profile D of Figure 4.6c (includes concrete channels).

Table 4.18d: Rating of Topographic Complexity for Vernal Pool Systems.

Pool Type	Replicate Number	Topographic Complexity Score (A = 12; B = 9; C = 6; D = 3)
Small Pools	Replicate 1	
	Replicate 2	
	Replicate 3	
	Average Score for All Three Small Pool Replicates	
Large Pools	Replicate 1	
	Replicate 2	
	Replicate 3	
	Average Score for All Three Large Pool Replicates	
Average Score for All Small and Large Pool Replicates		

4.4 Attribute 4: Biotic Structure

The biotic structure of a wetland includes all of its organic matter that contributes to its material structure and architecture. Living vegetation and coarse detritus are examples of biotic structure. Plants strongly influence the quantity, quality, and spatial distribution of water and sediment within wetlands. For example, in many wetlands, including bogs and tidal marshes, much of the sediment pile is organic. Vascular plants in estuarine and riverine wetlands entrap suspended sediment. 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 Plant Community Metric

A. Definition: The Plant Community Metric is composed of three submetrics for each wetland type. Two of these sub-metrics, Number of Co-dominant Plants and Percent Invasion, are common to all wetland types. For all wetlands except Vernal Pools and Vernal Pool Systems, the Number of Plant Layers as defined for CRAM is also assessed. For Vernal Pools and Pool Systems, the Number of Plant layers submetric is replaced by the Native Species Richness submetric. A thorough reconnaissance of an AA is required to assess its condition using these submetrics. The assessment for each submetric is guided by a set of Plant Community Worksheets. The Plant Community metric is calculated based on these worksheets.

A "plant" is defined as an individual of any species of tree, shrub, herb/forbs, moss, fern, emergent, submerged, submergent or floating macrophyte, including non-native (exotic) plant species. For the purposes of CRAM, a plant "layer" is a stratum of vegetation indicated by a discreet canopy at a specified height that comprises at least 5% of the area of the AA where the layer is expected to occur.

Non-native species owe their occurrence in California to the actions of people ever since shortly before Euro American contact. "Invasive" species are non-native species that tend to dominate one or more plant layers within an AA. CRAM uses the California Invasive Plant Council (Cal-IPC) list to determine the invasive status of plants, with augmentation by regional experts.

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 the dominant species, such as 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 validation studies, regional botanical surveys, and historical resources. This metric requires the ability to recognize the most common and abundant plants species of wetlands. 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.

4.4.1.1 Number of Plant Layers Present

The first submetric of the Plant Community Metric is the Number of Plant Layers Present in the AA. This submetric does not pertain to Vernal Pools or Playas. Plant layers play a large role in the assessment of the biotic structure attribute. They are distinguished from one another by the differences in average maximum heights of their co-dominant plant species. For the Other Depressional Wetlands, plus Estuarine, Lacustrine, and Non-confined Riverine Wetlands a maximum of five plant layers are recognized by CRAM. For Slope Wetlands and Confined Riverine Wetlands, a maximum of four layers are recognized. To be counted in CRAM, a layer must cover at least 5% of *the portion of the AA that is suitable for the layer* (see Appendix II). This would be the littoral zone of lakes and depressional wetlands for the one aquatic layer, called "floating." The "short," "medium," and "tall" layers might be found throughout the non-aquatic areas of each wetland class, except in areas of exposed bedrock, mudflat, beaches, active point bars, etc. The "very tall" layer is usually expected to occur along the backshore, except in forested wetlands.

It is essential that the layers be identified by the actual plant heights (i.e., the approximate maximum heights) of plant species in the AA, regardless of the growth potential of the species. For example, in a riverine system a young sapling redwood between 0.5 m and 0.75 m tall would belong to the "medium" layer, even though in the future the same individual redwood might belong to the "very tall" layer. Some species might belong to multiple plant layers. For example, groves of red alders of all different ages and heights might collectively represent all four non-aquatic layers in a riverine AA. Riparian vines, such as wild grape, might also dominate all of the non-aquatic layers.

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

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

Short Vegetation. This layer varies in maximum height among the wetland types, but is never taller than 50 cm. It includes small emergent vegetation and plants. It can include young forms of species that grow taller. Vegetation that is naturally short in its mature stage includes *Rorippa nasturtium-aquaticum* (watercress), small Isoetes (quillworts*), Distichlis spicata* (saltgrass), *Jaumea carnosa* (jaumea), *Ranunculus flamula* (creeping buttercup), *Alisma* spp. (water plantain), *Sparganium* (burweeds), and *Sagitaria* spp. (arrowhead).

Medium Vegetation. This layer never exceeds 75 cm in height. It commonly includes emergent vegetation such *Salicornia virginica* (pickleweed), *Atriplex* spp. (saltbush), rushes (*Juncus* spp.), and *Rumex crispus* (curly dock).

Tall Vegetation. This layer never exceeds 1.5 m in height. It usually includes the tallest emergent vegetation and the larger shrubs. Examples include *Typha latifolia* (broad-leaved cattail), *Scirpus californicus* (bulrush), *Rubus ursinus* (California blackberry), and *Baccharis piluaris* (coyote brush).

Very Tall Vegetation. This layer is reserved for shrubs, vines, and trees that are taller than 1.5 m. Examples include *Plantanus racemosa* (western sycamore), *Populus fremontii* (Fremont cottonwood), *Alnus rubra* (red alder), *Sambucus mexicanus* (Blue elderberry), and *Corylus californicus* (hazelnut).

4.4.1.2 Number of Co-dominant Species

The second submetric, Number of Co-dominant Species, deals directly with dominant plant species richness in each plant layer and for the AA as a whole. For each plant layer in the AA, all species represented by living vegetation that comprises at least 10% relative cover within the layer are considered to be dominant (see Appendix II). Only living vegetation in growth position is considered in this metric. Dead or senescent vegetation is disregarded.

The investigator lists the names of all co-dominant plant species in each layer. The list is used to determine the total number of co-dominant species for all the layers that are represented in the AA. Some species, such as wild grapes and poison oak, can dominate multiple layers. Even though such plants provide have functional differences between layers, they should only be counted once when calculating the Number of Co-dominant Species for the AA. Ni matter how many layers a given species dominates, it should only be counted once as a co-dominant.

4.4.1.3 Percent Invasion

For the third submetric, Percent Invasion, the number of invasive co-dominant species for all plant layers combined is assessed as a percentage of the total number of co-dominants, based on the results of the Number of Co-dominant Species sub-metric. The invasive status for many California wetland and riparian plant species is based on the Cal-IPC list (Appendix V). However, the best professional judgment of local experts may be used instead to determine whether or not a co-dominant species is invasive. To the extent possible, photographs of known invasive plant species will be available through the eCRAM software to minimize the amount of botanical expertise needed to determine the status of co-dominant plants as invasive. If the status cannot be determined in the field, then a voucher specimen and field photographs of the plants in question should be used in conjunction with the Jepson Manual (Hickman 1993) or in consultation with appropriate experts to determine invasive status. Even if they appear in multiple layers plant species should only be counted once when calculating the Number of Co-dominant Species.

4.4.1.4 Native Plant Species Richness

This submetric only applies to Vernal Pools and Vernal Pool System. These wetlands are distinguished from all other wetland types by a unique native flora. This submetric is based on the total number of native plant species listed in Appendix V that appear in the AA. For Vernal Pool Systems, native species richness is assessed for all the replicate pools combined.

Worksheet 4.8.1: Plant layer heights for all wetland types

Wetland Type	**Plant Layers**				
	Aquatic	**Semi-aquatic and Riparian**			
	Floating	**Short**	**Medium**	**Tall**	**Very Tall**
Perennial Saline Estuarine	On Water Surface	<0.3 m	0.3 – 0.75 m	0.75 – 1.5 m	>1.5 m
Perennial Non-saline Estuarine, Seasonal Estuarine	On Water Surface	<0.3 m	0.3 – 0.75 m	0.75 – 1.5 m	>1.5 m
Lacustrine, Depressional and Non-confined Riverine	On Water Surface	<0.5 m	0.5 – 1.5 m	1.5 - 3.0 m	>3.0 m
Slope	NA	<0.3 m	0.3 – 0.75 m	0.75 – 1.5 m	>1.5 m
Confined Riverine	NA	<0.5 m	0.5 – 1.5 m	1.5 – 3.0 m	>3.0 m

Worksheet 4.8.2: Co-dominant species richness for all wetland types, except Confined Riverine, Slope wetlands, Vernal Pools, and Playas
(A dominant species represents ≥10% *relative* cover)

Note: Plant species should only be counted once when calculating the Number of Co-dominant Species and Percent Invasion metric scores.

Floating or Canopy-forming	**Invasive?**	**Short**	**Invasive?**
Medium	**Invasive?**	**Tall**	**Invasive?**
Very Tall	**Invasive?**		
		Total number of co-dominant species for all layers combined (enter here and use in Table 4.19)	
		Percent Invasion (enter here and use in Table 4.19)	

Worksheet 4.8.3: Co-dominant species richness for Confined Riverine and Slope wetlands
(A dominant species represents ≥10% *relative* cover)

Note: Plant species should only be counted once when calculating the Number of Co-dominant Species and Percent Invasion metric scores.

Short	**Invasive?**	**Medium**	**Invasive?**
Tall	**Invasive?**	**Very Tall**	**Invasive?**
		Total number of co-dominants for all layers combined (enter here and use in Table 4.19)	
		Percent Invasion (enter here and use in Table 4.19)	

Worksheet 4.8.4: Co-dominant Plant Species in Vernal Pool Systems – Large Pools

(A dominant species represents ≥10% *relative* cover)

Note: Plant species should only be counted once when calculating the Number of Co-dominant Species and Percent Invasion metric scores.

Large Pools	**Replicate 1**	**Co-dominant Species**
	No. of Co-dominant Species	
	No. of Co-dominant Species Score	
	No. of Invasive Co-dominant Species	
	Percent Invasion	
	Percent Invasion Score	
	Replicate 2	**Co-dominant Species**
	No. of Co-dominant Species	
	No. of Co-dominant Species Score	
	No. of Invasive Co-dominant Species	
	Percent Invasion	
	Percent Invasion Score	
	Replicate 3	**Co-dominant Species**
	No. of Co-dominant Species	
	No. of Co-dominant Species Score	
	No. of Invasive Co-dominant Species	
	Percent Invasion	
	Percent Invasion Score	
	Average No. of Co-dominant Species Score for All Three Large Pool Replicates (enter here and on worksheet 4.8.7)	
	Average Percent Invasion Score for All Three Large Pool Replicates (enter here and on worksheet 4.8.7)	

Worksheet 4.8.5:
Co-dominant Plant Species in Vernal Pool Systems – Small Pools
(A dominant species represents ≥10% *relative* cover)

Note: Plant species should only be counted once when calculating the Number of Co-dominant Species and Percent Invasion metric scores.

	Replicate 1		**Co-dominant Species**
	No. of Co-dominant Species		
	No. of Co-dominant Species Score		
	No. of Invasive Co-dominant Species		
	Percent Invasion		
	Percent Invasion Score		
	Replicate 2		**Co-dominant Species**
	No. of Co-dominant Species		
	No. of Co-dominant Species Score		
	No. of Invasive Co-dominant Species		
Small Pools			
	Percent Invasion		
	Percent Invasion Score		
	Replicate 3		**Co-dominant Species**
	No. of Co-dominant Species		
	No. of Co-dominant Species Score		
	No. of Invasive Co-dominant Species		
	Percent Invasion		
	Percent Invasion Score		
	Average No. of Co-dominant Species Score for All Three Small Pool Replicates (enter here and on Plant Community Metric Worksheet 7)		
	Average Percent Invasion Score for All Three Small Pool Replicates (enter here and on Plant Community Metric Worksheet 7)		

Worksheet 4.8.6:
Co-dominant Plant Species in Playas and Individual Vernal Pools
(A dominant species represents ≥10% *relative* cover)

Plant Name	**Invasive?**	**Plant Name**	**Invasive?**
Total number of co-dominant species (enter here and use in Table 4.19)			
Percent Invasion (enter here and use in Table 4.19)			

Worksheet 4.8.7: Native Plant Species Observed in Vernal Pools or Vernal Pool Systems

Total Number of Species (enter here and use in Table 4.19)		

Worksheet 4.8.8:
Summary Submetric Scores for Vernal Pool Systems

Average No. of Co-dominant Species Score for All Small and Large Pools in AA (enter here and on AA Score Card)	
Average Percent Invasion Score for All Small and Large Pools in AA (enter here and on AA Score Card)	

Table 4.19: Ratings for submetrics of Plant Community Metric.

Rating	Number of Plant Layers Present	Number of Co-dominant Species		Percent Invasion	
Perennial Saline Wetlands					
A	4 – 5	≥ 5		0 – 15%	
B	2 – 3	4		16 – 30%	
C	1	2 – 3		31 – 45%	
D	0	0 – 1		46 – 100%	
Perennial Non-Saline and Seasonal Estuarine Wetlands					
A	4 – 5	≥ 7		0 – 20%	
B	3	5 – 6		21 – 35%	
C	1 – 2	3 – 4		36 – 60%	
D	0	0 – 2		61 – 100%	
Lacustrine, Depressional and Non-confined Riverine Wetlands					
A	4 – 5	≥ 12		0 – 15%	
B	3	9 – 11		16 – 30%	
C	1 – 2	6 – 8		31 – 45%	
D	0	0 – 5		46 – 100%	
Slope Wetlands					
A	4	≥ 7		0 – 20%	
B	3	5 – 6		21 – 35%	
C	1 – 2	3 – 4		36 – 60%	
D	0	0 – 2		61 – 100%	
Confined Riverine Wetlands					
A	4	≥ 11		0 – 15%	
B	3	8 – 10		16 – 30%	
C	1 – 2	5 – 7		31 – 45%	
D	0	0 – 4		46 – 100%	
Playas					
A	Not Applicable	≥ 7		0 – 15%	
B		5 – 6		16 – 30%	
C		3 – 4		31 – 45%	
D		0 – 2		46 – 100%	
Individual Vernal Pools and Vernal Pool Systems					
	Not Applicable	**Large Pools**	**Small Pools**	**Large Pools**	**Small Pools**
A		≥ 9	≥ 7	0 – 15%	0 – 15%
B		5 – 8	5 – 6	16 – 35%	16 – 35%
C		3 – 4	3 – 4	36 – 55%	36 – 55%
D		0 – 2	0 – 2	56 – 100%	56 – 100%

Native Species Richness Individual Vernal Pools		Native Species Richness Vernal Pool Systems (all 6 replicate pools combined)	
A	≥ 7	**A**	≥ 9
B	5 – 6	**B**	6 – 8
C	3 – 4	**C**	3 – 5
D	0 – 2	**D**	0 – 2

4.4.2 Horizontal Interspersion and Zonation

A. Definition: Horizontal biotic structure refers to the variety and interspersion of plant "zones." Plant zones are plant monocultures or obvious multi-species associations that are arrayed along gradients of elevation, moisture, or other environmental factors that seem to affect the plant community organization in plan view. Interspersion is essentially a measure of the number of distinct plant zones and the amount of edge between them.

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. 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 some cases, one or two 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 4.7 through 4.10 can aid evaluating the degree of horizontal interspersion (adapted from Mack 2001), which is rated using Table 4.19a-c.

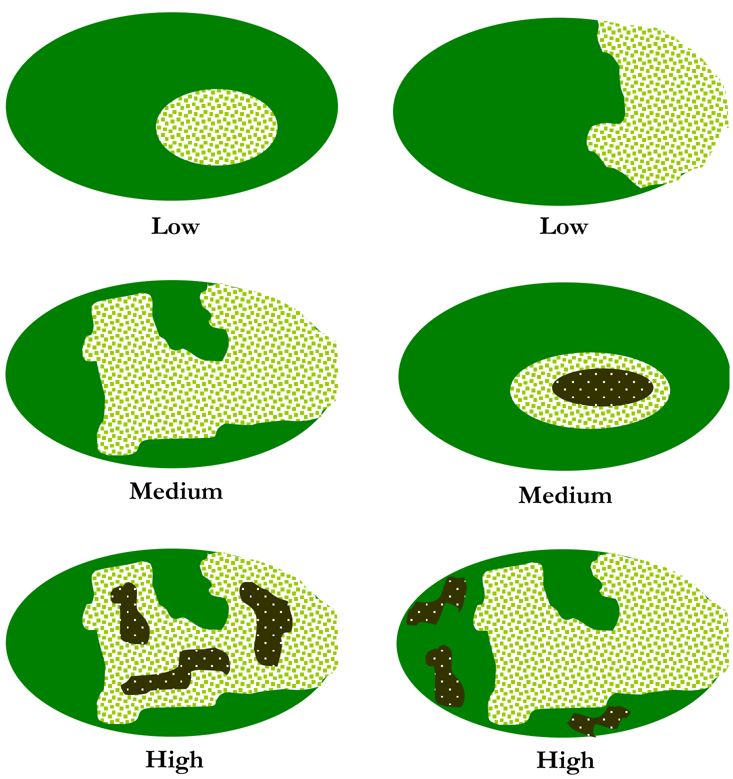


Figure 4.7: Diagram of the degrees of interspersion of plant zones for Lacustrine, Depressional, Playas, and Slope wetlands. Hatching patterns represent plant zones (adapted from Mack 2001). Each zone must comprise at least 5% of the AA.

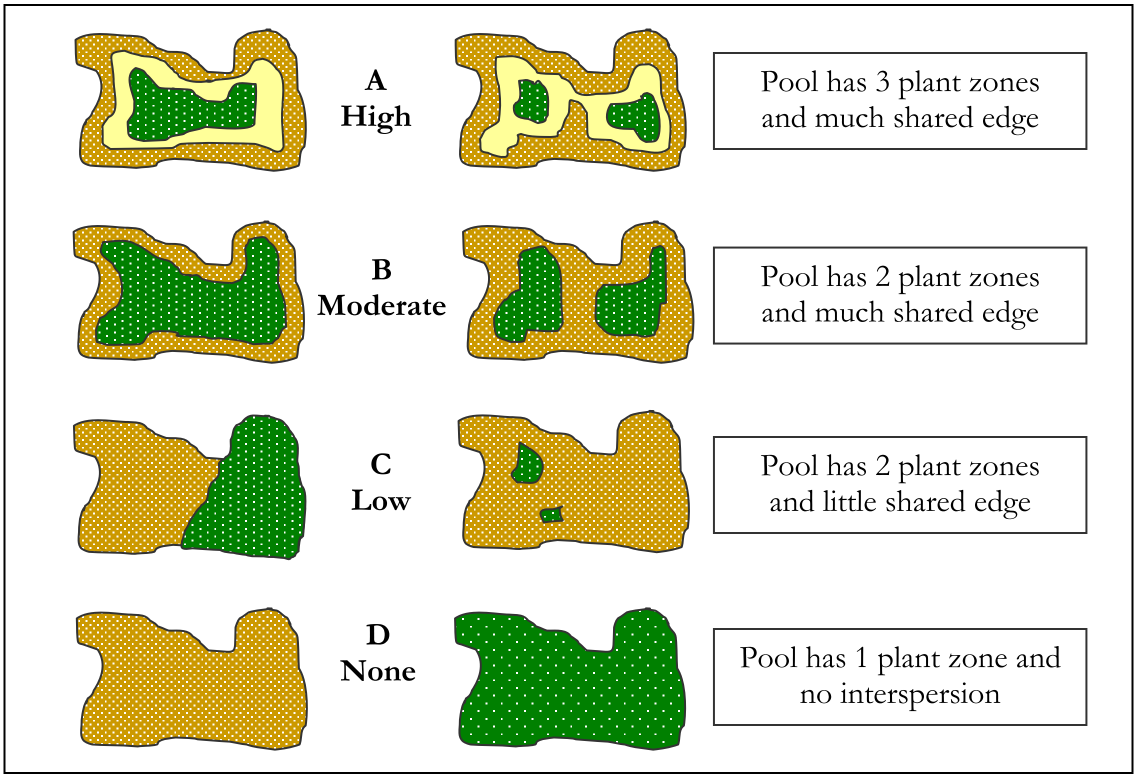


Figure 4.8: Schematic diagrams illustrating varying degrees of interspersion of plant zones for Individual Vernal Pools. Each zone must comprise at least 5% of the pool area.

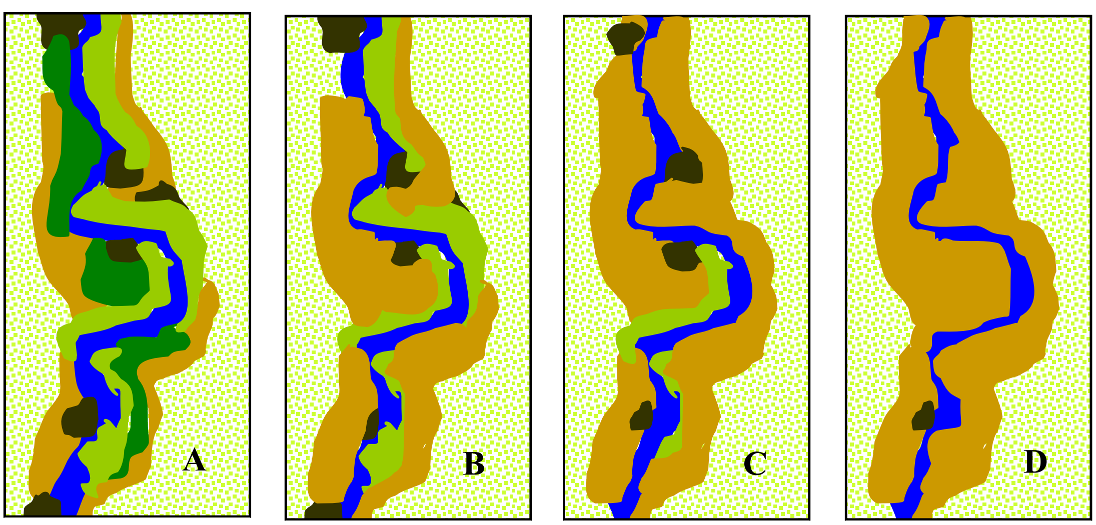


Figure 4.9: Schematic diagrams illustrating varying degrees of interspersion of plant zones for all Riverine wetlands. Each zone comprises at least 5% of the AA.

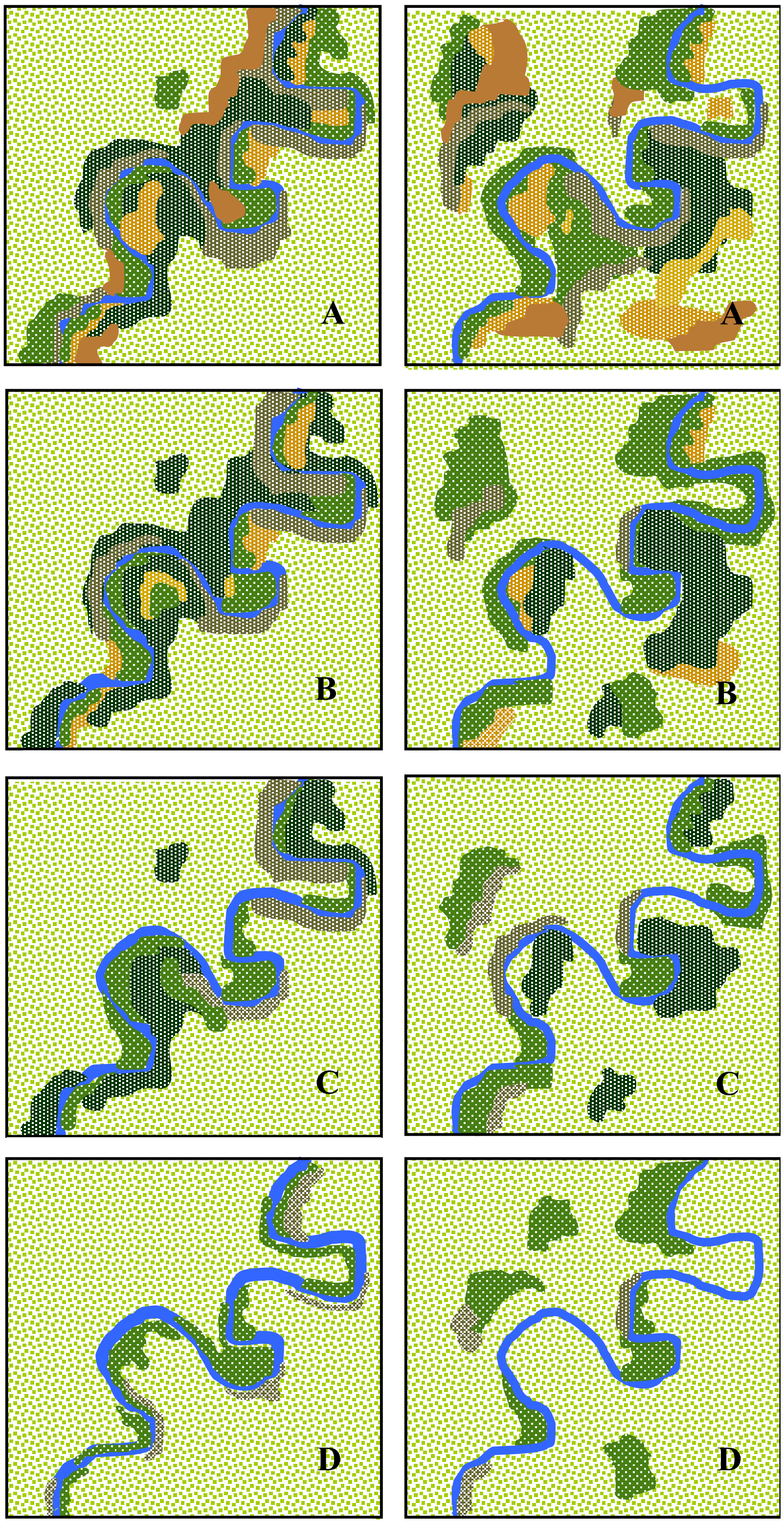


Figure 4.10: Schematic diagrams of varying degrees of interspersion of plant zones and patches for Perennial Saline, Non-saline, and Seasonal Estuarine wetlands. In these diagrams, each plant zone or patch type has a unique color and comprises at least 5% of the AA. There are two examples for each condition A-D. The left-side example in each pair shows zones or patches organized around a tidal channel, and the right-side example in each pair shows patches or zones that are more broadly distributed across the wetland plain.

Table 4.20a: Rating of Horizontal Interspersion of Plant Zones for all AAs except Riverine and Vernal Pool Systems.

Rating	Alternative States (based on Figures 4.7, 4.8, and 4.10)
A	AA has a high degree of plan-view interspersion.
B	AA has a moderate degree of plan-view interspersion.
C	AA has a low degree of plan-view interspersion.
D	AA has essentially no plan-view interspersion.

Table 4.20b: Rating of Horizontal Interspersion of Plant Zones for Riverine AAs.

Rating	Alternative States (based on Figure 4.9)
A	AA has a high degree of plan-view interspersion.
B	AA has a moderate degree of plan-view interspersion.
C	AA has a low degree of plan-view interspersion.
D	AA has essentially no plan-view interspersion.

Table 4.20c: Rating of Horizontal Interspersion for Vernal Pool Systems.

Pool Type	Replicate Number	Horizontal Interspersion Score		
Small Pools	Replicate 1			
	Replicate 2			
	Replicate 3			
	Average Score for All Three Small Pool Replicates			
Large Pools	Replicate 1			
	Replicate 2			
	Replicate 3			
	Average Score for All Three Large Pool Replicates			
Average Score for All Small and Large Pool Replicates				

4.4.3 *Vertical Biotic Structure*

A. Definition: The vertical component of biotic structure assesses the degree of overlap among plant layers. The same plant layers used to assess the Plant Community Composition metrics (see Section 4.4.2) are used to assess Vertical Biotic Structure. To be counted in CRAM, a layer must cover at least 5% of the portion of the AA that is suitable for the layer (see Appendix II). 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 the vertical complexity of the wetland's vegetation. For many types of wetlands in California, overlapping layers of vegetation above or below the water surface contribute to vertical gradients in light and temperature that result in greater species diversity of macroinvertebrates, fishes, amphibians, and birds. In riparian areas, the species richness of birds and small mammals tends to increase with the density and number of well-developed, overlapping plant layers. Many species of birds that nest near the ground or water surface in wetlands commonly require a cover of vegetation at their nest sites. Multiple layers of vegetation also enhance hydrological functions, including rainfall interception, reduced evaporation from soils, and enhanced filtration of floodwaters.

In many depressional wetlands and some wet meadows, the detritus of above-ground growth of low and medium layers of herbaceous plants and emergent monocots tends to get entrained within the layers as an internal canopy below the maximum height of the upper plant layer. These "entrained canopies" serve as cover for many wildlife species.

In estuarine wetlands, the entrained canopies entrap debris including coarse plant litter that is lifted into the canopies by rising tides. As the tide goes out, the material is left hanging in the plant cover. Over time, these entrained canopies can gain enough density and thickness to provide important shelter for many species of birds and small mammals that inhabit estuarine wetlands. Most passerine birds and rails that nest in estuarine wetlands choose to nest below an entrained canopy because it protects them from avian predators, including owls and harriers.

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.

Plant layers for this metric are determined in the same way as defined in the Plant Community Metric. Only the maximum height of any vegetation should be used to determine the plant layer to which it belongs. For example, although a tall tree might span the entire range of all the layers, it can only represent one layer, based on its overall height. Standing (upright) dead or senescent vegetation from the previous growing season can be used in addition to live vegetation to assess the number of plant layers present. However, the lengths of prostrate stems or shoots are disregarded. I other words, fallen plants are not lifted into a vertical position as evidence of plant height.

Once the plant layers in the wetland are identified, use the following worksheet and figures to assess the Vertical Biotic Structure metric. Note that plant layers in perennial saline estuarine wetlands can be difficult to distinguish, and assessing the entrained canopy in an estuarine wetland requires close examination of the low plant layers.

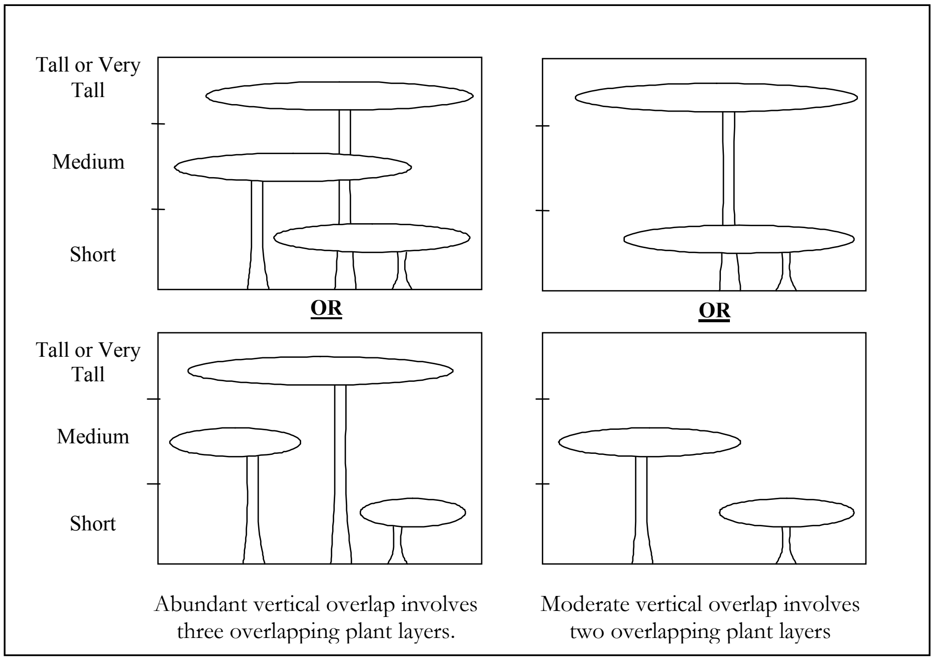


Figure 4.11: Schematic diagrams of vertical interspersion of plant layers for Riverine wetlands for Depressional and Lacustrine wetlands having Tall or Very Tall plant layers.

Table 4.21: Rating of Vertical Biotic Structure for Riverine AAs and for Lacustrine and Depressional AAs supporting Tall or Very Tall plant layers (see Figure 4.11).

Rating	Alternative States
A	More than 50% of the vegetated area of the AA supports abundant overlap of plant layers (see Figures 4.11).
B	More than 50% of the area supports at least moderate overlap of plant layers.
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 plant layers, **or** two layers are well represented with little overlap, **or** AA is sparsely vegetated overall.

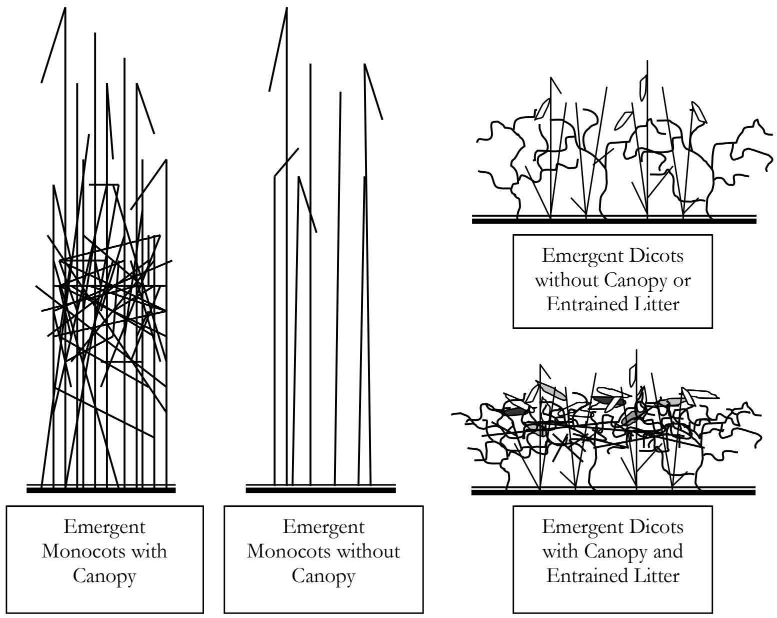


Figure 4.12: Schematic diagrams of entrained plant canopies as an important aspect of Vertical Biotic Structure in all Estuarine wetlands, or in Depressional and Lacustrine wetlands dominated by emergent monocots or lacking Tall and Very Tall plant layers. In Estuarine wetlands, the ability to conceal a hand or foot beneath the canopy is a key indicator of its density.

Table 4.22: Rating of Vertical Biotic Structure for wetlands dominated by emergent monocots or lacking Tall and Very Tall plant layers, especially Estuarine saline wetlands (see Figure 4.12).

Rating	Alternative States
A	Most of the vegetated plain of the AA has a dense canopy of living vegetation or entrained litter or detritus forming an entrained canopy that shades the soil surface and provides abundant cover for wildlife, such as small mammals and ground-dwelling birds.
B	Less than half of the vegetated plain of the AA has a dense entrained canopy as described in "A" above; OR Most of the vegetated plain has a dense entrained canopy but it is too close to the soil surface to provide cover for wildlife.
C	Less than half of the vegetated plain of the AA has a dense canopy of vegetation or entrained litter AND the canopy is too close to the soil surface to provide cover for wildlife.
D	Most of the AA lacks a dense entrained canopy of vegetation or litter.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Depressional wetland in a horse paddock, Elkhorn, Monterey County

CHAPTER 5:
GUIDELINES TO COMPLETE STRESSOR CHECKLISTS

A. Definition: For the purposes of CRAM, a stressor is an anthropogenic perturbation within a wetland or its setting that is likely to negatively impact the functional capacity of a CRAM Assessment Area (AA). In contrast, disturbances are distinctly defined as natural phenomena, although they might have similar impacts as stressors.

B. Rationale: Physical and biological processes connect wetlands to their environmental settings and thus help shape wetland conditions, which are therefore influenced by land use practices within the settings (Frissell *et al.* 1986, Roth *et al.* 1996, Scott *et al.* 2002). Wetland conditions can also be affected by stressors operating directly within the wetlands, although these tend to be less abundant than stressors originating in the surrounding landscape.

The purpose of the Stressor Checklist is to identify stressors within a CRAM Assessment Area (AA) or its immediate hat might help account for any low CRAM scores. In some cases, a single stressor might be the primary cause for low-scoring conditions, but conditions are usually due to interactions among multiple stressors (USEPA 2002).

There are four underlying assumptions of the Stressor Checklist: (1) stressors can help explain CRAM scores; (2) wetland condition declines as the number of stressors acting on the wetland increases (there is no assumption that the decline is additive (linear), non-linear, or multiplicative); (3) increasing 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 process to identify stressors is the same for all wetland types. For each CRAM attribute, a variety of possible stressors are listed. Their presence and likelihood of significantly affecting the AA are recorded in the Stressor Checklist Worksheet. For the Hydrology, Physical Structure, and Biotic Structure attributes, the focus is on stressors operating within the AA or within 50 m of the AA. For the Buffer and Landscape Context attribute, the focus is on stressors operating within 500 m of the AA. More distant stressors that have obvious, direct, controlling influences on the AA can also be noted.

Table 5.1: Wetland disturbances and conversions.

<table>
<tr><td colspan="2">Is there evidence of a major disturbance? (select one best answer)</td><td>flood</td><td>fire</td><td>landslide</td><td>other</td><td>none</td></tr>
<tr><td colspan="2">If there is evidence of disturbance, how severe was it?</td><td colspan="2">effects will last next 5 years</td><td>effects will last 3-5 years</td><td colspan="2">effects will last 1-2 years</td></tr>
<tr><td rowspan="4">If the wetland has been converted from another type, what type was it?</td><td rowspan="4">not converted</td><td colspan="2">depressional</td><td>vernal pool</td><td colspan="2">vernal pool system</td></tr>
<tr><td colspan="2">non-confined riverine</td><td>confined riverine</td><td colspan="2">seasonal estuarine</td></tr>
<tr><td colspan="2">perennial saline estuarine</td><td>perennial non-saline estuarine</td><td colspan="2">wet meadow</td></tr>
<tr><td colspan="2">lacustrine</td><td>seep or spring</td><td colspan="2">playa</td></tr>
</table>

Joshua N. Collins

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

Worksheet 5.1: Stressor Checklist Worksheet

HYDROLOGY ATTRIBUTE (WITHIN 50 M OF AA)	**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 (agricultural drainage, mosquito control, etc.)		
Actively managed hydrology		
Comments		

PHYSICAL STRUCTURE ATTRIBUTE (WITHIN 50 M OF AA)	**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		

BIOTIC STRUCTURE ATTRIBUTE (WITHIN 50 M OF AA)	**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		
Biological resource extraction or stocking (fisheries, aquaculture)		
Excessive organic debris in matrix (for vernal pools)		
Lack of vegetation management to conserve natural resources		
Lack of treatment of invasive plants adjacent to AA or buffer		
Comments		

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

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Todd Keeler-Wolf

Playa wetland, Soda Lake, California

APPENDIX I:
PROTOCOL FOR PROJECT ASSESSMENT BASED ON CRAM
Version 1.1

Introduction

There are generally two kinds of CRAM applications: assessments of ambient condition and assessments of project conditions. The approach is essentially the same in each case. The critical concepts common to both are Sample Universe and Sample Frame. The Sample Universe is the population of possible CRAM Assessment Areas (AAs) that is supposed to be assessed. The Sample Frame is a map of the Sample Universe. For more information about sample frames go to http://epa.gov/nheerl/arm/designing/design_intro.htm.

In the case of an ambient assessment, the Sample Universe consists of all the possible AAs of a single wetland type within a prescribed area that is larger than a project. For example, an ambient Sample Universe might encompass all of the possible AAs for lacustrine wetlands within a watershed, administrative region of an agency, congressional district, etc. In the case of a project assessment, the Sample Universe is all of the possible AAs for one kind of wetland within the boundaries of one project. The results are used to characterize the project.

Project Definition

For the purposes of CRAM, a "project" is any activity authorized under Section 404 of the US Clean Water Act, under the State's 401 Certification/WDR Programs, or under Section 1600 of the State's Fish and Game Code that directly changes the extent, type, or condition of at least 0.1 ha of non-riverine wetland, or at least 100m of riverine wetland length as defined in the CRAM Manual.

Project Assessment Steps

Step 1: Identify the Project Boundary

The project boundary is usually designated by the project sponsors and could include upland areas and other non-wetland areas (Figure 1). The project boundary has to be imported into a GIS as an overlay on 1-3m pixel resolution aerial imagery or a wetland inventory of comparable resolution and of recent vintage.

If a project is part of a larger wetland and is less that 80% of the recommended minimum size for a CRAM Assessment Area than conduct two assessments, one that is confined to project and one for the larger Assessment Area that includes the project.

Step 2: Identify the Sample Universe

Overlay the project boundary on the aerial imagery in the GIS and digitize the boundary of all non-riverine wetlands at least 0.1 ha in area and all riverine wetlands at least 100m long within the footprint of the project (Figure 1). All the wetlands of one type comprise a separate Sample Universe. There will be as many Sample Universes as there are wetland types within the project that meet the minimum polygon size requirements.

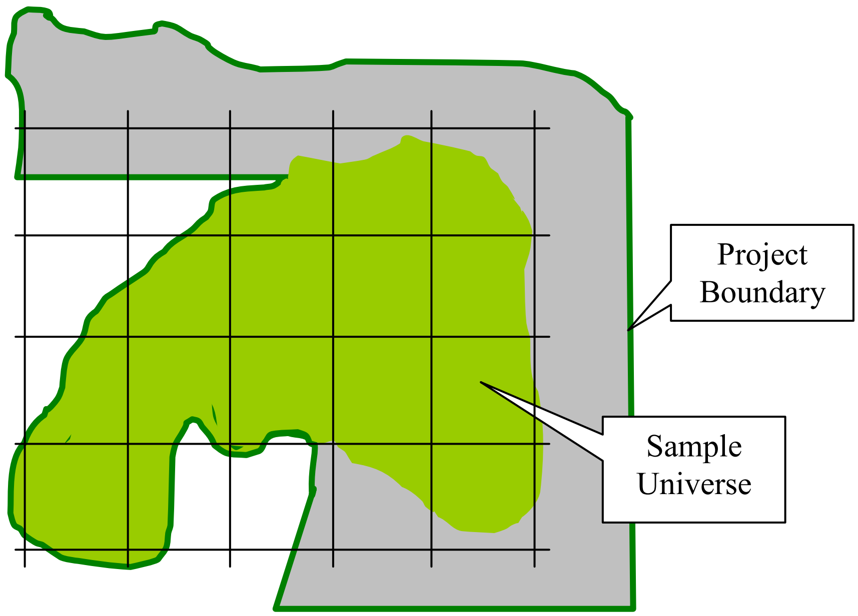


Figure 1: Diagrams of Project Boundary (dark green line) and Sample Universe (area shaded light green) showing a grid used to develop the Sample Frame of candidate AAs. A GIS can be used to generate the Sample Frame without using a grid.

Step 3: For each Sample Universe, Develop the Sample Frame (Figures 2-4)

The Sample Frame will be a map of all candidate AAs within the Sample Universe. See the following Table 3.7 from Chapter 3 of the CRAM Manual for a list of recommended AA sizes for each wetland type.

There are two ways to begin creating a Sample Frame. One way is to overlay the Sample Universe with a grid having a cell size just large enough to encompass one AA. Another way is to use a GIS to generate a map of the maximum number of non-overlapping AAs. At this stage of Sample Frame development, candidate AAs can overlap the edge of the Sample Universe, although they cannot overlap each other.

Any AAs that do not meet the criteria for an AA as presented in Chapter 3 of the CRAM Manual must be rejected. The following considerations are especially important.

a. Each AA should not cross any obvious, major physical changes in topography, hydrology, or infrastructure that significantly control the sources, volumes, rates, or general composition of sediment supplies or water supplies within the AA at the time of the field assessment.

b. Each AA can only include one wetland type. No AA can include any portion of more than one type of wetland, as defined by the CRAM Manual.

c. Reject any candidate AA that is more than 50% outside the Sample Universe. The remaining AAs comprise the Sample Frame (Figure 3).

Table 3.7 (from Chapter 3 of the CRAM Manual): Preferred and minimum AA sizes for each wetland type. Note: wetlands smaller than the preferred AA sizes can be assessed in their entirety.

Wetland Type	Recommended AA Size
Slope	
Spring or Seep	Preferred size is 0.50 ha (about 75m x 75m, but shape can vary); there is no minimum size (least examples can be mapped as dots).
Wet Meadow	Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); minimum size is 0.1 ha (about 30m x 30m).
Depressional	
Vernal Pool	There are no size limits (see Section 3.5.6 and Table 3.8).
Vernal Pool System	Preferred size is 1.0 km (about 300m x 300m, but shape can vary); There is no minimum size (see Section 3.5.6 and Table 3.8).
Other Depressional	Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.1 ha (about 30m x 30m).
Riverine	
Confined and Non-confined	Preferred length is 10x average bankfull channel width; maximum length is 200m; minimum length is 100m. AA should extend laterally (landward) to encompass all the vegetation (trees, shrubs vines, etc) that probably provide woody debris, leaves, insects, etc. directly to the channel and its floodplain (Figure 3.4); minimum width is 2m.
Lacustrine	Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.5 ha (about 75m x 75m).
Playa	Preferred size is 2.0 ha (about 140m x 140m, but shape can vary); Minimum size is 0.5 ha (about 75m x 75m).
Estuarine	
Perennial Saline	Preferred size and shape for estuarine wetlands is a 1.0 ha circle (radius about 55m), but the shape can be non-circular if necessary to fit the wetland and to meet hydro-geomorphic and other criteria as outlined in Sections 3.5.1 through 3.5.3. The minimum size is 0.1 ha (about 30m x 30m).
Perennial Non-saline	
Seasonal	

Step 4: Identify and assess any Sample Universe only large enough for one AA.

In these kinds of cases, the Sampler Universe and the AA are the same. After completing Step 4, go to Step 8.

Step 5: Identify any Sample Universe that is only large enough for two or three AAs, and assess all thee AAs that comprise the Sample Universe.

If at least 20% of any AA is outside the boundary of the Sample Universe, then, to the extent possible, re-shape the AA so that it fits entirely within the Sample Universe (Figure 4). After completing Step 5, go to Step 8.

Step 6: For each Sample Universe large enough for more than three AAs, assess the first two AAs randomly selected from the Sample Frame.

If at least 20% of a selected AA is outside the boundary of the Sample Universe, then re-shape the AA so that it fits entirely within the Sample Universe (Figure 4). Average the overall sites scores for these first two AAs. After completing Step 6, go to Step 7.

Step 7: For each Sample Universe identified in Step 6, complete the assessment.

Randomly select and assess a third AA. If the overall CRAM score for the third AA differs from the average score of the first two AAs by more than 15%, randomly select and assess a fourth AA. If the overall score for the fourth AA differs from the average score of the first three AAs by more than 15%, then randomly select and assess a fifth AA. If at least 20% of any AA is outside the boundary of the Sample Universe, then, to the extent possible, re-shape the AA so that it fits entirely within the Sample Universe (Figure 4). Continue this process until the overall score for the latest AA does not differ from the average score for all the previous AAs by more than 15%. After completing Step7, go to Step 8.

Step 8: Upload the CRAM results for each AA to the CRAM website.

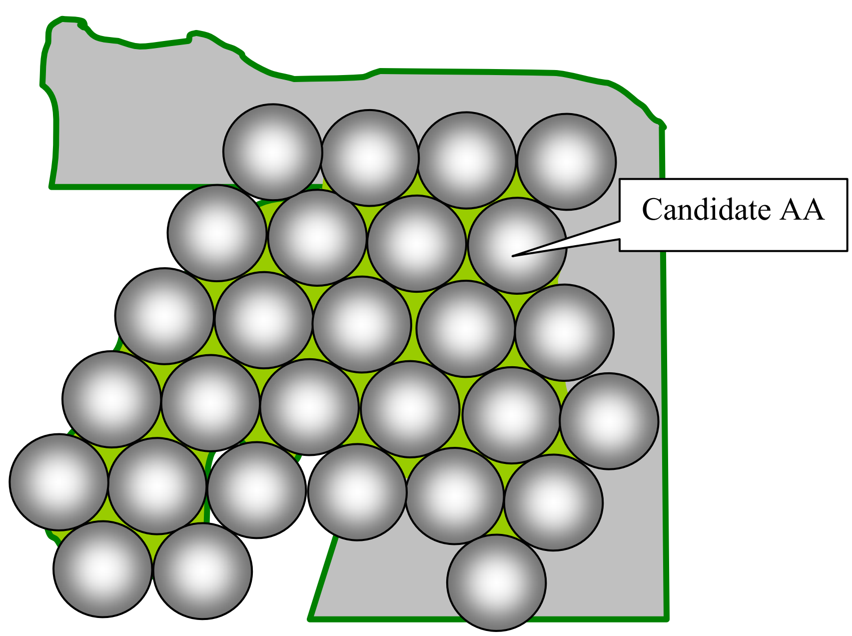


Figure 2: Map of the maximum number of candidate AAs generated in a GIS.

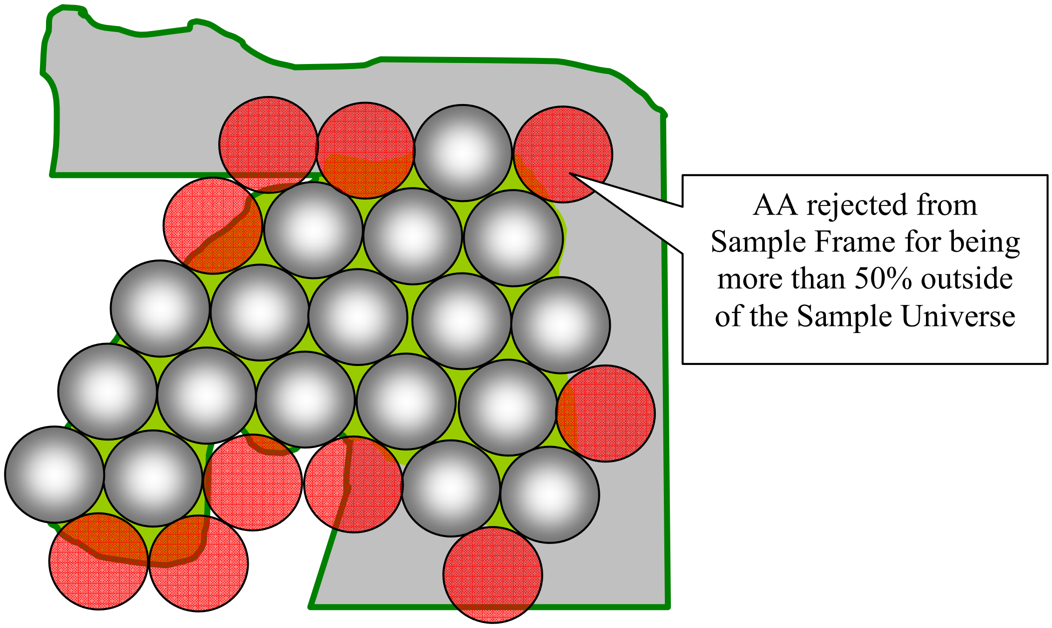


Figure 3: Map of the maximum number of candidate AAs showing AAs rejected for being more than 50% outside of the sample universe (red AAs.

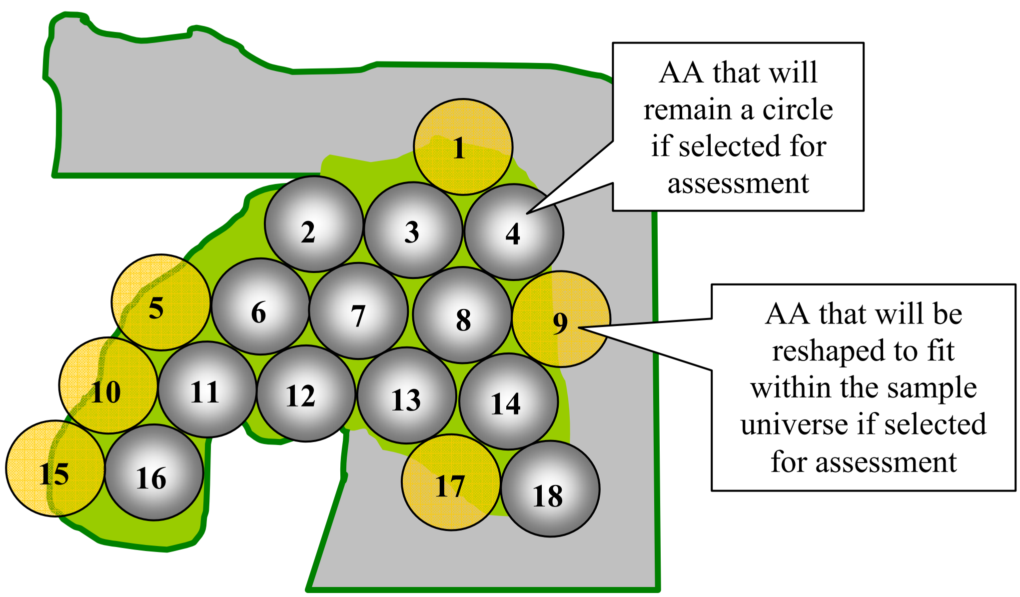
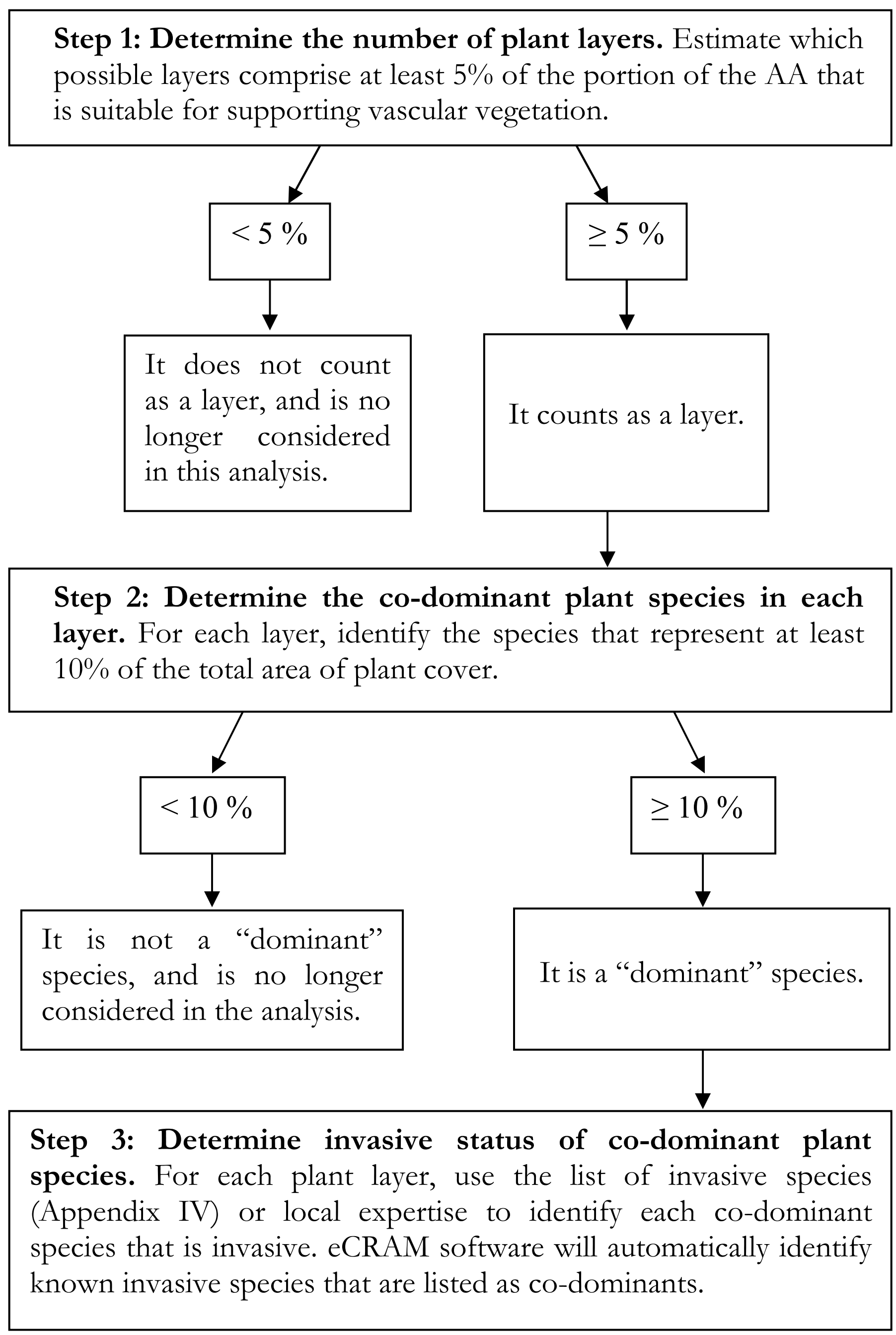


Figure 4: Sample Frame of final candidate AAs showing those entirely within the Sample universe (grey AAs) that do not have to be re-shaped if selected for assessment, and THOSE at 20% outside the sample universe (yellow AAs) that have to be reshaped if assessed. Each AA of the sample frame is numbered for random selection.

Joshua N. Collins

Seasonal depressional wetland, Sonoma County

APPENDIX II:
FLOW CHART TO DETERMINE PLANT DOMINANCE



Joshua N. Collins

Lacustrine and riparian wetlands, Phillip Burton Wilderness, Point Reyes National Seashore

APPENDIX III: GLOSSARY

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

allochthanous – external source of energy for a stream (e.g., dead leaves, branches, and dead trees that fall into the river)

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 – the portion of a wetland or riverine system that is the subject of the CRAM evaluation

assessment window – the period of time when assessments of wetland condition should be conducted. In general, it is during the growing season for the characteristic plant community of the wetland type to be assessed.

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, which 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, physio-chemical characteristics, and functional processes, relative to healthy wetlands of the same type. There are three primary aspects of condition: location, form, and structure.

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 riverine 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 hill slopes, 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

function – for the purposes of Level 2 assessment, a function is something that a wetland stream or riparian area does. For example, groundwater recharge, flood-stage desynchronization, pollution filtration, wildlife support, and recreation are wetland functions. In this context, functions are identified separately from the processes that cause them to happen. In most cases, Level 3 tools are needed to assess the processes that account for functions.

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

hummock – a mound composed of organic materials

hyporheic – saturated zone under a river or stream, comprising substrate with the interstices filled with water

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 of a wetland 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

rating – for a CRAM metric, a rating represents its 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

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 line connecting the lowest or deepest points along the riverbed

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 non-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).

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

xeric – characterized by an extremely dry habitat

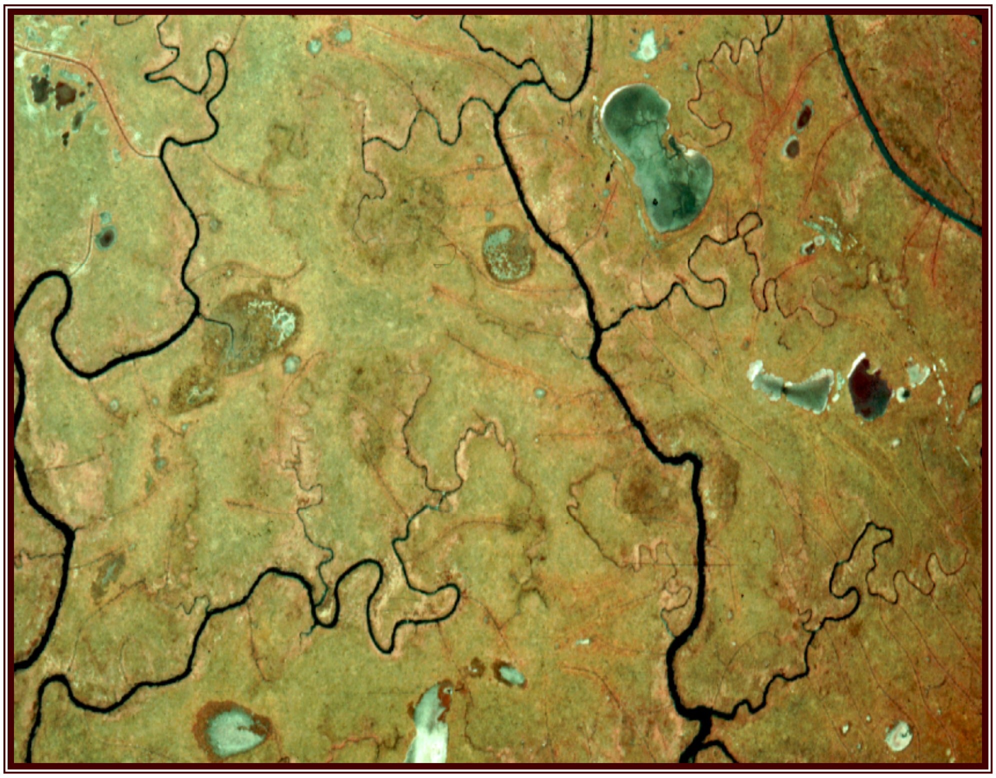
zonation – distribution of plants or animals arranged in zones or bands, caused by gradations of abiotic and/or biotic factors


Joshua N. Collins

Depressional wetland, McCabe Creek Meadow, Yosemite National Park

APPENDIX IV: ACRONYM LIST

AA	Assessment Area
BMP	Best Management Practices
Cal-IPC	California Invasive Plant Council
CDF	California Department of Forestry and Fire Protection
CEDEN	California Environmental Data Exchange Network
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CRAM	California Rapid Assessment Method for Wetlands
DOQQ	Digital Orthogonal Quarterly Quadrangles
eCRAM	An electronic version of CRAM
GIS	Geographic Information System
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic Functional Assessment Method
IBI	Index of Biotic Integrity
JD	Jurisdictional Delineation
NAIP	National Agriculture Imagery Program
NGO	Non-governmental Organization
NHD	National Hydrography Dataset
Non-PS	Non-point Source of pollution
NRC	National Research Council
NWI	National Wetlands Inventory
ORAM	Ohio Rapid Assessment Method
PI	Principal Investigator
POTW	Publically Owned Treatment Works
PS	Point Source of pollution
PSR	Pressure-State-Response Model
QA/QC	Quality Assurance/Quality Control
SPTH	Site Potential Tree Height
SPVH	Site Potential Vegetation Height
SWAMP	Surface Water Ambient Monitoring Program
WRAP	Wetland Rapid Assessment Procedure



Laurel Collins

Saline estuarine wetland, Petaluma River, California

APPENDIX V: INVASIVE PLANT SPECIES LIST

[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. The invasive status is based upon species with a rating of high, moderate, and limited in the Cal-IPC Invasive Plant Inventory (Cal-IPC 2006). Indicator status is from the U.S. Fish and Wildlife Service's National List of Plant Species That Occur in Wetlands: California (Region 0), May 1988. FAC=Facultative, FACU=Facultative Upland, FACW=Facultative Wetland, NI=No Indicator, OBL=Obligate Wetland, UPL=Obligate Upland, na=Indicator status not available. A positive (+) or negative (-) sign is used with the Facultative Indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands). An asterisk (*) following a regional Indicator identifies tentative assignments based on limited information from which to determine the indicator status.

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

Appendix V-A: List of California Plant Species (alphabetized by plant species)						
Plant Species	**Code[1]**	**Common Name**	**Invasive**	**Growth Habit**	**Family**	**Indicator status**
Abies concolor	Abco	white fir	No	tree	Pinaceae	na
Acer circinatum	Acci	vine maple	No	shrub	Aceraceae	FAC
Acer macrophyllum	Acma	big-leaf maple	No	tree	Aceraceae	FAC
Acer negundo L.	Acne	box elder	No	tree	Aceraceae	FACW
Adiantum aleuticum	Adal	Five fingered fern	No	herb	Pteridaceae	na
Adiantum jordanii	Adjo	California maidenhair	No	herb	Pteridaceae	NI
Aesculus californica	Aeca	California buckeye	No	tree	Hippocastanaceae	na
Ageratina adenophora	Agad	sticky eupatorium	Yes	herb	Asteraceae	NI
Agrostis gigantea	Aggi	redtop	No	herb	Poaceae	NI
Agrostis stolonifera L.	Agst	creeping bentgrass	Yes	herb	Poaceae	FACW
Agrostis viridis	Agvi	water bentgrass	No	herb	Poaceae	OBL

Appendix V-A: List of California Plant Species (alphabetized by plant species)						
Plant Species	**Code[1]**	**Common Name**	**Invasive**	**Growth Habit**	**Family**	**Indicator status**
Ailanthus altissima (P. Mill.) Swingle	Aial	tree of heaven	Yes	tree	Simaroubaceae	FACU
Alisma plantago-aquatica	Alpl	water plantain	No	herb	Alismataceae	OBL
Allenrolfea occidentalis	Aloc	iodine bush	No	shrub	Chenopodiaceae	FACW+
Alnus incana	Alin	mountain alder	No	shrub	Betulaceae	NI
Alnus rhombifolia	Alrh	white alder	No	tree	Betulaceae	FACW
Alnus rubra	Alru	red alder	No	tree	Betulaceae	FACW
Alopecurus aequalis	Alae	shortawn foxtail	No	herb	Poaceae	OBL
Amaranthus albus	Amal	tumbleweed	No	herb	Amaranthaceae	FACU
Amaranthus californicus	Amca	California pigweed	No	herb	Amaranthaceae	FACW
Ambrosia artemisiifolia	**Amat**	common ragweed	No	herb	Asteraceae	FACU
Ambrosia chamissonis	Amch	beach-bur	No	shrub	Asteraceae	NI
Ambrosia psilostachya DC.	Amps	western ragweed	No	herb	Asteraceae	FAC
Ammannia coccinea Rottb.	Amco	tooth-cup	No	herb	Lythraceae	OBL
Ammophila arenaria	Amar	European beach grass	Yes	herb	Poaceae	FACU
Anagallis arvensis L.	Anar	scarlet pimpernel	No	herb	Primulaceae	FAC
Andropogon glomeratus (Walt.) B.S.P.	Angl	southwestern bushy bluestem	No	herb	Poaceae	FACW
Anemopsis californica (Nutt.)	Anca	yerba mansa	No	herb	Saururaceae	OBL
Anthriscus caucalis	**Ancc**	bur chervil	No	herb	Apiaceae	na
Apium graveolens L.	Apgr	celery	No	herb	Apiaceae	FACW*
Apocynum cannabinum	Apca	indian hemp	No	shrub	Apocynaceae	FAC
Aquilegia formosa	Aqfo	columbine	No	herb	Ranunculaceae	OBL
Aralia californica A. Wats.	**Arcl**	California spikenard	No	herb	Araliaceae	FACW
Artemisia californica	Arca	California sagebrush	No	shrub	Asteraceae	NI
Artemisia douglasiana Bess.	**Ardg**	mugwort	No	shrub	Asteraceae	FACW
Artemisia ludoviciana	Arlu	silver wormwood	No	shrub	Asteraceae	FACU-
Artemisia tridentata	Artr	Great Basin sage	No	shrub	Asteraceae	na
Arundo donax L.	Ardo	giant reed	Yes	shrub	Poaceae	FAC+

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Plant Species	**Code[1]**	**Common Name**	**Invasive**	**Growth Habit**	**Family**	**Indicator status**
Aster subulatus Michx.	Assu	slender aster	No	herb	Asteraceae	FACW
Athyrium filix-femina	Atfi	common ladyfern	No	herb	Dryopteridaceae	FAC
Atriplex californica Moq.	Atca	California saltbush	No	shrub	Chenopodiaceae	FAC
Atriplex lentiformis ssp. lentiformis	Atle	Brewer's saltbush	No	shrub	Chenopodiaceae	FAC
Atriplex semibaccata	Atse	Australian saltbush	Yes	shrub	Chenopodiaceae	FAC
Atriplex triangularis	Attr	saltbush	No	herb	Chenopodiaceae	NI
Atriplex wattsonii	Atwa	Watson's saltbush	No	shrub	Chenopodiaceae	FACW+
Avena barbata	Avba	slender wild oat	Yes	herb	Poaceae	NI
Avena fatua	Avfa	wild oat	Yes	herb	Poaceae	NI
Avena sativa	Avsa	hay	No	herb	Poaceae	NI
Baccharis douglasii	Bado	marsh baccharis/Douglas' false-willow	No	shrub	Asteraceae	OBL
Baccharis emoryi Gray	Baem	Emory baccharis	No	shrub	Asteraceae	FACW
Baccharis pilularis	Bapi	coyote brush	No	shrub	Asteraceae	NI
Baccharis salicifolia	Basa	mule fat	No	shrub	Asteraceae	FACW
Baccharis sarothroides Gray	**Basr**	broom baccharis	No	shrub	Asteraceae	FAC
Bassia hyssopifolia	Bahy	bassia	Yes	herb	Chenopodiaceae	FAC
Batis maritima L.	Bama	saltwort, beachwort	No	shrub	Bataceae	OBL
Bergia texana (Hook.) Seub. ex Walp.	Bete	Texas bergia	No	herb	Elatinaceae	OBL
Berula erecta (Huds.) Coville	Beer	cutleaf water-parsnip	No	herb	Apiaceae	OBL
Beta vulgaris	Bevu	wild beet	No	herb	Chenopodiaceae	FACU
Bidens laevis (L.) B.S.P.	Bila	bur-marigold	No	herb	Asteraceae	OBL
Blennosperma nanum	Blna	common blennosperma	No	herb	Asteraceae	FACW
Boykinia occidentalis	Booc	coast boykinia	No	herb	Saxifragaceae	FACW
Brassica nigra	Brni	black mustard	Yes	herb	Brassicaceae	NI
Brickellia californica	Brca	California brickellbush	No	shrub	Scrophulariaceae	FACU
Bromus diandrus	Brdi	ripgut brome	Yes	herb	Poaceae	NI
Bromus madritensis	Brma	foxtail chess	Yes	herb	Poaceae	UPL

Appendix V-A: List of California Plant Species (alphabetized by plant species)						
Plant Species	**Code[1]**	**Common Name**	**Invasive**	**Growth Habit**	**Family**	**Indicator status**
Bromus mollis	Brmo	soft brome	No	herb	Poaceae	FACU-
Bromus tectorum	Brte	cheat grass	Yes	herb	Poaceae	NI
Callitriche heterophylla Pursh	Cahe	water starwort	No	herb	Callitrichaceae	OBL
Calocedrus decurrens	Cade	incense cedar	No	tree	Cupressaceae	na
Caltha palustris	Capa	marsh marigold	No	herb	Ranunculaceae	NI
Calystegia macrostegia	Cama	morning-glory	No	herb	Convovulaceae	NI
Calystegia sepium (L.) R. Br.	Case	hedge bindweed	No	herb	Convovulaceae	OBL
Camissonia chieranthifolia var. suffruticosa	Cach	beach evening primrose	No	shrub	Onagraceae	NI
Cardamine californica	Caca	milk maids, tooth wort	No	herb	Brassicaceae	UPL
Carduus pycnocephalus	Capy	Italian thistle	Yes	herb	Asteraceae	NI
Carex barbarae	Caba	Santa Barbara sedge	No	herb	Cyperaceae	FACW
Carex lenticularis	Cale	lakeshore sedge	No	herb	Cyperaceae	na
Carex lyngbyei	Caly	Lyngbyei's sedge	No	herb	Cyperaceae	OBL
Carex praegracilis W. Boott	Capr	clustered field sedge	No	herb	Cyperaceae	FACW-
Carex schottii	Casc	Schott's sedge	No	herb	Cyperaceae	OBL
Carex spissa Bailey	Casp	San Diego sedge	No	herb	Cyperaceae	FAC*
Carex Whitneyi	Cawh	sedge	No	herb	Cyperaceae	na
Carpobrotus edulis	Caed	iceplant	Yes	herb	Aizoaceae	NI
Casuarina equisetifolia	Caeq	river she-oak	No	tree	Casuarinaceae	na
Centaurea solstitialis	Ceso	yellow starthistle	Yes	herb	Asteraceae	NI
Centella asiatica	Ceas	Asiatic pennywort	No	herb	Apiaceae	NI
Cercocarpus betuloides	Cebe	mountain mahogany	No	shrub	Rosaceae	na
Chenopodium album	Chal	lamb's quarters	No	herb	Chenopodiaceae	FAC
Chenopodium ambrosioides	Cham	Mexican tea	No	herb	Chenopodiaceae	FAC
Chrysanthemum coronarium	Chco	garland chrysanthemum	Yes	herb	Asteraceae	na
Chrysothamnus nauseosus	Chna	rabbit brush	No	shrub	Asteraceae	na
Cicuta douglasii	Cido	western waterhemlock	No	herb	Apiaceae	OBL

Appendix V-A: List of California Plant Species (alphabetized by plant species)						
Plant Species	**Code[1]**	**Common Name**	**Invasive**	**Growth Habit**	**Family**	**Indicator status**
Cirsium arvense	Ciar	Canada thistle	Yes	herb	Asteraceae	FAC-
Cirsium vulgare (Savi) Ten.	Civu	bull thistle	Yes	herb	Asteraceae	FAC
Clematis ligusticifolia	Clli	virgin's bower	No	shrub	Ranunculaceae	FAC
Conium maculatum L.	Coma	poison hemlock	Yes	herb	Apiaceae	FAC
Conyza bonariensis	Cobo	horseweed	No	herb	Asteraceae	na
Conyza canadensis (L.) Cronq.	Coca	horseweed	No	herb	Asteraceae	FAC
Cordylanthus maritimus ssp. maritimus	**Comr**	salt marsh bird's beak	No	herb	Scrophulariaceae	OBL
Cordylanthus mollis ssp. mollis	Como	soft bird's beak	No	herb	Scrophulariaceae	OBL
Cornus sericea	Cosr	creek dogwood	No	shrub	Cornaceae	FACW
Cortaderia jubata	Coju	Andean pampas grass	Yes	herb	Poaceae	NI
Cortaderia selloana	Cose	pampas grass	Yes	herb	Poaceae	NI
Cotula coronopifolia L.	Coco	brass buttons	Yes	herb	Asteraceae	FACW+
Crassula aquatica (L.) Schoenl.	Craq	water pygmyweed	No	herb	Crassulaceae	OBL
Cressa truxillensis Kunth	Crtr	alkali weed	No	shrub	Convovulaceae	FACW
Crypsis schoenoides	Crsc	swamp pickle-grass	No	herb	Poaceae	OBL
Crypsis vaginiflora (Forsk.) Opiz	Crva	sharp-leaved Timothy	No	herb	Poaceae	OBL
Cuscuta salina	Cusa	witch's hair/dodder	No	herb	Cuscutaceae	NI
Cynara cardunculus	Cyca	artichocke thistle	Yes	herb	Asteraceae	NI
Cynodon dactylon	Cyda	Bermuda grass	Yes	herb	Poaceae	FACU
Cynosurus echinatus	Cyec	bristly dogstail grass	Yes	herb	Poaceae	na
Cyperus eragrostis Lam.	Cyer	umbrella sedge	No	herb	Cyperaceae	FACW
Cyperus esculentus	Cyes	nutsedge	No	herb	Cyperaceae	FACW
Cyperus involucratus	Cyin	nutsedge	No	herb	Cyperaceae	FACW+
Cyperus rotundus L.	Cyro	purple nutsedge	No	herb	Cyperaceae	FAC
Cyperus squarrosus L.	Cysq	awned flatsedge/bearded flatsedge	No	herb	Cyperaceae	OBL
Datisca glomerata (K. Presl) Baill.	Dagl	Durango root	No	herb	Datiscaceae	FACW
Delairea odorata/Senecio mikanoides	Deod	Cape (German) ivy	Yes	herb	Asteraceae	na

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Deschampsia cespitosa	Dece	tufted hairgrass	No	herb	Poaceae	FACW
Dichelostemma capitatum ssp. capitatum	Dica	blue dicks	No	herb	Liliaceae	FAC*
Distichlis spicata (L.) Greene	Disp	saltgrass	No	herb	Poaceae	FACW
Downingia cuspidata	Docu	toothed calicoflower	No	herb	Campanulaceae	OBL
Dryopteris arguta	Drar	wood fern	No	herb	Dryopteridaceae	NI
Echinochloa crus-galli (L.) Beauv.	Eccr	banyard grass	No	herb	Poaceae	FACW
Eclipta prostrata	Ecpr	eclipta	No	herb	Asteraceae	FAC+
Ehrharta erecta	Eher	veldt grass	Yes	herb	Poaceae	NI
Elatine brachysperma Gray	Elbr	shortseed waterwort	No	herb	Elatinaceae	OBL
Eleocharis acicularis	Elac	hairgrass	No	herb	Cyperaceae	OBL
Eleocharis geniculata	Elge	annual spikerush	No	herb	Cyperaceae	OBL
Eleocharis macrostachya	Elma	common spikerush	No	herb	Cyperaceae	NI
Eleocharis montevidensis	Elmo	sand spikerush	No	herb	Cyperaceae	FACW
Eleocharis parishii	Elpa	Parish's spikerush	No	herb	Cyperaceae	FACW
Eleocharis radicans	Elra	rooted spikerush	No	herb	Cyperaceae	OBL
Eleocharis rostellata	Elro	beaked spikerush	No	herb	Cyperaceae	OBL
Elymus elymoides	Elel	squirreltail	No	herb	Poaceae	FACU-
Emmenanthe penduliflora	Empe	whispering bells	No	herb	Hydrophyllaceae	NI
Encelia californica	Enca	bush sunflower	No	shrub	Asteraceae	NI
Epilobium (Zauschneria) canum	Epca	california fuchsia	No	herb	Onagraceae	na
Epilobium ciliatum Raf.	Epci	hairy willow-herb	No	herb	Onagraceae	FACW
Epilobium pygmaeum (Speg.)	Eppy	smooth willow-herb	No	herb	Onagraceae	OBL
Equisetum arvense	Eqar	common horsetail	No	herb	Equisetaceae	FAC
Equisetum laevigatum	Eqla	smooth scouring rush	No	herb	Equisetaceae	FACW
Equisetum telmateia Ehrh.	Eqte	giant horsetail	No	herb	Equisetaceae	OBL
Eriogonum fasciculatum	Erfa	California buckwheat	No	shrub	Polygonaceae	na
Eriophyllym confertifolium	Erco	golden yarrow	No	shrub	Asteraceae	NI

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Erodium botrys	Erbo	long-beaked filaree	No	herb	Geraniaceae	NI
Erodium cicutarium	Erci	red-stem filaree	Yes	herb	Geraniaceae	NI
Eryngium aristulatum var. parishii	Erar	San Diego-button celery	No	herb	Apiaceae	OBL
Eucalyptus globulus	Eugl	Tasmanian blue gum	Yes	tree	Mytaceae	NI
Euphorbia peplus	Eupe	petty spurge	No	herb	Euphorbiaceae	NI
Euphorbia terracina	Eute	Geraldton carnation weed	Yes	herb	Euphorbiaceae	na
Foeniculum vulgare P. Mill.	Fovu	sweet fennel	Yes	herb	Apiaceae	FACU-
Frankenia salina (Molina)	Frsa	alkali heath	No	herb	Frankeniaceae	FACW+
Fraxinus dipetala	Frdi	California ash	No	tree	Oleaceae	NI
Fraxinus latifolia	Frla	Oregon ash	No	tree	Oleaceae	FACW
Fraxinus velutina Torr.	Frve	velvet ash	No	tree	Oleaceae	FACW
Galium aparine	Gaap	goose grass	No	herb	Rubiaceae	FACU
Genista monspessulana	Gemo	French broom	Yes	shrub	Fabaceae	na
Glaux maritima	Glma	sea-milkwort	No	herb	Primulaceae	OBL
Gnaphalium californicum	**Gncl**	California everlasting	No	herb	Asteraceae	NI
Gnaphalium canescens ssp. beneolens	Gnca	fragrant everlasting	No	herb	Asteraceae	NI
Gnaphalium palustre Nutt.	Gnpa	lowland cudweed	No	herb	Asteraceae	FACW
Grindelia hirsutula var. hirsutula	Grhi	hairy gumweed	No	herb	Asteraceae	FACW
Grindelia stricta	Grst	marsh gum-plant	No	shrub	Asteraceae	OBL
Hedera helix	Hehe	English ivy	Yes	vine ("shrub")	Araliaceae	NI
Helianthus annuus L.	Hean	common sunflower	No	herb	Asteraceae	FAC-
Helianthus californicus DC.	**Hecl**	California sunflower	No	herb	Asteraceae	OBL
Heliotropium curassavicum L.	Hecu	alkali heliotrope	No	herb	Boraginaceae	OBL
Hemizonia paniculata Gray	Hepa	fascicled tarweed	No	herb	Asteraceae	FACU*
Hemizonia parryi var. australis	**Hepr**	southern tarplant	No	herb	Asteraceae	FAC
Heracleum lanatum	Hela	cow parsnip	No	herb	Apiaceae	FACU
Hesperevax caulescens	Heca	hogwallow starfish	No	herb	Asteraceae	OBL

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

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

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

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Mimulus aurantiacus	Miau	bush monkeyflower	No	shrub	Scrophulariaceae	NI
Mimulus cardinalis Dougl. ex Benth.	Mica	scarlet monkeyflower	No	herb	Scrophulariaceae	OBL
Mimulus guttatus DC.	Migu	common monkeyflower	No	herb	Scrophulariaceae	FACW+
Mimulus moschatus	Mimo	musk monkeyflower	No	herb	Scrophulariaceae	OBL
Monanthochloe littoralis	Moli	wiregrass/shoregrass	No	herb	Poaceae	OBL
Muhlenbergia rigens (Benth.) A.S. Hitchc.	Muri	deergrass	No	herb	Poaceae	FACW
Myoporum laetum	Myla	mousehole tree	Yes	tree	Myoporaceae	NI
Myosotis symphytifolia	Mysy	forget-me-not	No	herb	Boraginaceae	NI
Myosurus minimus L.	Mymi	mouse tail	No	herb	Ranunculaceae	OBL
Myriophyllum aquaticum	Myaq	parrot's feather	Yes	herb	Haloragaceae	OBL
Najas marina	Nama	holly-leaved water-nymph	No	herb	Hydrocharitaceae	OBL
Nemacaulis denudata var. denudata	Nede	wooly-heads	No	herb	Polygonaceae	NI
Nicotiana glauca Graham	Nigl	tree tobacco	Yes	shrub	Solanaceae	FAC
Olea europaea	Oleu	olive	Yes	tree	Oleaceae	NI
Orizopsis mileaceum	Ormi	smilo grass	Yes	herb	Poaceae	NI
Osmorhiza brachypoda	Osbr	California sweetcicely	No	herb	Apiaceae	NI
Oxalis pes-caprae	Oxpe	Bermuda buttercup	Yes	herb	Oxalidaceae	NI
Parapholis incurva	Pain	sickle grass	No	herb	Poaceae	OBL
Paspalum distichum	Padi	knot grass	No	herb	Poaceae	OBL
Pennisetum clandestinum	Pecl	kikuyu grass	Yes	herb	Poaceae	FACU
Petasites frigidus (L.) Fries	Pefr	coltsfoot	No	herb	Asteraceae	NI
Phacelia distans	Phdi	phacelia	No	herb	Hydrophyllaceae	NI
Phalaris aquatica	Phaq	Harding grass	Yes	herb	Poaceae	FAC
Phalaris arundinacea	Phar	reed canary grass	No	herb	Poaceae	OBL
Phalaris lemmonii	Phle	Lemmon's canary grass	No	herb	Poaceae	FACW
Phoenix canariensis	Phca	Phoenix date palm	Yes	tree	Arecaceae	NI
Phragmites australis (Cav.) Trin. ex Steud.	Phau	common reed	No	herb	Poaceae	FACW

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Phyllospadix scouleri Hook.	Phsc	Scouler's surfgrass	No	herb	Zosteraceae	OBL
Phyllospadix torreyi S. Wats.	Phto	Torrey's surfgrass	No	herb	Zosteraceae	OBL
Picris echioides L.	Piec	bristly ox-tongue	Yes	herb	Asteraceae	FAC
Pilularia americana	Piam	American pillwort	No	herb	Marsileaceae	OBL
Pimpinella anisum	Pian	anise	No	herb	Umbelliferae	NI
Pinus jeffryi	Pije	Jeffrey pine	No	tree	Pinaceae	na
Pinus ponderosa	Pipo	ponderosa pine	No	tree	Pinaceae	FACU
Piptatherum miliaceum	Pimi	smilo grass	Yes	herb	Poaceae	NI
Plagiobothrys leptocladus	Plle	alkali plagiobothrys	No	herb	Boraginaceae	OBL
Plagiobothrys stipitatus	Plst	stipitate popcorn flower	No	herb	Boraginaceae	OBL
Plagiobothrys undulatus	Plun	coast popcorn-flower	No	herb	Boraginaceae	FACW
Plantago elongata Pursh	Plel	slender plantain	No	herb	Plantaginaceae	FACW*
Plantago erecta	Pler	dwarf plantain	No	herb	Plantaginaceae	na
Plantago lanceolata L.	Plla	English plantain	Yes	herb	Plantaginaceae	FAC-
Plantago major	Plma	common plantain	No	herb	Plantaginaceae	FAC
Plantago subnuda	Plsu	naked plantain	No	herb	Plantaginaceae	FACW
Platanus racemosa	Plra	western sycamore	No	tree	Platanaceae	FACW
Pluchea odorata	Plod	salt marsh fleabane	No	herb	Asteraceae	OBL
Pluchea sericea (Nutt.) Cav.	Plse	arrow weed	No	shrub	Asteraceae	FACW
Poa pratensis	Popr	Kentucky bluegrass	Yes	herb	Poaceae	FACU
Polygonum amphibium L.	Poam	water smartweed	No	herb	Polygonaceae	OBL
Polygonum arenastrum Jord. ex Boreau	Poar	common knotweed	No	herb	Polygonaceae	FAC
Polygonum lapathifolium L.	Pola	willow weed	No	herb	Polygonaceae	OBL
Polygonum punctatum	Popu	water smartweed	No	herb	Polygonaceae	OBL
Polypogon monspeliensis (L.) Desf.	Pomo	annual beard grass/rabbitfoot grass	Yes	herb	Poaceae	FACW+
Populus balsamifera	Poba	black cottonwood	No	tree	Salicaceae	FACW
Populus fremontii S. Wats.	Pofr	Fremont cottonwood	No	tree	Salicaceae	FAC+*

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Portulaca oleracea	Pool	common purslane	No	herb	Portulacaceae	FAC
Potamogeton foliosus Raf.	Pofo	leafy pondweed	No	herb	Potamogetonaceae	OBL
Potamogeton nodosus Poir.	Pono	long-leaved pondweed	No	herb	Potamogetonaceae	OBL
Potamogeton pectinatus	Pope	fennel-leaf pondweed	No	herb	Potamogetonaceae	OBL
Potentilla anserina	Poan	cinquefoil	No	herb	Rosaceae	NI
Prunus ilicifolia	Pril	holly-leaved cherry	No	tree	Rosaceae	na
Pseudotsuga menziesii	Psme	douglas fir	No	tree	Pinaceae	NI
Psilocarphus brevissimus Nutt.	Psbr	wooly marbles	No	herb	Asteraceae	OBL
Pteridium aquilinum	Ptaq	bracken fern	No	herb	Polypodiaceae	FACU
Puccinellia distans (Jacq.) Parl.	Pudi	European alkali grass	No	herb	Poaceae	OBL
Pulicaria paludosa Link	Pupa	Spanish sunflower	No	herb	Asteraceae	NI
Purshia tridentata	Putr	antelope bush	No	shrub	Rosaceae	na
Quercus agrifolia	Quag	coast live oak	No	tree	Fagaceae	NI
Quercus berberidifolia	Qube	scrub oak	No	shrub	Fagaceae	NI
Quercus durata	Qudu	leather oak	No	tree	Fagaceae	NI
Quercus garryana	Quga	Oregon oak	No	tree	Fagaceae	na
Quercus kelloggii	Quke	California black oak	No	tree	Fagaceae	na
Quercus lobata	Qulo	valley oak	No	tree	Fagaceae	FACU
Ranunculus aquatilis L.	Raaq	water buttercup	No	herb	Ranunculaceae	OBL
Raphanus sativus L.	Rasa	wild radish	Yes	herb	Brassicaceae	UPL
Retama monosperma	Remo	bridal broom	Yes	shrub	Fabaceae	NI
Rhamnus californica	Rhca	California coffeeberry	No	shrub	Rhamnaceae	NI
Rhododendron occidentalis	Rhoc	western azalea	No	shrub	Ericaceae	na
Rhus intergrifolia	Rhin	lemonadeberry	No	shrub	Anacardiaceae	na
Rhus ovata	Rhov	sugar bush	No	shrub	Anacardiaceae	NI
Ribes divaricatum	Ridi	spreading gooseberry	No	shrub	Grossulariaceae	FACW
Ribes speciosum	Risp	fucshia-flowered gooseberry	No	shrub	Grossulariaceae	NI

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Ribes visicosissimum	Rivi	sticky currant	No	shrub	Grossulariaceae	na
Ricinus communis L.	Rico	castor bean	Yes	herb	Euphorbiaceae	FACU
Robinia pseudoacacia	Rops	black locust	Yes	tree	Fabaceae	FACU-
Rorippa curvipes Greene	Rocu	bluntleaf yellow-cress	No	herb	Brassicaceae	OBL
Rorippa nasturtium-aquaticum	Rona	water cress	No	herb	Brassicaceae	OBL
Rorippa palustris (L.) Bess.	Ropa	marsh yellow-cress	No	herb	Brassicaceae	OBL
Rosa californica	Roca	California rose	No	shrub	Rosaceae	FAC
Rosa gymnocarpa	Rogy	wood rose	No	shrub	Rosaceae	NI
Rosa woodsii	Rowo	Wood's rose	No	shrub	Rosaceae	FAC-
Rubus discolor	Rudi	Himalaya blackberry	Yes	shrub	Rosaceae	FACW
Rubus parviflorus	Rupa	thimbleberry	No	shrub	Rosaceae	FAC+
Rubus rosaefolius	Ruro	Mauritius raspberry	No	shrub	Rosaceae	NI
Rubus ursinus	Ruur	California blackberry	No	herb	Rosaceae	FAC+
Rubus villosus	Ruvi	low-running blackberry	No	shrub	Rosaceae	NI
Rumex conglomeratus Murr.	Ruco	clustered dock	No	herb	Polygonaceae	FACW
Rumex crispus L.	Rucr	curly dock	Yes	herb	Polygonaceae	FACW-
Rumex maritimus L.	**Rumr**	golden dock	No	herb	Polygonaceae	FACW+
Ruppia maritima L.	Ruma	ditch-grass	No	herb	Potamogetonaceae	OBL
Salicornia bigelovii Torr.	Sabi	pickleweed	No	herb	Chenopodiaceae	OBL
Salicornia europea (S. rubra)	Saeu	slender glasswort	No	herb	Chenopodiaceae	OBL
Salicornia subterminalis	Sasu	Parish's glasswort	No	herb	Chenopodiaceae	OBL
Salicornia utahensis	Saut	Utah pickleweed	No	herb	Chenopodiaceae	NI
Salicornia virginica L.	Savi	common pickleweed	No	herb	Chenopodiaceae	OBL
Salix babylonica	Saba	weeping willow	No	tree	Chenopodiaceae	FACW-
Salix exigua Nutt.	Saex	sandbar willow/narrow-leaved willow	No	shrub	Salicaceae	FACW
Salix gooddingii Ball	Sago	Goodding's black willow	No	tree	Salicaceae	FACW
Salix laevigata Bebb	Sala	red willow	No	tree	Salicaceae	FACW+

Appendix V-A: List of California Plant Species (alphabetized by plant species)						
Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
***Salix lasiolepis* Benth.**	**Sals**	arroyo willow	No	shrub/tree	Salicaceae	FACW
Salix lemmonii	Sale	Lemmon's willow	No	shrub	Salicaceae	OBL
Salix lucida Muhl.	Salu	shining willow	No	shrub/tree	Salicaceae	FACW
***Salix lutea* Nutt.**	**Salt**	yellow willow	No	shrub/tree	Salicaceae	OBL
Salix melanopsis	**Samp**	dusky willow	No	shrub	Salicaceae	FACW
Salix scouleriana	Sasc	Scouler willow	No	shrub	Salicaceae	FAC
Salix sitchensis	Sasi	Sitka willow	No	shrub/tree	Salicaceae	FACW+
Salsola soda L.	Saso	oppositeleaf Russian thistle	Yes	herb	Chenopodiaceae	FACW+
Salsola tragus	Satr	Russian thistle/tumbleweed	Yes	herb	Chenopodiaceae	NI
Salvia apiana	Saap	white sage	No	shrub	Lamiaceae	NI
Sambucus melanocarpa	Saml	black elderberry	No	shrub	Caprifoliaceae	FACU
Sambucus mexicana K. Presl ex DC.	Same	Mexican elderberry/blue elderberry	No	shrub	Caprifoliaceae	FACU
Saponaria officinalis	Saof	bouncing bet	Yes	herb	Caryophyllaceae	FACU
Schinus molle	Scmo	Peruvian pepper tree	Yes	tree	Anacardiaceae	NI
Schinus terebinthifolius Raddi	Scte	Brazilian pepper tree	Yes	tree	Anacardiaceae	NI
Scirpus acutus Muhl. ex Bigelow	Scac	common tule	No	herb	Cyperaceace	OBL
Scirpus americanus Pers.	Scam	three-square bulrush	No	herb	Cyperaceace	OBL
Scirpus californicus (C.A. Mey.) Steud.	Scca	California bulrush	No	herb	Cyperaceace	OBL
Scirpus cernuus Vahl	Scce	bulrush	No	herb	Cyperaceace	OBL
Scirpus maritimus L.	Scma	alkali bulrush	No	herb	Cyperaceace	OBL
Scirpus microcarpus	Scmi	bulrush	No	herb	Cyperaceace	OBL
Scirpus robustus Pursh	Scro	bulrush	No	herb	Cyperaceace	OBL
Senecio mikanoides/Delairea odorata	Semi	Cape (German) ivy	Yes	herb	Asteraceae	NI
Senecio triangularis	Setr	arrowleaf ragwort	No	herb	Asteraceae	OBL
Senecio vulgaris	Sevu	common groundsel	No	herb	Asteraceae	NI*
Sequoia sempervirens	Sese	redwood	No	tree	Taxodiaceae	NI
Silybum marianum	Sima	milk thistle	Yes	herb	Asteraceae	NI

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Sisymbrium irio	Siir	London rocket	Yes	herb	Brassicaceae	NI
Sisyrinchium bellum S. Wats.	Sibe	blue-eyed grass	No	herb	Iridaceae	FAC+
Solanum douglasii	Sodo	white-flowered nightshade	No	herb	Solanaceae	FAC
Solanum xantii	Soxa	nightshade	No	herb	Solanaceae	NI
Sonchus asper (L.) Hill	Soas	prickly sow-thistle	Yes	herb	Asteraceae	FAC
Sonchus oleraceous	Sool	common sow-thistle	No	herb	Asteraceae	NI*
Spartina alterniflora Loisel.	Spal	salt-water cordgrass	Yes	herb	Poaceae	OBL
Spartina densiflora Brongn.	Spde	dense-flowered cordgrass	Yes	herb	Poaceae	OBL
Spartina foliosa Trin.	Spfo	California cordgrass	No	herb	Poaceae	OBL
Spartina HYBRID	Sphy	cordgrass	No	herb	Poaceae	OBL
Spartina patens (Ait.) Muhl.	Sppa	salt-meadow cordgrass	Yes	herb	Poaceae	OBL
Spergularia bocconii	Spbo	Boccone's sandspurrey	No	herb	Carophyllaceae	FAC*
Spergularia macrotheca	**Spmc**	sand-spurrey	No	herb	Carophyllaceae	FAC+
Spergularia marina	Spma	saltmarsh sand-spurrey	No	herb	Carophyllaceae	OBL
Spergularia rubra	Spru	red sand-spurrey	No	herb	Carophyllaceae	FAC-
Spirodela punctata (G.F.W. Mey.)	Sppu	dotted duckmeat	No	herb	Lemnaceae	OBL
Sporobolus airoides	Spai	alkali sacaton	No	herb	Poaceae	FAC+
Stachys ajugoides Benth.	Staj	Ajuga hedgenettle	No	herb	Lamiaceae	OBL
Stachys albens Gray	Stal	rigid hedgenettle/marsh hedgenettle	No	herb	Lamiaceae	OBL
Stellaria media	Stme	common chickweed	No	herb	Caryophyllaceae	FACU
Suaeda calceoliformis	**Sucl**	horned sea-blite	No	herb	Chenopodiaceae	NI
Suaeda californica	Suca	sea-blite	No	shrub	Chenopodiaceae	FACW
Suaeda esteroa	Sues	estuary sea-blite	No	herb	Chenopodiaceae	FACW
Suaeda moquinii	Sumo	bush seepweed	No	shrub	Chenopodiaceae	na
Suaeda taxifolia	Suta	woolly sea-blite	No	shrub	Chenopodiaceae	NI
Taeniatherum caput-medusae	Taca	medusa-head	Yes	herb	Poaceae	NI
Tamarix parviflora	Tapa	tamarisk	Yes	shrub/tree	Tamaricaceae	FAC

Appendix V-A: List of California Plant Species (alphabetized by plant species)						
Plant Species	**Code[1]**	**Common Name**	**Invasive**	**Growth Habit**	**Family**	**Indicator status**
Tamarix ramosissima Ledeb.	Tara	saltceder	Yes	shrub/tree	Tamaricaceae	FAC
Taraxacum officinale	Taof	dandelion	No	herb	Asteraceae	FACU
Tetragonia tetragonioides	Tete	New Zealand spinach	No	herb	Aizoaceae	FACU*
Tolmiea menziesii	Tome	pig-a-back plant	No	herb	Saxifragaceae	OBL
Toxicodendron diversilobum	Todi	poison oak	No	shrub	Anacardiaceae	NI
Tribulus terrestris	Trte	puncturevine	No	herb	Zygophyllaceae	na
Trifolium repens L.	Trre	white clover	No	herb	Fabaceae	FAC
Triglochin concinna	Trco	arrow-grass	No	herb	Juncaginaceae	OBL
Triglochin maritima	Trma	seaside arrow-grass	No	herb	Juncaginaceae	OBL
Tropaeolum majus	**Trmj**	garden nasturtium	Yes	herb	Tropaeolaceae	na
Tsuga heterophylla	Tshe	hemlock	No	tree	Pinaceae	FACU
Typha angustifolia	Tyan	narrow-leaved cattail	No	herb	Typhaceae	OBL
Typha domingensis	Tydo	southern cattail	No	herb	Typhaceae	OBL
Typha latifolia	Tyla	common cattail/broad-leaved cattail	No	herb	Typhaceae	OBL
Umbellularia californica	Umca	California bay/California laurel	No	tree	Lauraceae	FAC
Urtica dioica L.	Urdi	stinging nettle	No	herb	Urticaceae	FACW
Veratrum californicum Dur.	**Vecl**	California corn lily	No	herb	Liliaceae	OBL
Verbascum thapsus	Veth	woolly mullein	Yes	herb	Scrophulariaceae	na
Verbena scabra Vahl	Vesc	sandpaper vervain	No	herb	Verbenaceae	OBL
Veronica americana Schwein	Veam	American speedwell/ brooklime	No	herb	Scrophulariaceae	OBL
Veronica anagallis-aquatica L.	Vean	water speedwell	No	herb	Scrophulariaceae	OBL
Veronica catenata.	Veca	chain speedwell	No	herb	Scrophulariaceae	OBL
Veronica peregrina L.	Vepe	hairy purslane/speedwell	No	herb	Scrophulariaceae	OBL
Vinca major	Vima	greater periwinkle	Yes	herb	Apocynaceae	NI
Viola adunca	Viad	hookedspur violet	No	herb	Violaceae	FAC
Vitis californica	Vica	California wild grape	No	vine ("shrub")	Vitaceae	FACW
Vulpia myuros (L.) K.C. Gmel.	Vumy	foxtail fescue	Yes	herb	Poaceae	FACU*

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

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Washingtonia filifera	Wafi	California fan palm	No	tree	Arecaceae	FACW
Wolffia columbiana Karst.	Woco	watermeal	No	herb	Lemnaceae	OBL
Woodwardia fimbriata	Wofi	giant chain fern	No	herb	Blechnaceae	FACW
Xanthium spinosum L.	Xasp	spiny cocklebur	No	herb	Asteraceae	FAC+
Xanthium strumarium L.	Xast	cocklebur	No	herb	Asteraceae	FAC+
Yucca whipplei	Yuwh	chaparral yucca	No	shrub	Liliaceae	na
Zannichellia palustris L.	Zapa	horned-pondweed	No	herb	Zannichelliaceae	OBL
Zostera marina L.	Zoma	common eelgrass	No	herb	Zosteraceae	OBL
Zostera pacifica L.	Zopa	seawrack/eelgrass	No	herb	Zosteraceae	OBL

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

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

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

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Retama monosperma	Remo	bridal broom	Yes	shrub	Fabaceae	NI
Cynosurus echinatus	Cyec	bristly dogstail grass	Yes	herb	Poaceae	na
Picris echioides L.	Piec	bristly ox-tongue	Yes	herb	Asteraceae	FAC
Baccharis sarothroides Gray	**Basr**	broom baccharis	No	shrub	Asteraceae	FAC
Juncus phaeocephalus	Juph	brown-headed creeping rush	No	herb	Juncaceae	FACW
Cirsium vulgare (Savi) Ten.	Civu	bull thistle	Yes	herb	Asteraceae	FAC
Scirpus cernuus Vahl	Scce	bulrush	No	herb	Cyperaceace	OBL
Scirpus microcarpus	Scmi	bulrush	No	herb	Cyperaceace	OBL
Scirpus robustus Pursh	Scro	bulrush	No	herb	Cyperaceace	OBL
Anthriscus caucalis	**Ancc**	bur chervil	No	herb	Apiaceae	na
Bidens laevis (L.) B.S.P.	Bila	bur-marigold	No	herb	Asteraceae	OBL
Mimulus aurantiacus	Miau	bush monkeyflower	No	shrub	Scrophulariaceae	NI
Suaeda moquinii	Sumo	bush seepweed	No	shrub	Chenopodiaceae	na
Encelia californica	Enca	bush sunflower	No	shrub	Asteraceae	NI
Fraxinus dipetala	Frdi	California ash	No	tree	Oleaceae	NI
Umbellularia californica	Umca	California bay/California laurel	No	tree	Lauraceae	FAC
Quercus kelloggii	Quke	California black oak	No	tree	Fagaceae	na
Juglans californica	Juca	California black walnut	No	tree	Juglandaceae	FAC
Rubus ursinus	Ruur	California blackberry	No	herb	Rosaceae	FAC+
Brickellia californica	Brca	California brickellbush	No	shrub	Scrophulariaceae	FACU
Aesculus californica	Aeca	California buckeye	No	tree	Hippocastanaceae	na
Eriogonum fasciculatum	Erfa	California buckwheat	No	shrub	Polygonaceae	na
Scirpus californicus (C.A. Mey.) Steud.	Scca	California bulrush	No	herb	Cyperaceace	OBL
Medicago polymorpha L.	Mepo	California burclover	Yes	herb	Fabaceae	FACU-
Rhamnus californica	Rhca	California coffeeberry	No	shrub	Rhamnaceae	NI
Spartina foliosa Trin.	Spfo	California cordgrass	No	herb	Poaceae	OBL
Veratrum californicum Dur.	**Vecl**	California corn lily	No	herb	Liliaceae	OBL

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Gnaphalium californicum	**Gncl**	California everlasting	No	herb	Asteraceae	NI
Washingtonia filifera	Wafi	California fan palm	No	tree	Arecaceae	FACW
Epilobium (Zauschneria) canum	Epca	california fuchsia	No	herb	Onagraceae	na
Lonicera hispidula	Lohi	California honeysuckle	No	shrub	Caprifoliaceae	NI
Lythrum californicum Torr. & Gray	Lyca	California loosestrife	No	herb	Lythraceae	OBL
Adiantum jordanii	Adjo	California maidenhair	No	herb	Pteridaceae	NI
Amaranthus californicus	Amca	California pigweed	No	herb	Amaranthaceae	FACW
Rosa californica	Roca	California rose	No	shrub	Rosaceae	FAC
Artemisia californica	Arca	California sagebrush	No	shrub	Asteraceae	NI
Atriplex californica Moq.	Atca	California saltbush	No	shrub	Chenopodiaceae	FAC
Aralia californica A. Wats.	**Arcl**	California spikenard	No	herb	Araliaceae	FACW
Helianthus californicus DC.	**Hecl**	California sunflower	No	herb	Asteraceae	OBL
Osmorhiza brachypoda	Osbr	California sweetcicely	No	herb	Apiaceae	NI
Vitis californica	Vica	California wild grape	No	vine ("shrub")	Vitaceae	FACW
Cirsium arvense	Ciar	Canada thistle	Yes	herb	Asteraceae	FAC-
Delairea odorata/Senecio mikanoides	Deod	Cape (German) ivy	Yes	herb	Asteraceae	na
Senecio mikanoides/Delairea odorata	Semi	Cape (German) ivy	Yes	herb	Asteraceae	NI
Ricinus communis L.	Rico	castor bean	Yes	herb	Euphorbiaceae	FACU
Apium graveolens L.	Apgr	celery	No	herb	Apiaceae	FACW*
Veronica catenata.	Veca	chain speedwell	No	herb	Scrophulariaceae	OBL
Yucca whipplei	Yuwh	chaparral yucca	No	shrub	Liliaceae	na
Bromus tectorum	Brte	cheat grass	Yes	herb	Poaceae	NI
Potentilla anserina	Poan	cinquefoil	No	herb	Rosaceae	NI
Rumex conglomeratus Murr.	Ruco	clustered dock	No	herb	Polygonaceae	FACW
Carex praegracilis W. Boott	Capr	clustered field sedge	No	herb	Cyperaceae	FACW-
Boykinia occidentalis	Booc	coast boykinia	No	herb	Saxifragaceae	FACW
Isocoma menziesii	Isme	coast goldenbush	No	shrub	Asteraceae	FAC+

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Quercus agrifolia	Quag	coast live oak	No	tree	Fagaceae	NI
Plagiobothrys undulatus	Plun	coast popcorn-flower	No	herb	Boraginaceae	FACW
Xanthium strumarium L.	Xast	cocklebur	No	herb	Asteraceae	FAC+
Petasites frigidus (L.) Fries	Pefr	coltsfoot	No	herb	Asteraceae	NI
Aquilegia formosa	Aqfo	columbine	No	herb	Ranunculaceae	OBL
Blennosperma nanum	Blna	common blennosperma	No	herb	Asteraceae	FACW
Typha latifolia	Tyla	common cattail/broad-leaved cattail	No	herb	Typhaceae	OBL
Stellaria media	Stme	common chickweed	No	herb	Caryophyllaceae	FACU
Zostera marina L.	Zoma	common eelgrass	No	herb	Zosteraceae	OBL
Senecio vulgaris	Sevu	common groundsel	No	herb	Asteraceae	NI*
Equisetum arvense	Eqar	common horsetail	No	herb	Equisetaceae	FAC
Polygonum arenastrum Jord. ex Boreau	Poar	common knotweed	No	herb	Polygonaceae	FAC
Athyrium filix-femina	Atfi	common ladyfern	No	herb	Dryopteridaceae	FAC
Mimulus guttatus DC.	Migu	common monkeyflower	No	herb	Scrophulariaceae	FACW+
Salicornia virginica L.	Savi	common pickleweed	No	herb	Chenopodiaceae	OBL
Plantago major	Plma	common plantain	No	herb	Plantaginaceae	FAC
Portulaca oleracea	Pool	common purslane	No	herb	Portulacaceae	FAC
Ambrosia artemisiifolia	**Amat**	common ragweed	No	herb	Asteraceae	FACU
Phragmites australis (Cav.) Trin. ex Steud.	Phau	common reed	No	herb	Poaceae	FACW
Juncus effusus	Juef	common rush	No	herb	Juncaceae	FACW+
Sonchus oleraceous	Sool	common sow-thistle	No	herb	Asteraceae	NI*
Eleocharis macrostachya	Elma	common spikerush	No	herb	Cyperaceae	NI
Helianthus annuus L.	Hean	common sunflower	No	herb	Asteraceae	FAC-
Scirpus acutus Muhl. ex Bigelow	Scac	common tule	No	herb	Cyperaceace	OBL
Spartina HYBRID	Sphy	cordgrass	No	herb	Poaceae	OBL
Heracleum lanatum	Hela	cow parsnip	No	herb	Apiaceae	FACU
Baccharis pilularis	Bapi	coyote brush	No	shrub	Asteraceae	NI

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Cornus sericea	Cosr	creek dogwood	No	shrub	Cornaceae	FACW
Agrostis stolonifera L.	Agst	creeping bentgrass	Yes	herb	Poaceae	FACW
Larrea tridentata	Latr	creosote bush	No	shrub	Zygophyllaceae	na
Mesembryanthemum crystallinum L.	Mecr	crystalline iceplant	Yes	herb	Aizoaceae	FAC
Rumex crispus L.	Rucr	curly dock	Yes	herb	Polygonaceae	FACW-
Berula erecta (Huds.) Coville	Beer	cutleaf water-parsnip	No	herb	Apiaceae	OBL
Taraxacum officinale	Taof	dandelion	No	herb	Asteraceae	FACU
Muhlenbergia rigens (Benth.) A.S. Hitchc.	Muri	deergrass	No	herb	Poaceae	FACW
Lotus scoparius	Losc	deerweed	No	shrub	Fabaceae	NI
Spartina densiflora Brongn.	Spde	dense-flowered cordgrass	Yes	herb	Poaceae	OBL
Ruppia maritima L.	Ruma	ditch-grass	No	herb	Potamogetonaceae	OBL
Spirodela punctata (G.F.W. Mey.)	Sppu	dotted duckmeat	No	herb	Lemnaceae	OBL
Pseudotsuga menziesii	Psme	douglas fir	No	tree	Pinaceae	NI
Datisca glomerata (K. Presl) Baill.	Dagl	Durango root	No	herb	Datiscaceae	FACW
Salix melanopsis	**Samp**	dusky willow	No	shrub	Salicaceae	FACW
Lupinus lepidus	Lule	dwarf lupine	No	herb	Fabaceae	na
Lepidium latipes Hook.	Lela	dwarf pepper grass	No	herb	Brassicaceae	OBL
Plantago erecta	Pler	dwarf plantain	No	herb	Plantaginaceae	na
Eclipta prostrata	Ecpr	eclipta	No	herb	Asteraceae	FAC+
Baccharis emoryi Gray	Baem	Emory baccharis	No	shrub	Asteraceae	FACW
Hedera helix	Hehe	English ivy	Yes	vine ("shrub")	Araliaceae	NI
Plantago lanceolata L.	Plla	English plantain	Yes	herb	Plantaginaceae	FAC-
Suaeda esteroa	Sues	estuary sea-blite	No	herb	Chenopodiaceae	FACW
Puccinellia distans (Jacq.) Parl.	Pudi	European alkali grass	No	herb	Poaceae	OBL
Ammophila arenaria	Amar	European beach grass	Yes	herb	Poaceae	FACU
Hemizonia paniculata Gray	Hepa	fascicled tarweed	No	herb	Asteraceae	FACU*
Potamogeton pectinatus	Pope	fennel-leaf pondweed	No	herb	Potamogetonaceae	OBL

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Adiantum aleuticum	Adal	Five fingered fern	No	herb	Pteridaceae	na
Hydrocotyle ranunculoides L. f.	Hyra	floating marsh pennywort	No	herb	Apiaceae	OBL
Ludwigia peploides (Kunth) Raven	Lupe	floating water primrose, false loosestrife	No	herb	Onagraceae	OBL
Myosotis symphytifolia	Mysy	forget-me-not	No	herb	Boraginaceae	NI
Bromus madritensis	Brma	foxtail chess	Yes	herb	Poaceae	UPL
Vulpia myuros (L.) K.C. Gmel.	Vumy	foxtail fescue	Yes	herb	Poaceae	FACU*
Gnaphalium canescens ssp. beneolens	Gnca	fragrant everlasting	No	herb	Asteraceae	NI
Populus fremontii S. Wats.	Pofr	Fremont cottonwood	No	tree	Salicaceae	FAC+*
Genista monspessulana	Gemo	French broom	Yes	shrub	Fabaceae	na
Ribes speciosum	Risp	fucshia-flowered gooseberry	No	shrub	Grossulariaceae	NI
Tropaeolum majus	**Trmj**	garden nasturtium	Yes	herb	Tropaeolaceae	na
Chrysanthemum coronarium	Chco	garland chrysanthemum	Yes	herb	Asteraceae	na
Euphorbia terracina	Eute	Geraldton carnation weed	Yes	herb	Euphorbiaceae	na
Woodwardia fimbriata	Wofi	giant chain fern	No	herb	Blechnaceae	FACW
Equisetum telmateia Ehrh.	Eqte	giant horsetail	No	herb	Equisetaceae	OBL
Arundo donax L.	Ardo	giant reed	Yes	shrub	Poaceae	FAC+
Leymus condensatus	Leco	giant wild-rye	No	herb	Poaceae	FACU
Rumex maritimus L.	**Rumr**	golden dock	No	herb	Polygonaceae	FACW+
Eriophyllym confertifolium	Erco	golden yarrow	No	shrub	Asteraceae	NI
Lasthenia glabrata Lindl.	Lagl	goldfields	No	herb	Asteraceae	FACW
Salix gooddingii Ball	Sago	Goodding's black willow	No	tree	Salicaceae	FACW
Galium aparine	Gaap	goose grass	No	herb	Rubiaceae	FACU
Artemisia tridentata	Artr	Great Basin sage	No	shrub	Asteraceae	na
Vinca major	Vima	greater periwinkle	Yes	herb	Apocynaceae	NI
Eleocharis acicularis	Elac	hairgrass	No	herb	Cyperaceae	OBL
Grindelia hirsutula var. hirsutula	Grhi	hairy gumweed	No	herb	Asteraceae	FACW

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Marsilea vestita	Mave	hairy pepperwort	No	herb	Marsileaceae	OBL
Veronica peregrina L.	Vepe	hairy purslane/speedwell	No	herb	Scrophulariaceae	OBL
Epilobium ciliatum Raf.	Epci	hairy willow-herb	No	herb	Onagraceae	FACW
Phalaris aquatica	Phaq	Harding grass	Yes	herb	Poaceae	FAC
Avena sativa	Avsa	hay	No	herb	Poaceae	NI
Calystegia sepium (L.) R. Br.	Case	hedge bindweed	No	herb	Convovulaceae	OBL
Tsuga heterophylla	Tshe	hemlock	No	tree	Pinaceae	FACU
Rubus discolor	Rudi	Himalaya blackberry	Yes	shrub	Rosaceae	FACW
Hesperevax caulescens	Heca	hogwallow starfish	No	herb	Asteraceae	OBL
Prunus ilicifolia	Pril	holly-leaved cherry	No	tree	Rosaceae	na
Najas marina	Nama	holly-leaved water-nymph	No	herb	Hydrocharitaceae	OBL
Viola adunca	Viad	hookedspur violet	No	herb	Violaceae	FAC
Marrubium vulgare L.	Mavu	horehound	Yes	herb	Lamiaceae	FACU
Suaeda calceoliformis	**Sucl**	horned sea-blite	No	herb	Chenopodiaceae	NI
Zannichellia palustris L.	Zapa	horned-pondweed	No	herb	Zannichelliaceae	OBL
Conyza bonariensis	Cobo	horseweed	No	herb	Asteraceae	na
Conyza canadensis (L.) Cronq.	Coca	horseweed	No	herb	Asteraceae	FAC
Isoetes howellii Engelm.	Isho	Howell's quillwort	No	herb	Isoetaceae	OBL
Carpobrotus edulis	Caed	iceplant	Yes	herb	Aizoaceae	NI
Calocedrus decurrens	Cade	incense cedar	No	tree	Cupressaceae	na
Apocynum cannabinum	Apca	indian hemp	No	shrub	Apocynaceae	FAC
Allenrolfea occidentalis	Aloc	iodine bush	No	shrub	Chenopodiaceae	FACW+
Lolium multiflorum	Lomu	Italian ryegrass	Yes	herb	Poaceae	NI
Carduus pycnocephalus	Capy	Italian thistle	Yes	herb	Asteraceae	NI
Pinus jeffryi	Pije	Jeffrey pine	No	tree	Pinaceae	na
Poa pratensis	Popr	Kentucky bluegrass	Yes	herb	Poaceae	FACU
Pennisetum clandestinum	Pecl	kikuyu grass	Yes	herb	Poaceae	FACU

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Paspalum distichum	Padi	knot grass	No	herb	Poaceae	OBL
Kyllinga brevifolia	Kybr	kyllinga	No	herb	Cyperaceae	FACW
Carex lenticularis	Cale	lakeshore sedge	No	herb	Cyperaceae	na
Chenopodium album	Chal	lamb's quarters	No	herb	Chenopodiaceae	FAC
Malosma laurina	Mala	laurel sumac	No	shrub	Anacardiaceae	NI
Potamogeton foliosus Raf.	Pofo	leafy pondweed	No	herb	Potamogetonaceae	OBL
Lemna minuta	**Lemu**	least duckweed	No	herb	Lemnaceae	OBL
Quercus durata	Qudu	leather oak	No	tree	Fagaceae	NI
Phalaris lemmonii	Phle	Lemmon's canary grass	No	herb	Poaceae	FACW
Salix lemmonii	Sale	Lemmon's willow	No	shrub	Salicaceae	OBL
Rhus intergrifolia	Rhin	lemonadeberry	No	shrub	Anacardiaceae	na
Lemna minor L.	Lemi	lesser duckweed	No	herb	Lemnaceae	OBL
Sisymbrium irio	Siir	London rocket	Yes	herb	Brassicaceae	NI
Erodium botrys	Erbo	long-beaked filaree	No	herb	Geraniaceae	NI
Juncus longistylus	Julo	long-beaked rush	No	herb	Juncaceae	na
Potamogeton nodosus Poir.	Pono	long-leaved pondweed	No	herb	Potamogetonaceae	OBL
Lythrum hyssopifolium	Lyhy	loosestrife	Yes	herb	Lythraceae	FACW
Gnaphalium palustre Nutt.	Gnpa	lowland cudweed	No	herb	Asteraceae	FACW
Rubus villosus	Ruvi	low-running blackberry	No	shrub	Rosaceae	NI
Carex lyngbyei	Caly	Lyngbyei's sedge	No	herb	Cyperaceae	OBL
Malacothrix californica	Maca	malacothrix	No	herb	Asteraceae	na
Baccharis douglasii	Bado	marsh baccharis/Douglas' false-willow	No	shrub	Asteraceae	OBL
Grindelia stricta	Grst	marsh gum-plant	No	shrub	Asteraceae	OBL
Jaumea carnosa (Less.) Gray	Jaca	marsh jaumea/salty Susan	No	herb	Asteraceae	OBL
Caltha palustris	Capa	marsh marigold	No	herb	Ranunculaceae	NI
Rorippa palustris (L.) Bess.	Ropa	marsh yellow-cress	No	herb	Brassicaceae	OBL

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Lilaeopsis masonii	Lima	Mason's lilaeopsis	No	herb	Apiaceae	OBL
Rubus rosaefolius	Ruro	Mauritius raspberry	No	shrub	Rosaceae	NI
Hordeum secalinum	Hose	meadow barley	No	herb	Poaceae	NI
Hordeum geniculatum/H. marinum gussonianum	Hoge	Mediterrenean barley	Yes	herb	Poaceae	NI
Taeniatherum caput-medusae	Taca	medusa-head	Yes	herb	Poaceae	NI
Sambucus mexicana K. Presl ex DC.	Same	Mexican elderberry/blue elderberry	No	shrub	Caprifoliaceae	FACU
Juncus mexicanus	Jume	Mexican rush	No	herb	Juncaceae	FACW
Leptochloa uninervia (J. Presl)	Leun	Mexican sprangletop	No	herb	Poaceae	FACW
Chenopodium ambrosioides	Cham	Mexican tea	No	herb	Chenopodiaceae	FAC
Cardamine californica	Caca	milk maids, tooth wort	No	herb	Brassicaceae	UPL
Silybum marianum	Sima	milk thistle	Yes	herb	Asteraceae	NI
Calystegia macrostegia	Cama	morning-glory	No	herb	Convovulaceae	NI
Alnus incana	Alin	mountain alder	No	shrub	Betulaceae	NI
Cercocarpus betuloides	Cebe	mountain mahogany	No	shrub	Rosaceae	na
Myosurus minimus L.	Mymi	mouse tail	No	herb	Ranunculaceae	OBL
Myoporum laetum	Myla	mousehole tree	Yes	tree	Myoporaceae	NI
Artemisia douglasiana Bess.	**Ardg**	mugwort	No	shrub	Asteraceae	FACW
Baccharis salicifolia	Basa	mule fat	No	shrub	Asteraceae	FACW
Mimulus moschatus	Mimo	musk monkeyflower	No	herb	Scrophulariaceae	OBL
Plantago subnuda	Plsu	naked plantain	No	herb	Plantaginaceae	FACW
Typha angustifolia	Tyan	narrow-leaved cattail	No	herb	Typhaceae	OBL
Tetragonia tetragonioides	Tete	New Zealand spinach	No	herb	Aizoaceae	FACU*
Solanum xantii	Soxa	nightshade	No	herb	Solanaceae	NI
Cyperus esculentus	Cyes	nutsedge	No	herb	Cyperaceae	FACW
Cyperus involucratus	Cyin	nutsedge	No	herb	Cyperaceae	FACW+
Isoetes nuttallii A. Braun ex Engelm.	Isnu	Nuttall's quillwort	No	herb	Isoetaceae	OBL
Holodiscus discolor	Hodi	oceanspray	No	shrub	Rosaceae	na

Appendix V-B: List of California Plant Species (alphabetized by plant species)						
Plant Species	**Code[1]**	**Common Name**	**Invasive**	**Growth Habit**	**Family**	**Indicator status**
Olea europaea	Oleu	olive	Yes	tree	Oleaceae	NI
Salsola soda L.	Saso	oppositeleaf Russian thistle	Yes	herb	Chenopodiaceae	FACW+
Fraxinus latifolia	Frla	Oregon ash	No	tree	Oleaceae	FACW
Quercus garryana	Quga	Oregon oak	No	tree	Fagaceae	na
Cortaderia selloana	Cose	pampas grass	Yes	herb	Poaceae	NI
Salicornia subterminalis	Sasu	Parish's glasswort	No	herb	Chenopodiaceae	OBL
Eleocharis parishii	Elpa	Parish's spikerush	No	herb	Cyperaceae	FACW
Myriophyllum aquaticum	Myaq	parrot's feather	Yes	herb	Haloragaceae	OBL
Mentha pulegium	Mepu	pennyroyal	Yes	herb	Lamiaceae	OBL
Lepidium nitidum	Leni	peppergrass	No	herb	Brassicaceae	FAC
Mentha piperita	Mepi	peppermint	No	herb	Lamiaceae	NI
Lepidium latifolium L.	**Lelf**	perennial pepperweed	Yes	herb	Brassicaceae	FACW
Lolium perenne L.	Lope	perennial ryegrass	No	herb	Poaceae	FAC*
Schinus molle	Scmo	Peruvian pepper tree	Yes	tree	Anacardiaceae	NI
Euphorbia peplus	Eupe	petty spurge	No	herb	Euphorbiaceae	NI
Phacelia distans	Phdi	phacelia	No	herb	Hydrophyllaceae	NI
Phoenix canariensis	Phca	Phoenix date palm	Yes	tree	Arecaceae	NI
Salicornia bigelovii Torr.	Sabi	pickleweed	No	herb	Chenopodiaceae	OBL
Tolmiea menziesii	Tome	pig-a-back plant	No	herb	Saxifragaceae	OBL
Matricaria suaveolens	Masu	pineapple weed	No	herb	Asteraceae	NI
Conium maculatum L.	Coma	poison hemlock	Yes	herb	Apiaceae	FAC
Toxicodendron diversilobum	Todi	poison oak	No	shrub	Anacardiaceae	NI
Pinus ponderosa	Pipo	ponderosa pine	No	tree	Pinaceae	FACU
Lactuca serriola L.	Lase	prickly lettuce	No	herb	Asteraceae	FAC
Sonchus asper (L.) Hill	Soas	prickly sow-thistle	Yes	herb	Asteraceae	FAC
Tribulus terrestris	Trte	puncturevine	No	herb	Zygophyllaceae	na
Cyperus rotundus L.	Cyro	purple nutsedge	No	herb	Cyperaceae	FAC

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Chrysothamnus nauseosus	Chna	rabbit brush	No	shrub	Asteraceae	na
Alnus rubra	Alru	red alder	No	tree	Betulaceae	FACW
Spergularia rubra	Spru	red sand-spurrey	No	herb	Carophyllaceae	FAC-
Salix laevigata Bebb	Sala	red willow	No	tree	Salicaceae	FACW+
Erodium cicutarium	Erci	red-stem filaree	Yes	herb	Geraniaceae	NI
Agrostis gigantea	Aggi	redtop	No	herb	Poaceae	NI
Sequoia sempervirens	Sese	redwood	No	tree	Taxodiaceae	NI
Phalaris arundinacea	Phar	reed canary grass	No	herb	Poaceae	OBL
Stachys albens Gray	Stal	rigid hedgenettle/marsh hedgenettle	No	herb	Lamiaceae	OBL
Bromus diandrus	Brdi	ripgut brome	Yes	herb	Poaceae	NI
Casuarina equisetifolia	Caeq	river she-oak	No	tree	Casuarinaceae	na
Eleocharis radicans	Elra	rooted spikerush	No	herb	Cyperaceae	OBL
Juncus occidentalis	Juoc	rush	No	herb	Juncaceae	NI
Salsola tragus	Satr	Russian thistle/tumbleweed	Yes	herb	Chenopodiaceae	NI
Cordylanthus maritimus ssp. maritimus	**Comr**	salt marsh bird's beak	No	herb	Scrophulariaceae	OBL
Pluchea odorata	Plod	salt marsh fleabane	No	herb	Asteraceae	OBL
Juncus lesueurii	Jule	salt rush	No	herb	Juncaceae	FACW
Atriplex triangularis	Attr	saltbush	No	herb	Chenopodiaceae	NI
Tamarix ramosissima Ledeb.	Tara	saltceder	Yes	shrub/tree	Tamaricaceae	FAC
Distichlis spicata (L.) Greene	Disp	saltgrass	No	herb	Poaceae	FACW
Spergularia marina	Spma	saltmarsh sand-spurrey	No	herb	Carophyllaceae	OBL
Spartina patens (Ait.) Muhl.	Sppa	salt-meadow cordgrass	Yes	herb	Poaceae	OBL
Spartina alterniflora Loisel.	Spal	salt-water cordgrass	Yes	herb	Poaceae	OBL
Batis maritima L.	Bama	saltwort, beachwort	No	shrub	Bataceae	OBL
Carex spissa Bailey	Casp	San Diego sedge	No	herb	Cyperaceae	FAC*
Eryngium aristulatum var. parishii	Erar	San Diego-button celery	No	herb	Apiaceae	OBL

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Eleocharis montevidensis	Elmo	sand spikerush	No	herb	Cyperaceae	FACW
Salix exigua Nutt.	Saex	sandbar willow/narrow-leaved willow	No	shrub	Salicaceae	FACW
Verbena scabra Vahl	Vesc	sandpaper vervain	No	herb	Verbenaceae	OBL
Spergularia macrotheca	**Spmc**	sand-spurrey	No	herb	Carophyllaceae	FAC+
Carex barbarae	Caba	Santa Barbara sedge	No	herb	Cyperaceae	FACW
Lepidospartum squamatum	Lesq	scalebroom	No	shrub	Asteraceae	NI
Mimulus cardinalis Dougl. ex Benth.	Mica	scarlet monkeyflower	No	herb	Scrophulariaceae	OBL
Anagallis arvensis L.	Anar	scarlet pimpernel	No	herb	Primulaceae	FAC
Carex schottii	Casc	Schott's sedge	No	herb	Cyperaceae	OBL
Salix scouleriana	Sasc	Scouler willow	No	shrub	Salicaceae	FAC
Phyllospadix scouleri Hook.	Phsc	Scouler's surfgrass	No	herb	Zosteraceae	OBL
Quercus berberidifolia	Qube	scrub oak	No	shrub	Fagaceae	NI
Limonium californicum	Lica	sea lavender/marsh rosemary	No	herb	Plumbaginaceae	OBL
Suaeda californica	Suca	sea-blite	No	shrub	Chenopodiaceae	FACW
Glaux maritima	Glma	sea-milkwort	No	herb	Primulaceae	OBL
Triglochin maritima	Trma	seaside arrow-grass	No	herb	Juncaginaceae	OBL
Zostera pacifica L.	Zopa	seawrack/eelgrass	No	herb	Zosteraceae	OBL
Carex Whitneyi	Cawh	sedge	No	herb	Cyperaceae	na
Crypsis vaginiflora (Forsk.) Opiz	Crva	sharp-leaved Timothy	No	herb	Poaceae	OBL
Salix lucida Muhl.	Salu	shining willow	No	shrub/tree	Salicaceae	FACW
Alopecurus aequalis	Alae	shortawn foxtail	No	herb	Poaceae	OBL
Elatine brachysperma Gray	Elbr	shortseed waterwort	No	herb	Elatinaceae	OBL
Parapholis incurva	Pain	sickle grass	No	herb	Poaceae	OBL
Juncus nevadensis	June	Sierra rush	No	herb	Juncaceae	FACW
Lupinus chamissonis	Luch	silver dune lupine	No	shrub	Fabaceae	na
Lotus argophyllus	Loar	silver lotus	No	herb	Fabaceae	NI
Artemisia ludoviciana	Arlu	silver wormwood	No	shrub	Asteraceae	FACU-

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

Appendix V-B: List of California Plant Species (alphabetized by plant species)

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

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Fraxinus velutina Torr.	Frve	velvet ash	No	tree	Oleaceae	FACW
Holcus lanatus	Hola	velvet grass	Yes	herb	Poaceae	FAC
Hordeum intercedens Nevski	Hoin	vernal barley	No	herb	Poaceae	FAC
Acer circinatum	Acci	vine maple	No	shrub	Aceraceae	FAC
Clematis ligusticifolia	Clli	virgin's bower	No	shrub	Ranunculaceae	FAC
Agrostis viridis	Agvi	water bentgrass	No	herb	Poaceae	OBL
Ranunculus aquatilis L.	Raaq	water buttercup	No	herb	Ranunculaceae	OBL
Rorippa nasturtium-aquaticum	Rona	water cress	No	herb	Brassicaceae	OBL
Alisma plantago-aquatica	Alpl	water plantain	No	herb	Alismataceae	OBL
Crassula aquatica (L.) Schoenl.	Craq	water pygmyweed	No	herb	Crassulaceae	OBL
Polygonum amphibium L.	Poam	water smartweed	No	herb	Polygonaceae	OBL
Polygonum punctatum	Popu	water smartweed	No	herb	Polygonaceae	OBL
Veronica anagallis-aquatica L.	Vean	water speedwell	No	herb	Scrophulariaceae	OBL
Callitriche heterophylla Pursh	Cahe	water starwort	No	herb	Callitrichaceae	OBL
Wolffia columbiana Karst.	Woco	watermeal	No	herb	Lemnaceae	OBL
Hydrocotyle umbellata L.	Hyum	water-pennywort	No	herb	Apiaceae	OBL
Hydrilla verticillata (L. f.) Royle	Hyve	waterthyme	Yes	herb	Hydrocharitaceae	OBL
Atriplex wattsonii	Atwa	Watson's saltbush	No	shrub	Chenopodiaceae	FACW+
Salix babylonica	Saba	weeping willow	No	tree	Chenopodiaceae	FACW-
Rhododendron occidentalis	Rhoc	western azalea	No	shrub	Ericaceae	na
Lilaeopsis occidentalis	Lioc	western grasswort	No	herb	Apiaceae	OBL
Hesperocnide tenella	Hete	western nettle	No	herb	Urticaceae	na
Ambrosia psilostachya DC.	Amps	western ragweed	No	herb	Asteraceae	FAC
Platanus racemosa	Plra	western sycamore	No	tree	Platanaceae	FACW
Cicuta douglasii	Cido	western waterhemlock	No	herb	Apiaceae	OBL
Emmenanthe penduliflora	Empe	whispering bells	No	herb	Hydrophyllaceae	NI
Alnus rhombifolia	Alrh	white alder	No	tree	Betulaceae	FACW

Appendix V-B: List of California Plant Species (alphabetized by plant species)

Plant Species	Code[1]	Common Name	Invasive	Growth Habit	Family	Indicator status
Trifolium repens L.	Tre	white clover	No	herb	Fabaceae	FAC
Abies concolor	Abco	white fir	No	tree	Pinaceae	na
Salvia apiana	Saap	white sage	No	shrub	Lamiaceae	NI
Melilotus alba	Meal	white sweetclover	Yes	herb	Fabaceae	FACU
Solanum douglasii	Sodo	white-flowered nightshade	No	herb	Solanaceae	FAC
Hydrocotyle verticillata Thunb.	**Hyvr**	whorled marsh pennywort	No	herb	Apiaceae	OBL
Beta vulgaris	Bevu	wild beet	No	herb	Chenopodiaceae	FACU
Avena fatua	Avfa	wild oat	Yes	herb	Poaceae	NI
Raphanus sativus L.	Rasa	wild radish	Yes	herb	Brassicaceae	UPL
Polygonum lapathifolium L.	Pola	willow weed	No	herb	Polygonaceae	OBL
Monanthochloe littoralis	Moli	wiregrass/shoregrass	No	herb	Poaceae	OBL
Cuscuta salina	Cusa	witch's hair/dodder	No	herb	Cuscutaceae	NI
Dryopteris arguta	Drar	wood fern	No	herb	Dryopteridaceae	NI
Rosa gymnocarpa	Rogy	wood rose	No	shrub	Rosaceae	NI
Rosa woodsii	Rowo	Wood's rose	No	shrub	Rosaceae	FAC-
Verbascum thapsus	Veth	woolly mullein	Yes	herb	Scrophulariaceae	na
Suaeda taxifolia	Suta	woolly sea-blite	No	shrub	Chenopodiaceae	NI
Psilocarphus brevissimus Nutt.	Psbr	wooly marbles	No	herb	Asteraceae	OBL
Nemacaulis denudata var. denudata	Nede	wooly-heads	No	herb	Polygonaceae	NI
Juncus rugulosus Engelm.	Juru	wrinkled rush	No	herb	Juncaceae	OBL
Lupinus arboreus	Luar	yellow bush lupine	No	shrub	Fabaceae	na
Centaurea solstitialis	Ceso	yellow starthistle	Yes	herb	Asteraceae	NI
Iris pseudacorus	Irps	yellow water iris/yellow flag	Yes	herb	Iridaceae	OBL
Salix lutea Nutt.	**Salt**	yellow willow	No	shrub/tree	Salicaceae	OBL
Anemopsis californica (Nutt.)	Anca	yerba mansa	No	herb	Saururaceae	OBL


Steve Abern

Riverine wetlands, Tuolumne Meadows, Yosemite National Park

APPENDIX VI: VERNAL POOL PLANT SPECIES LIST

Indicator status is from the U.S. Fish and Wildlife Service's National List of Plant Species That Occur in Wetlands: California (Region 0), May 1988. FAC=Facultative, FACU=Facultative Upland, FACW=Facultative Wetland, NI=No Inidcator, OBL=Obligate Wetland, UPL=Obligate Upland. A positive (+) or negative (-) sign is used with the Facultative Indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive sign indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative sign indicates a frequency toward the lower end of the category (less frequently found in wetlands). An asterisk (*) indicates national indicator status.

Appendix VI: List of Vernal Pool Plant Species			
Plant Species	**Native**	**Invasive**	**Indicator status**
Agrostis hendersonii	Yes	No	FACW
Alopecurus saccatus (A. howellii)	Yes	No	OBL
Bergia texana	Yes	No	OBL
Blennosperma nanum var. nanum	Yes	No	OBL
Callitriche heterophylla	Yes	No	OBL
Callitriche marginata	Yes	No	OBL
Castilleja campestris ssp. campestris	Yes	No	OBL
Castilleja campestris ssp. succulenta	Yes	No	OBL
Centunculus minimus	Yes	No	FACW
Chamaesyce hooveri	Yes	No	NI
Crassula aquatica	Yes	No	OBL
Crassula saginoides	Yes	No	NI
Cuscuta howelliana	Yes	No	NI
Damasonium californicum (Macherocarpus californicus)	Yes	No	OBL

Appendix VI: List of Vernal Pool Plant Species

Plant Species	Native	Invasive	Indicator status
Deschampsia danthonioides	Yes	No	FACW
Downingia bella	Yes	No	OBL
Downingia bicornuta var. bicornuta	Yes	No	OBL
Downingia bicornuta var. picta	Yes	No	OBL
Downingia concolor var. concolor	Yes	No	OBL
Downingia cuspidata	Yes	No	OBL
Downingia insignis	Yes	No	OBL
Downingia ornatissima var. eximia	Yes	No	OBL
Downingia ornatissima var. ornatissima	Yes	No	OBL
Downingia pulchella	Yes	No	OBL
Downingia pusilla (Downingia humilis)	Yes	No	OBL
Eleocharis acicularis	Yes	No	OBL
Eleocharis macrostachya	Yes	No	OBL
Epilobium cleistogamum (Boisduvalia cleistogamum)	Yes	No	OBL
Eryngium aristulatum var. aristulatum	Yes	No	OBL
Eryngium aristulatum var. hooveri	Yes	No	OBL
Eryngium castrense (E. vaseyi var. castrense)	Yes	No	FACW
Eryngium constancei	Yes	No	OBL
Eryngium pinnatisectum	Yes	No	OBL
Eryngium spinosepalum	Yes	No	NI
Eryngium vaseyi	Yes	No	FACW
Gratiola ebracteata	Yes	No	OBL
Gratiola heterosepela	Yes	No	OBL
Hesperevax caulescens (Evax caulescens)	Yes	No	NI

Appendix VI: List of Vernal Pool Plant Species

Plant Species	**Native**	**Invasive**	**Indicator status**
Isoetes howellii	Yes	No	OBL
Isoetes nuttallii	Yes	No	NI
Isoetes orcuttii	Yes	No	OBL
Juncus leiospermus var. ahartii	Yes	No	NI
Juncus leiospermus var. leiospermus	Yes	No	NI
Juncus uncialis	Yes	No	OBL
Lasthenia chrysantha	Yes	No	FACU
Lasthenia conjugens	Yes	No	NI
Lasthenia ferrisiae	Yes	No	NI
Lasthenia fremontii	Yes	No	OBL
Lasthenia glaberrima	Yes	No	OBL
Lasthenia glabrata ssp. glabrata	Yes	No	FACW
Layia fremontii	Yes	No	NI
Legenere limosa	Yes	No	OBL
Lepidium latipes var. latipes	Yes	No	NI
Lilaea scilloides	Yes	No	OBL
Limnanthes alba	Yes	No	OBL
Limnanthes douglasii var. nivea	Yes	No	OBL
Limnanthes douglasii var. rosea	Yes	No	OBL
Limnanthes floccosa ssp. californica	Yes	No	OBL
Limnanthes floccosa ssp. floccosa	Yes	No	OBL
Marsellia oligospora	Yes	No	FAC
Marsellia vestita	Yes	No	NI
Mimulus tricolor	Yes	No	OBL

Appendix VI: List of Vernal Pool Plant Species

Plant Species	Native	Invasive	Indicator status
Montia fontana (M. verna)	Yes	No	OBL
Myosurus apetalus	Yes	No	NI
Myosurus minimus	Yes	No	OBL
Myosurus sessilis	Yes	No	NI
Navarretia heteranda	Yes	No	OBL
Navarretia intertexta ssp. intertexta	Yes	No	OBL
Navarretia leucocephala ssp. bakeri	Yes	No	OBL
Navarretia leucocephala ssp. leucocephala	Yes	No	OBL
Navarretia leucocephala ssp. pauciflora	Yes	No	OBL
Navarretia myersii	Yes	No	NI
Navarretia nigelliformus ssp. nigelliformis	Yes	No	OBL
Navarretia nigelliformus ssp. radians	Yes	No	NI
Navarretia prostrata	Yes	No	OBL
Navarretia tagetina	Yes	No	NI
Neostapfia colusana	Yes	No	OBL
Orcuttia inaequalis	Yes	No	NI
Orcuttia pilosa	Yes	No	NI
Orcuttia tenuis	Yes	No	OBL
Orcuttia viscida	Yes	No	NI
Pilularia americana	Yes	No	OBL
Plagiobothrys acanthocarpus	Yes	No	OBL
Plagiobothrys austinae	Yes	No	NI
Plagiobothrys bracteatus	Yes	No	OBL
Plagiobothrys humistratus	Yes	No	OBL

Appendix VI: List of Vernal Pool Plant Species			
Plant Species	**Native**	**Invasive**	**Indicator status**
Plagiobothrys hystriculus (presumed extinct)	Yes	No	FACW
Plagiobothrys leptocladus	Yes	No	OBL
Plagiobothrys stipitatus var. micranthus	Yes	No	OBL
Plagiobothrys stipitatus var. stipatatus	Yes	No	OBL
Plagiobothrys trachycarpus	Yes	No	FACW
Plagiobothrys undulatus	Yes	No	FACW+
Plantago bigelovii	Yes	No	OBL
Plantago elongata	Yes	No	FACW
Pogogyne douglasii	Yes	No	NI
Pogogyne zizyphoroides	Yes	No	OBL
Psilocarphus brevissimus var. brevissimus	Yes	No	OBL
Psilocarphus brevissimus var. multiflorus	Yes	No	OBL
Psilocarphus oregonus	Yes	No	OBL
Psilocarphus tenellus var. globiferus (P. tenellus var. tenuis)	Yes	No	FAC
Ranunculus bonariensis var. trisepalus (R. alveolatus)	Yes	No	OBL
Sagina decumbens ssp. occidentalis	Yes	No	FAC
Sibara virginica	Yes	No	NI
Sidalcea calycosa ssp. calycosa	Yes	No	OBL
Sidalcea hirsuta	Yes	No	OBL
Triteleia hyacinthina (Brodiaea hyacinthia)	Yes	No	FACW
Tuctoria greenei	Yes	No	OBL
Tuctoria mucronata	Yes	No	NI