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Quality Assurance Project Plan

for the

Development of a Wetland Rapid Assessment Method in California

Funding Numbers: CD-979189-01-0 and CD-97918701-0

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Introduction

Overall Goals and Objectives

The overall goal of the project is to develop a Rapid Assessment Method (RAM) for wetlands in California. The California RAM (CRAM) will be based on approaches created in other states, especially Washington and Ohio, where RAMs are routinely used to assess wetland resources.

The CRAM will initially focus on wetlands in the coastal watersheds three regions: the San Francisco Bay Area, Morro Bay Area, and the Southern California Bight. The effort will expand to include regions, until the method has been validated for all kinds of wetlands in California. The regional approach is necessary to account for the variability in wetland type, form, and function that occurs with latitude, altitude, and distance inland from the coast. An organizational structure has been created to foster collaboration and coordination among the regional efforts.

The CRAM will assess individual wetlands based on visible conditions that indicate functional levels of support for beneficial uses and ecological services. A major aspect of CRAM development will therefore be field tests to identify suites of visible conditions, termed metrics, that indicate important wetland functions.

For each HGM class of wetland, our effort to develop the CRAM will involve 3 basic analytical steps: (1) *semi-quantitative verification* of the metrics based on best professional judgment of their suitability to describe wetland conditions in each region; (2) *quantitative calibration* using existing datasets to test for correlation between the metrics and levels of the highest priority functions in each region; and (3) *validation* based on applications of the CRAM at randomly chosen sites along well-documented stressor gradients.

There may be regional differences in wetland function that will translate into regional modules in the CRAM, but we will strive to develop a CRAM that pertains to all regions and wetlands of the state. We expect that calibration and validation will be ongoing to account for changes in wetland science and management priorities.

The overall objective of the CRAM is to assess the ambient condition of wetlands and associated resources. CRAM can be used to track the performance of wetland restoration and mitigation projects. It might also be used to prioritize restoration opportunities, identify design constraints, identify possible causes for project failure, and to predict the impacts of land use on wetland resources.

The overall goals and objectives of the project will be accomplished through an interdisciplinary effort focused on the following specific objectives in two distinct phases.



Phase I: CRAM Development, Verification, and Initial Calibration

- Objective 1:** Complete a literature search and review of existing RAMs from other states and eco-regions (especially Ohio’s Rapid Assessment Method and Washington State’s method) for inclusion in a draft CRAM.
- Objective 2:** Develop a draft CRAM for review by the Core Team and Regional Teams.
- Objective 3:** Verify the CRAM for subsequent *calibration* and *validation* by performing semi-quantitative analyses of the suitability of the draft metrics and scoring systems based on the “best professional judgment” of the Regional Teams. The Regional Teams will use the draft CRAM to reconnoiter sites that are especially well studied with regard to the highest priority functions to which the CRAM is designed to apply (Table 1). The Regional Teams and Core Team will use this semi-quantitative reconnaissance to refine the metrics and their scoring systems.
- Objective 4:** Initiate calibration by regressing CRAM metric scores on existing quantitative field data for the highest priority wetland HGM class and its highest priority functions in each region (Table 2). Version 1.0 of the CRAM will be developed from the draft CRAM based on these initial calibration results. The regions may choose different HGM classes to calibrate, depending on local priorities.

PHASE II: CRAM CALIBRATION AND VALIDATION (CONTINGENT ON CONTINUED FUNDING)

- Objective 5:** Calibrate by starting with the the highest priority HGM class (Objective 4) and proceeding to other HGM classes of wetlands depending upon funding and the availability of suitable datasets..
- Objective 6:** *Validate* the CRAM version 1.0 and subsequent versions by applying it to randomly selected sites for each HGM class of wetland along at least one well-documented gradient of a high-priority stressor in each region. The intent of the validation is to test the ability of the CRAM to distinguish among minimal, moderate, and severe levels of anthropogenic stress. The validation effort for each region will require a sample frame in a GIS from which at least 30 sites will be randomly drawn for independent applications of the CRAM in each HGM class, based on the advise of the Core Team. Sample frames are currently being developed for the priority HGM Classes in each region. Validation will proceed from one stressor gradient to another and to other HGM classes depending upon funding and the results of class-specific and stressor-specific calibration efforts.

As mentioned above, the exploratory nature of this work requires us to conduct this applied research in two phases –Developmental/Verification (Phase I) and Calibration/Validation (Phase II). This version of the QAPP deals primarily with Phase I. It will be revised prior to the initiation of Phase II.

Table 1: Example sites for verification of the draft CRAM. There is abundant information about these sites and they are well known by the Regional Teams.

Region	HGM Class	Example Sites for Verification
San Francisco Bay Area	Estuarine Fringe	Arrowhead Marsh (Alameda County)
		China Camp (Marin County)
		Rush Ranch (Solano County)
	Depressional	Montezuma Vernal Pools (Solano County)
		Berkeley Marina Wetlands (Alameda County)
		Dogtown Sag Ponds (Marin County)
	Slope	Marin Country Club Spring Run (Marin County)
		Wildcat Canyon Hillside Slumps (Contra Costa County)
		Laguna de Santa Rosa (Sonoma County)
	Riverine	Lower San Pedro Creek (San Mateo County)
		Lower Wildcat Creek (Contra Costa County)
		Alameda Creek Flood Control Channel (Alameda County)
	Lacustrine Fringe	Jewel Lake (Alameda County)
Chabot Lake (Alameda County)		
Searsville Lake (San Mateo County)		
Southern California Bight	Estuarine Fringe	
	Depressional	
	Slope	
Riverine		
Lacustrine Fringe		

Table 2: Priority wetland classes, functions, stressors, and related datasets for initial CRAM calibration in each region.

Region	Priority HGM Class for Phase I	Priority Functions	Priority Stressors	Primary Datasets
San Francisco Bay Area	Estuarine Fringe	Plant Community Support	NIS Plant Invasions	Team Arundo Del Norte
				Spartina Control Project
				SF Bay EMAP Intensification Project
			POTW Effluents	South Bay Conversion Study
				Shell Marsh and Peyton Slough Studies
			Hydrological Modification	Various surveys of diked marsh, muted tidal marsh, and restored tidal marshes
		CALFED Breach 1 and Breach 2 studies		
		Bird Community Support	Human Visitation	Human Disturbance to Wildlife Study
				Contamination
			Bay Protection Plan Wetland Survey	
USGS Bird Egg Contaminants Study				
PEEIR Contaminants Studies				
Southern California Bight				Data are being compiled by contractor to SCCWRP

Organization

This interdisciplinary project will be coordinated by the three Principal Investigators from the San Francisco Estuary Institute (SFEI), and the Southern California Coastal Water Research Project (SCCWRP). The PIs will be advised by a Core Team of state and federal agency representatives and academic scientists, with review by two Regional Teams representing the Southern California Bight and the San Francisco Bay Area. These Regional Teams will confer with the State Coastal Commission to transfer the CRAM to wetland interests along the Central California Coast.

Responsibilities of Principal Investigators (PIs), Core Team, and Regional Teams

1. Principal Investigators

- a. Organize the research approach to meet the project goals and objectives.
- b. Develop plans for compiling, verifying, and transmitting field data from the Regional Teams to data managers at SFEI and SCCWRP.
- c. Analyze data provided by the Regional Teams.
- d. Prepare CRAM documents including outreach materials, instruction manuals, and interim and final reports for verification, calibration, and validation of the CRAM.
- e. Write manuscripts for scientific publications.

2. Core Team

- a. Advise and review the work of the PIs to standardize and integrate across regions.
- b. Lead the Regional Teams during verification, calibration, and validation efforts.
- c. Organize, supervise, and provide logistical support for the Regional Teams, including securing all necessary permits and permission to access field sites.
- d. Compile, provide quality control, and transmit data to SFEI and SCCWRP in accordance with standardized procedures.

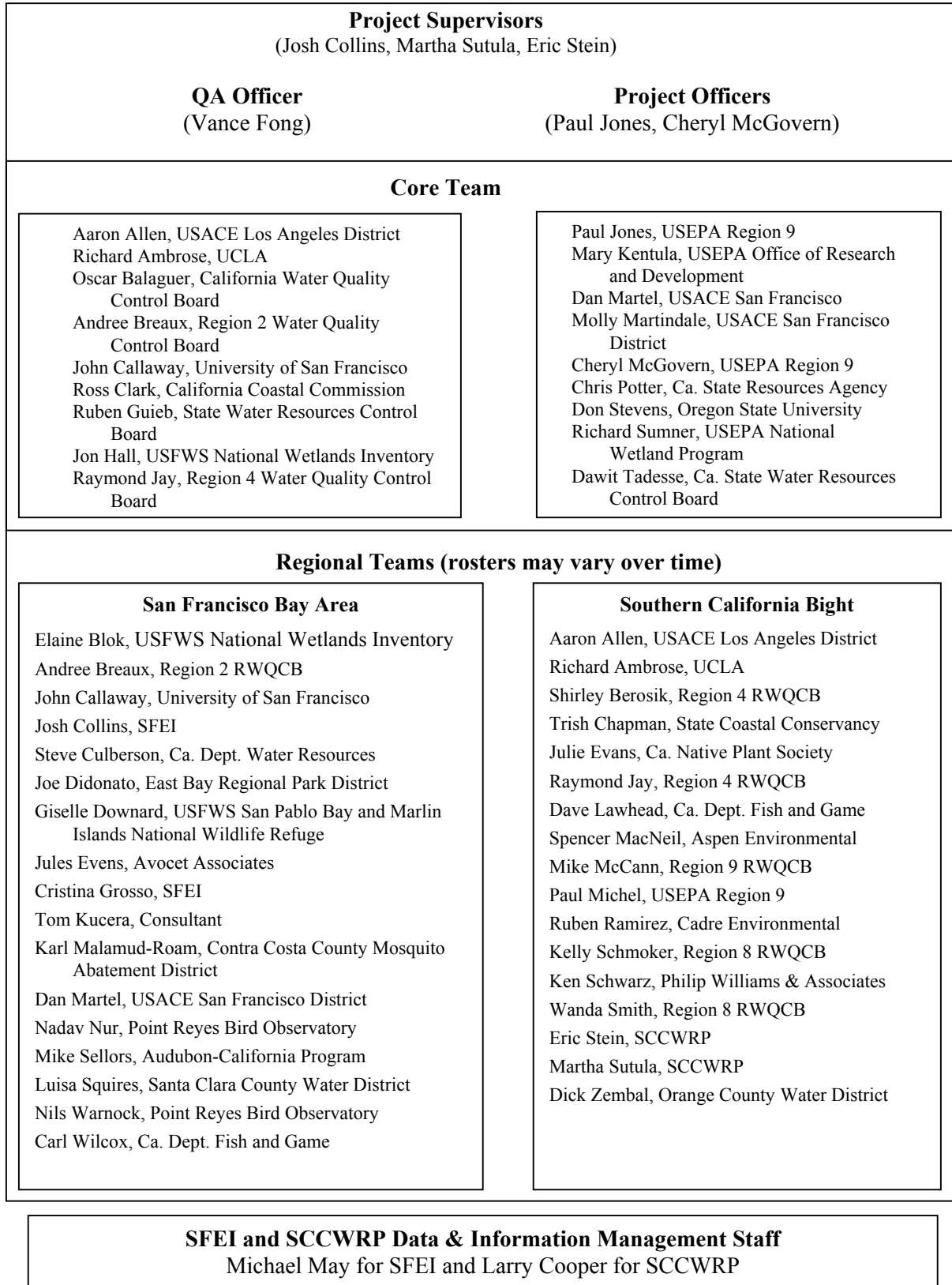
3. Regional Teams

- a. Review and recommend revisions of the CRAM for regional applications.
- b. Assist in regional data collection and compilation for verification, calibration, and validation of the CRAM.
- c. Participate in regional technical workshops and outreach efforts to help foster acceptance and use of the CRAM.

4. Data Managers

- a. Maintain accurate records of meetings, workshops, contacts, crew schedules, data collection, expenses, and other administrative matters.
- b. Ensure proper QA/QC procedures are followed for processing of field data and associated GIS information on the project.
- c. Provide for the entry and retrieval of data and information needed to verify, calibrate, validate, and implement the CRAM.

Organizational Chart



Conceptual Models

The Core Team has tentatively adopted 3 basic conceptual models for (1) wetland form, function, and controlling factors in California; (2) the EPA 3-tiered approach to regional wetland monitoring; and (3) the technical framework to develop a Rapid Assessment Method (RAM). It is expected that these general models pertain to all wetland types and to all regions in California.

Wetland Form, Function, and Controlling Factors

The evolution and natural maintenance of a wetland depend on supplies of water and sediment, as mitigated by vegetation. Water is needed to submerge the land, and sediment is needed to prevent the land from being too deeply submerged for wetland plants to survive. The quality and quantity of supplies of water and sediment are mainly controlled by climate, geology, and land use, but vegetation can significantly affect these supplies. Vegetation also affects the distribution and abundance of valuable wildlife by serving as habitat and food. The interactions among all these factors are dynamic because climate and land use are always changing, plant and animal species evolve, and the species composition of natural communities changes due to invasions and local extinctions.

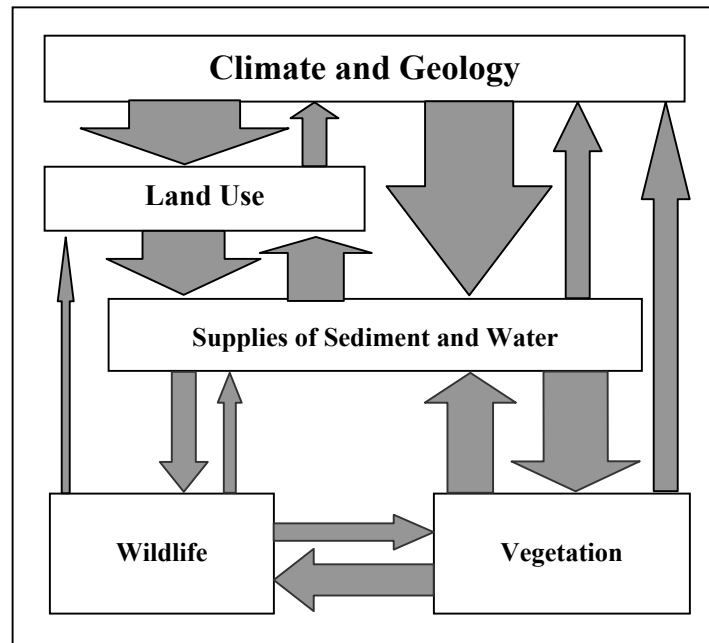


Figure 1: Diagram of primary factors that control wetland form and function. Arrows represent hydrology (including all processes of water and sediment movement and storage), herbivory, predation, or microbial processes, and they point from what controls these processes to what they affect. The boxes can therefore represent both the sources of and responses to natural disturbance and anthropogenic stress. The larger arrows represent greater relative importance.

The EPA 3-tierd Approach to Wetland Monitoring

US EPA is supporting a number of efforts in the nation to develop and strengthen wetland monitoring and compensatory mitigation through grant assistance under the Wetland Development Grants and policy and technical support from Headquarters and the Regions. The technical framework for EPA's support consists of three complementary levels: (1): Landscape Assessment; (2) Rapid Assessment; and (3) Intensive Site-Specific Monitoring.

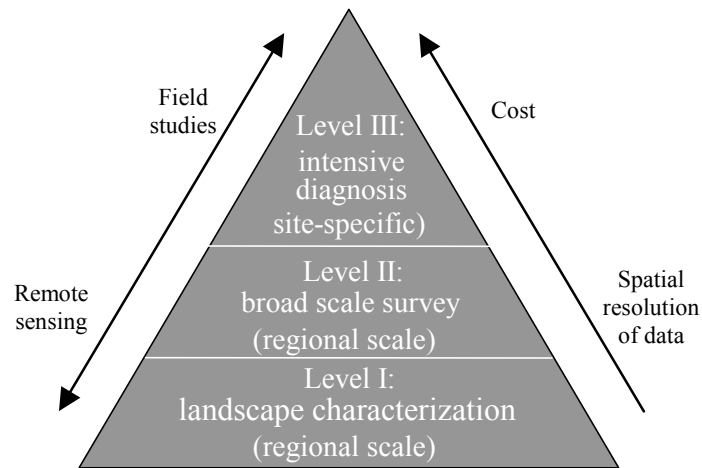


Figure 2: Conceptual model of the EPA 3-tiered approach to wetland monitoring.

The resolution of the monitoring data, its site-specificity, the amount of field work required to generate the data, and its cost all increase from Level I to level III. The monitoring results from each level address different needs for information, and each level of monitoring can be used to verify the other levels.

Landscape Assessment (Level I) relies almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about watershed conditions and the distribution and abundance of wetland types within watersheds. A Level 1 assessment can generate a sample frame for Level 1 and level 2 assessments of wetlands sites.

The CRAM will be an example of Level 1 monitoring. After the CRAM is validated through Level 3 studies, it could be used to rapidly assess ambient conditions and the performance of wetland projects. Level II methods monitoring can also be used to develop hypotheses about the causes of the observed conditions and to validate Level 1 assessments.

Intensive Site Assessment (Level 3) provides the field data necessary to validate the Level 2 (rapid assessment) methods, characterize reference condition, test hypotheses about the causes of wetland conditions as observed through Level 2, and develop design and performance standards for wetland projects. Wetland bio-assessment criteria (i.e., use of indices of biological integrity or IBIs) can be developed and used in Level 3 assessments.

Technical Framework to Develop a RAM

The overall framework for developing the RAM for wetlands in California is based on the rapid assessment experience of EPA and other states. The framework indicates that a RAM should be sensitive to regional variations in wetland form and function. However, it also indicates that a set of core metrics can be selected based on universal wetland features that pertain to all wetland classes.

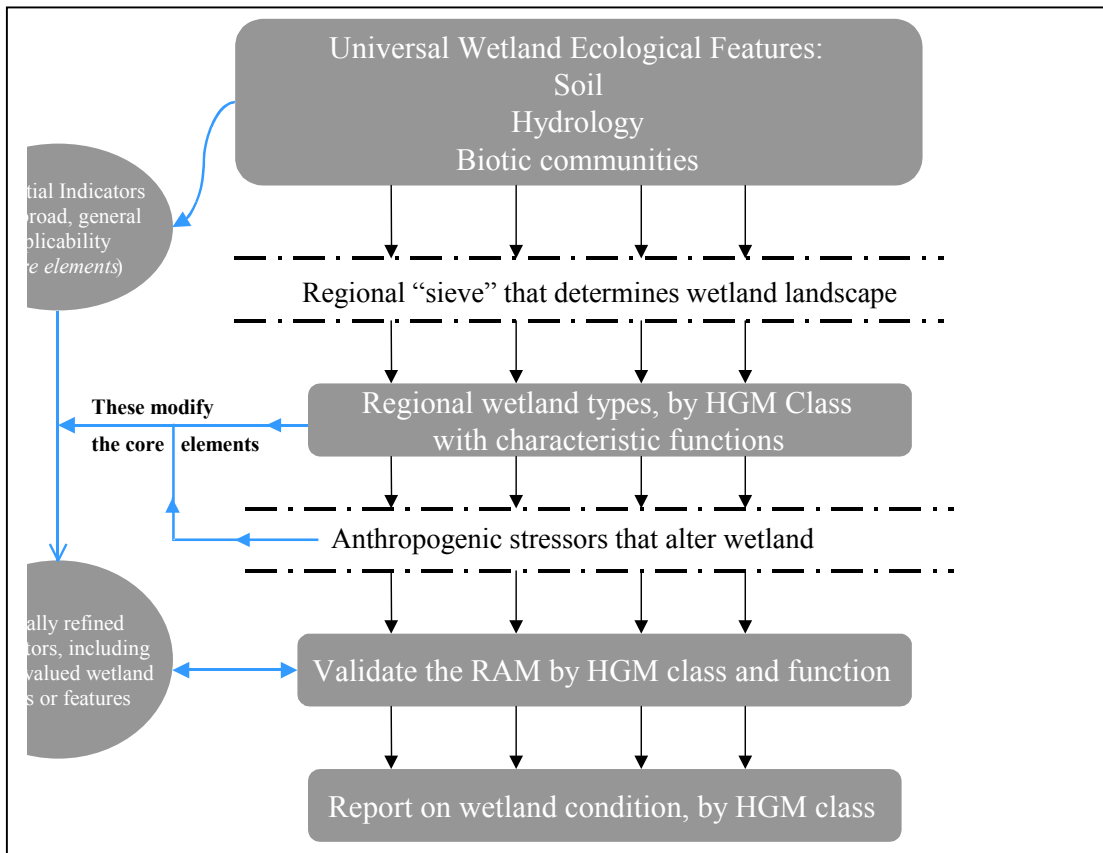


Figure 3: Conceptual Model of the Process to Develop the CRAM

Based on this model, the CRAM will address physical and biologic condition of wetlands, will be modified for regional variations in wetland form and function, will assess individual wetlands relative the reference conditions that indicate the best attainable regional conditions. The Initial metrics will be based on literature surveys and existing data relating physical or biological structure to ecological and hydro-geomorphological function. CRAM development will include field calibration and validation with Level III (site-specific) analysis. The CRAM might be customized, depending on the goal of the assessment (e.g. condition evaluation, impact assessment, mitigation compliance). Implementation will require a clear strategy for how the CRAM should be used in a regional monitoring context, with adequate institutional infrastructure to support training, standardized use, and efficient data management.

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Measurement and Data Acquisition

Data Quality Objectives (DQOs)

The objective of data management will be to assure that field, GIS, and laboratory data are accurately collected and verified for analysis and interpretation by SFEI and SCCWRP.

Experimental Approach

The project will be accomplished in two phases over a period of 12 to 24 months. This QAPP mostly pertains to Phase I, development and initial calibration a Rapid Assessment Method for California wetlands (CRAM). Phase I will be based on established hydrogeomorphic (HGM) approaches (Brinson 1995, Brinson and Rheinhardt, 1996) and bioassessment approaches (see www.epa.gov/owow/bawwg).

The intent is to develop the CRAM as a set of core metrics of condition that pertain to all wetland classes in California and that indicate levels of stress and function for the priority beneficial uses and ecological services of wetlands within each region. A set of numerical values will be assigned across the expected range in variability for each metric such that the CRAM can be used to score individual wetlands with regard to the core metrics. SFEI, SCCWRP, and the Regional Teams will use their best professional judgment to verify the applicability of the rapid assessment approach, the core metrics, and the scoring systems before more quantitative development of the CRAM will proceed. The verification process will focus on sites for which the history of environmental stress and function are well known by the PIs and the Regional Teams (see Table 1).

After the core metrics and the scoring systems have been verified, then they will be calibrated against existing datasets for the high-priority functions of one or more HGM classes within each region (see Table 2). The intent is to revise and refine the metrics such that they reflect known variations in type and level of function.

In Phase II (ongoing calibration and validation), a more rigorous and statistically valid methods will be employed to assess the sensitivity of the CRAM to varying levels of high-priority wetland stressors within each region.

SFEI and SCCWRP will add lists of variables to be measured, guidelines for their measurement, and data quality objectives this QAPP as they are developed before Phase II is initiated. The PIs will also develop a manual to be used in Phase II. A QA report in the form of a memo will accompany the final manual. The QA report will document how the results of the field tests conducted in Phase I were used to produce the manual for Phase II.

Because the funding has not yet been secured for Phase II and because the planning for validation will only be initiated during Phase I, we are requesting preliminary QAPP approval for the Phase I, and we propose to submit a more detailed QAPP for Phase II in December 2003, should we secure Phase II funding. The QAPP will be revised prior to implementing Phase II, based on the results of Phase I.

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The basic schedule of steps for Phase I is outlined below. Phase I will prepare the CRAM for continued calibration and validation during Phase II.

1. The Core Team will develop a draft CRAM based on literature reviews and using best professional judgment.
2. The Core and Regional Teams will translate regional NWI maps of wetlands types according to Cowardin et al. (1979) into maps of hydrogeomorphic (HGM) classes of wetlands as described by Brinson (1993). We anticipate that there will be four dominant HGM wetland classes in the study area: riverine, estuarine or marine fringe, lacustrine, and depressional. Slope wetlands are common in some locales within some regions and may also be included in Phase I of CRAM development.
3. The Core Team will refine the draft CRAM at workshops during January – April 2003. The Core Team and the PIs will review the draft CRAM and discuss logistics regarding its verification, including final selection of verification sites. To the extent that they are known at this time, details of the verification process are presented below for approval in our submittal of this QAPP.

The Core Team will refine the draft CRAM at workshops during January –April 2003. During this same period of time, and for the duration of the field season, the PIs will supervise the Regional Teams for verification of the draft CRAM. The PIs and Regional Teams will visit the sites elected for the verification process (see Table1 above) in each region. The adequacy of the metrics, sub-metrics, and scoring systems will be evaluated by compiling written critiques provided by all members of the field teams. In addition, the teams will score each element of the draft CRAM as follows:

1. Excellent (no modifications needed);
2. Adequate but in need of revision (with suggestions for changes)
3. Inadequate (should be eliminated or subjected to major revision).

The teams will be asked to fill out matrices to evaluate the consistency of each set of sub-metrics for each core metric across HGM classes. An example matrix is shown as Table 3.

Table 3: Sample matrix to evaluate the consistency of sub-metrics (eg., sub-metrics for Hydrology core metric) across HGM classes.

Sub-metrics of Hydrology Core Metric	HGM Class of Wetland				
	Depressiona l	tidal fringe	riverine	lacustrine	slope
source of water	<i>The verifiers will enter numerical scores into each cell of matrices such as this one, based on the scoring systems provided in the draft CRAM manual. In addition, the verifiers will enter letter codes that refer to comments about the applicability of the sub-metric or its scoring system. Matrices such as this will help us decide how the metrics, sub-metrics, and scoring systems should be revised to consistently assess conditions in each HGM class.</i>				
Connectivity					
max. water depth					
duration of inundation or saturation					
microtopography					

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The verification process could result in a variety of CRAM revisions. We expect few changes to the core metrics, more changes to the sub-metrics, and significant modifications of the scoring systems for some metrics. The verification process will also reveal any need to create modules within the CRAM to address significant differences in wetland form or function between regions or between HGM classes. We will attempt to minimize such extensive elaborations because they will ultimately reduce the likelihood of broad implementation by increasing the cost and complexity of manuals, training, and data management.

We expect that the Regional Teams will visit 15 sites evenly distributed among 5 HGM classes (tidal fringe, riverine, lacustrine, slope, and depressional).. This is not designed or expected to be a statistically valid exercise; the intent is to assess the overall approach and basic design of the draft CRAM based on best professional judgment at sites that are well known by the assessors. This verification process will continue until there is agreement between the PIs and the Core Team that the metrics and scoring systems are suitable to begin calibration exercise and to plan for validation as Phase II.

4. Beginning in March 2003, the Regional Teams will identify and acquire existing datasets that can be used to calibrate the verified metrics, sub-metrics, and scoring systems for selected wetland classes in each region (see Table 2 above). Criteria for data acceptance or rejection have been drafted (see Table 4 below).

Table 4: Requirements to accept existing intra-regional datasets for initial CRAM calibration

Applicability	Accuracy	Precision	Accessibility
Data pertain directly to the HGM class, wetland function, and stressors of interest. Data can be assigned to individual sites that collectively represent a broad range of stress for selected stressors.	Data can be summarized as statistical moments that indicate high, medium, and low functional levels that correlate to high, medium, and low levels of stress along one or more selected stressor gradients.	Data distinguish between high and low levels of function for maximum confidence levels of 0.1. Medium levels of function may be indistinguishable from the maximum or minimum levels.	Data are digital, readily available without charge or extensive revision, have passed review by their sources, and are supported by metadata that describe collection methods and data limitations in sufficient detail to determine their comparability to other data. In the absence of such metadata, the data authors must be responsive to information requests from CRAM partners.

5. The wetland GIS in each region will be used to organize and provide site imaging, existing data about verification sites, verification results, initial calibration data sets, and calibration results.
6. At the same workshops to be held March – April 2003, the participants will develop a framework for Phase II of the project. This framework will be the basis for a more detailed QAPP to cover Phase II.

Draft CRAM

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The draft CRAM will be based on a pre-draft list of metrics and sub-metrics, which itself is based on the Ohio Rapid Assessment Method, v. 5.0 (Mack 2001) and a review of other pertinent literature on rapid assessment methods (e.g., Collins 2001, Stein and Ambrose 1998, Whigham et al., 2002). A summary list of these metrics is provided in Table 5 below.

Table 5: Draft metrics, sub-metrics, and scoring system for review and revision by the PIs, Core Team, and Regional Teams during 2003.

Core Metric	Sub-metric	Points (% of total)
Size	none	5
Landscape condition, buffer size, and buffer condition	surrounding land use intensity	15
	average buffer width	
	buffer condition	
	adjacent habitat condition	
Hydrology	sources of water	30
	connectivity	
	water fluctuations	
	duration of saturation/inundation	
	modifications to natural hydrologic regime	
Habitat Structure	habitat development	10
	structural and spatial diversity	
	floodplain (riparian systems) or watershed integrity	
	linear contiguity of habitat (riparian systems) or connectivity with adjacent uplands/ecotones	
Habitat Alteration	substrate disturbance	10
	habitat disturbance	
Vegetation Community Structure	wetland plant communities	20
	plan or horizontal interspersions	
	invasive plant coverage	
	microtopography	
Living Resources Support	known occurrence of endangered or threatened species	5
	significant migratory songbird, waterfowl, or shorebird breeding, feeding, or roosting area	
	amphibian or reptile breeding or feeding area	
Special Wetland	vernal pool	5
	alpine wet meadow	
	tidal marsh (fresh, brackish, or saline)	
	other	

Data Quality Control

The Quality Control procedures will assure that the field teams are using the same approach and are obtaining information accurately when they are conducting wetland assessments using the CRAM.

Precision, accuracy, and completeness

This QAPP pertains to basic verification and initial calibration of the CRAM (Phase I) that does not involve collecting new quantitative data. New data will be collected during validation of the CRAM (Phase II). The QAPP will be updated to address the required precision, accuracy, and completeness of the validation data if Phase II of the project is funded. The following is a description of the basic procedures that will be followed during the Phase I effort.

The PIs will be responsible for making sure that all CRAM forms that are used in verification and calibration are filled completely. Regional Teams will provide the PIs with completed forms for a site within three days after the site is visited. The PIs will check each form for completeness (i.e., all fields requiring information are completed). If a PI finds that data are missing or that data have been incorrectly entered onto a form, then the persons who collected the information will be notified of the specific problem within two days after the form is submitted to the PIs, and, if necessary, sites will be visited again to obtain or correct the data in question.

Completeness of observations will be indicated by CRAM forms that have been reviewed by the PIs who find no lacking or incorrect or partial information, based on guidelines provided in the field manual.

Corrective Actions

Data compiled for any wetland site will be screened by the PIs. If errors and/or omissions are found, then the PIs will coordinate return visits to the sites in question. Corrective actions will be taken within two days after the problems have been determined.

Data Management

Data management for Phase I of this project will mostly involve hardcopy and electronic imaging and other background information for sites selected for verification and initial calibration of the CRAM, minutes of meetings and workshops, schedules of site visits, blank and completed verification and calibration forms, and pre-existing data used in the initial calibration. No new, quantitative data will be collected during Phase I.

Metadata will be prepared in the standard format of the National Biological Information Infrastructure (NBII, <http://www.nbio.gov/index.html>).

A full time computer staff manages routine backups for the computing systems at Databases at SFEI and SCCWRP. Backups are done daily. Backup tapes are stored in a fireproof facility off-site. Network security and computer security are governed by the network administrators at both SFEI and SCCWRP.

Review, Validation, and Verification of Phase I Information

Field crews will check the field verification and calibration forms of the CRAM before leaving each site. They will check the field data sheets for completeness, as defined above. The original forms will be transferred to the PIs, who will also check them for completeness and correctness as described above. Once the forms have been checked and approved, the information will be entered into electronic databases at SFEI and SCCWRP by their data management staff. SFEI and SCCWRP will then compare the electronic forms to the original forms and correct any and all error in the electronic forms. When outliers are found, SFEI and SCCWRP will work with their respective data collectors to determine if the data were incorrectly entered into the electronic versions or if the data were not correctly obtained in the field. If errors in field measurements are identified, the PIs will, as much as is possible, return to the sites and re-collect the information in question. After the electronic forms have been verified, three electronic copies of each form will be made. One copy will be retained by the PIs. A second copy will be provided to both SFEI and SCCWRP for review and storage. The third electronic copy of each form will be provided to the EPA Project Officers. The original forms for the Southern California Bight and the San Francisco Bay Area will be retained by SCCWRP and SFEI, respectively. The original forms for the Morro Bay Area will be retained by the California Coastal Commission.

Analysis of Verification Information

As described above, verification of the CRAM depends on best professional judgment and does not directly involve any quantitative data. The PIs and the Regional Teams will work together to reach consensus on the applicability and utility of the CRAM approach, its metrics, sub-metrics, and scoring systems. Majority and minority opinions will be documented through the verification matrices that will be produced for each core metric of the CRAM (see Table 3 above). Based on these matrices and the minutes of the verification workshops and meetings, SFEI and SCCWRP will co-produce a report of the findings of the verification process.

Analysis of Initial Calibration Information

The initial calibration of the CRAM will involve testing for correlation between CRAM scores for selected sites and pre-existing data for priority wetland functions of the same sites (see Table 2 above). The basic criteria for selecting test datasets have been developed (see Table 4). One of these criteria is that the quantitative data can be summarized for individual sites for which CRAM scores are developed. Based on this criterion, CRAM scores and summary quantitative data about function can be paired. CRAM scores for each sub-metric, core metric, and for sites as a whole can therefore be regressed on the functional data. These regressions will be used to quantify the correlation between the CRAM and the functional assessments. The degree of correlation will inform the decisions of the PIs and Core Team about the utility of the CRAM elements being tested. The statistical distribution of the CRAM scores relative to the functional data, and the form of the regression model will inform decisions about the scoring systems. For example, a uniform distribution and a positive linear model for the core metric called “size” would suggest that its score can increase arithmetically for equal increases in site size. A normal distribution and polynomial model would suggest that scores should increase to a certain optimal site size and then decrease for larger sites. A negative binomial distribution and a negative linear or curve-linear model would suggest that the scores might decrease rapidly for small increases in size and then gradually decrease

across larger sizes to a minimum score that corresponds to the asymptote of the regression model.

We anticipate that the existing quantitative data that can be assembled for the initial calibration might not be as useful as other data that are collected expressly for this purpose. The results of the initial calibration will therefore be used to revise the criteria for accepting calibration datasets and to inform the plans for continued calibration and validation using original data during Phase II.

Geographic Information Systems (GIS) Analyses

We will use GIS to help meet project objectives regarding site selection, measuring site size, and assessing landscape indicators. We will *not* digitize new geographic data to accomplish these objectives. Instead, we will use the best existing digital spatial data sets. We will seek to understand the limitations of those data and to quantify the effects of inaccuracies on our results and conclusions. Our fieldwork will check some of the information in the spatial data sets, so that we can provide some quality assessment on the source data. In addition, we will use metadata, published literature, and our own analyses to explore the quality of data, to quantify errors, and to understand uncertainties. We will quantitatively summarize the information on limitations in the source data and analyze and report the consequences of those uncertainties for project results and conclusions.

Data sources

Wetland maps are the most important GIS data for this project. We will use three sources of maps to describe the locations, extent, and characteristics of wetlands: The National Wetlands Inventory (NWI) of wetlands and the SFEI EcoAtlas.

The NWI data (<http://www.nwi.fws.gov>) are available for each region. The NWI uses manual photo-interpretation of aerial imaging supplemented with Soil Survey information and field checking to map (1979), which hierarchically places wetlands into systems, subsystems, and classes. The minimum mapping unit is usually between 1-3 acres. Additional information on data quality (attribute accuracy, logical consistency, and completeness); on data capture processes; and on the Cowardin classification is given by the NWI metadata (<ftp://www.nwi.fws.gov/metadata/>). These maps vary among the regions of the project, however, in terms of their accuracy, completeness, and vintage. NWI is currently working with SCCWRP to update the NWI maps for the Southern California Bight, with a completion date in 2004. SFEI and NWI have proposed to begin updating the NWI maps for the San Francisco Bay Area as part of Phase II of this project. It is therefore unlikely that the updated NWI maps for either region will be available for Phase I. To compensate for the uneven quality of the vintage NWI maps within and between the regions, SFEI and SCCWRP will work with the NWI and Regional Teams to “truth” the maps that must be used during the verification and initial calibration efforts of Phase I to the best extent possible.

SFEI maintains a regional GIS, called the Bay Area EcoAtlas, that includes maps of all the wetlands within the historical limits of the tides of San Francisco Bay, including past and present wetland restoration and mitigation projects. The minimum size wetlands shown on these maps is 0.25 acres. These maps have been extensively “truthed” by local agencies and wetland scientists based on high-resolution imaging and field surveys. At this time in the San Francisco Bay Area, these maps replace the NWI maps for wetlands within the historical limits of the tides. The EcoAtlas is online at

www.ecoatlas.org.

We will also use a variety of other spatial data to test for possible landscape indicators of wetland condition. We will acquire these data during Phase I of the project, and these will be listed in the next iteration of this QAPP.

Metadata

We will obtain the best available metadata from the supplier of each geographic coverage that we use. We will use the metadata to understand the strengths and weaknesses of each data set, to estimate uncertainties in the data, and to predict of how inaccuracies may affect project conclusions.

Quality Control

Our geographic analysis will use existing digitized information. We will therefore rely on available metadata, discussions with the Regional Teams, and ground-truthing to understand the implications of data quality. These results will be detailed in published papers and in QA reports to EPA. Both SFEI and SCCWRP have extensive QA/QC procedures in place for handling environmental monitoring data on a regular basis, and these can be found with each institution's information management specialists (see organizational chart).

Precision, Accuracy, and Completeness

The primary source of error in thematic maps, such as will be used in this project, is incorrect classification rather than spatial inaccuracy, particularly for digital maps derived from high quality source materials and reviewed by local experts. Incorrect classification can occur when small wetland sites are overlooked because of limited spatial resolution and field knowledge, or when sites are delimited but incorrectly identified. Incorrect classification also results when older maps do not reflect recent changes, such as wetland loss, restoration, or mitigation. For the regions of this project, arid nature of the landscapes adds uncertainty to the maps due to large inter-annual variations in water supply. For example, maps produced during droughts tend to show fewer wetlands or less extent of wetlands than maps produced during years of average or above-average rainfall. The PIs will rely upon the local and regional expertise of the Regional Teams to address these uncertainties.

Site Selection

Selection of sites for Phase I of the CRAM will be done informally by the Regional Teams using local knowledge. The selected sites will be identified in the GIS for each region.

Ground-Truthing

Our project does not have the resources to map small features missed in previous maps. However, our field visits to wetland sites that are selected for verification and initial calibration of the CRAM will provide some ground truthing of the source maps. We will be able to determine which of the wetland locations selected by the project participants have been correctly identified and classified. We will also gain some information on the extent of wetland loss between the time of source map production or updates and the present. Our fieldwork will also provide verification information for other mapped information in coverages, such as land use adjacent to sampled wetlands. We will

correct our digital coverages when discrepancies between maps and field observations are found.

Comparisons of Wetland Coverages

We will use GIS analysis to compare the regional wetland coverages to NWI and to quantify differences in number and extent of wetlands mapped. We will quantify how the regional coverages differ from NWI and from each other. The resulting information will be used to understand the effects of using three different wetland mappings and to interpret predictions from samples generated using the merged coverage.

Quality Assurance Report

Project reports and peer-reviewed publications will include analyses of the GIS components of the CRAM based on its verification and initial calibration, as detailed in this version of the QAPP. We will detail the sources of all spatial and field data used, metadata for those data, how the data were assembled and manipulated in our analyses, estimates of data quality from ground-truthing and comparison among wetland coverages, statistical methods used to relate sets of spatial measurements made with the GIS, and statistical significance and uncertainties in the resulting relationships. We will summarize these analyses to identify biases or uncertainties in the GIS source data and to estimate their effects on our results.

Assessment and Oversight

The PIs will work in cooperation with the Core Team and Regional Teams throughout the course of this project. Paul Jones and Cheryl McGovern, the respective Project Officers for the SFEI and SCCWRP efforts, will provide general oversight.

Audits

There are no planned audits for Phase I of this project. However, during the field exercises associated with verification and initial calibration of the CRAM, both project officers will accompany the Regional Teams to ensure procedures are being followed. Any deviations will be reported to the PIs and corrected to the satisfaction of the Project Officers.

QA Reports

SFEI and SCCWRP will prepare a QA report that documents how the results of the field tests conducted during Phase I were used to finalize the CRAM core metrics, sub-metrics, and scoring systems. This information will also be incorporated into a revision of the QAPP. The QA report, field manual, and revised QAPP will be completed and approved by EPA before Phase II is initiated.

SFEI and SCCWRP will prepare a QA report that assesses the QA/QC activities for the study at the conclusion of the second field season.

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References

- Brinson, M.M. 1995. The HGM approach explained. National Wetlands Newsletter. Nov-Dec 1995: 7-13.
- Brinson, M.M. and Rheinhardt, R.D. 1996. The role of reference wetlands in functional assessment and mitigation
- Collins, J.N. 2002. Bay Area Wetlands Regional Monitoring Program Plan. San Francisco Estuary Institute, Oakland, CA.
- Cowardin, L., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Services, U.S. Fish and Wildlife Service.
- Mack, John J. 2001. Ohio Rapid Assessment Method for Wetlands v. 5.0, User's Manual and Scoring Forms. Ohio EPA Technical Report WET/2001-1. Ohio Environmental Protection Agency, Division of Surface Water, 401/Wetland Ecology Unit, Columbus, Ohio.
- Stein, E.D., and R.F. Ambrose. 1998. A rapid impact assessment method for use in a regulatory context. Wetlands, Vol. 18, no. 3: 379-392.
- Whigham, D.F., Weller, D.E., Jacobs, A.D., Jordan, T.E., and Kentula, M.E. Assessing the ecological condition of wetland at the catchment scale. 2002. Manuscript.