Public Notice

Monitoring the US West Coast: An Assessment of California's Estuaries and the Pacific Ocean Year 2002 Pilot Wetland Assessment

San Francisco Bay Intensification Project
San Francisco Estuary Institute
7770 Pardee Lane
Oakland, CA 94621

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Introduction

The Environmental Monitoring Assessment Program (EMAP) Western Pilot is a five-year effort led by EPA's Office of Research and Development to advance the science of monitoring ecosystem health and demonstrate the applicability of EMAP assessment tools. The overall objective is to assess estuarine condition through an integrated comprehensive coastal monitoring program along the West Coast (including Alaska and Hawaii). It is also intended to demonstrate the value of survey-based monitoring by applying these techniques to problems of regional and state interest.

In 1999, a five-year cooperative agreement between EPA and the Southern California Coastal Water Research Project (SCCWRP) was implemented to accomplish the EMAP Western Pilot Study in California. This proposal is an incremental funding request to support the technical support activities that make up California's fourth year efforts. These activities advance EMAP's goal of expanding its program into wetlands, and provide continuity with data management and quality assurance procedures established in the previous years.

EMAP's efforts in the first three years have focused on subtidal and intertidal mudflat habitat. The fourth year will expand this effort to sample the intertidal mudflat and emergent macrophyte (marsh) habitats, with the following specific objectives:

1) Provide a statewide estimate of intertidal wetland condition for a core indicator set;
2) Intensify the assessment effort in southern California and the San Francisco (SF) Bay area;
3) Develop and apply additional indicators appropriate for wetland intertidal habitat.

The overlying purpose in the formulation of the sampling design and indicator selection for this assessment is to provide continuity with coastal EMAP sampling from previous years. This approach is being replicated in Oregon and Washington and will allow EPA-EMAP to produce a west coast-wide estimate of intertidal wetland condition for the core indicator set.

Assessment efforts will be intensified in southern California and the SF Bay area in order to serve the information needs of local, well-established coastal zone management units in those regions. These coastal zone management units are represented by the Southern California Wetland Recovery Project[1] (WRP) and the SF Bay Area Wetlands Regional

[1] The SCWRP is a partnership of 17 state and federal agencies working to develop and implement a regional plan for wetland acquisition, restoration, and enhancement in southern California. A list of partner agencies in the WRP can be found on the California Coastal Conservancy website (http://www.coastalconservancy.ca.gov/scwrp/index.html)

Monitoring Program (WRMP)[2], which were formed via cooperative agreement among the local, state, and federal agencies involved in wetland conservation, restoration, and management in their respective regions. Intensification in southern California and SF Bay will allow an independent estimate of wetland intertidal condition, which will allow EMAP to serve a management audience with data that would not be as useful if delivered as a statewide estimate alone.

Intensification of assessment in southern California and the SF Bay area also allows for the pilot study of additional indicators not included in the core set. Historically, EMAP assessments have focused on sediment contamination. While this issue is of great interest in southern California and the SF Bay areas, there are other important issues that are more specific to the intertidal wetland habitat, such as habitat fragmentation, threatened and endangered native species, the spread of non-indigenous species, modification of tidal flushing, and the impacts of urbanization of watersheds on wetland hydrology, water quality and habitat, etc. As part of the intensification effort, southern California and the SF Bay area will measure several new indicators to demonstrate the applicability of collecting such information using an EMAP probability-based survey.

Basic EMAP Sampling Design

The base sampling design allows for a statewide assessment of intertidal wetland condition as well as independent assessments of southern California[3] and S.F. Bay[4]. To achieve this, 30 Core Stations will be randomly allocated along the California coastline, and 30 will be allocated to each of the two intensification project areas. The 30 Core Stations allocated statewide will exclude S.F. Bay and southern California, and will be done following the sampling design utilized in previous west coast EMAP assessment of subtidal and intertidal mudflats.

In the intensification areas, some modifications of the traditional EMAP sampling design will be made to accommodate local management interests. In southern California, allocation of Core Stations will be random as per the traditional design, with one minor modification. If a point in a wetland intertidal patch smaller than 100 acres is rejected from the original sample because it does not fall in an intertidal area, its replacement will be selected from among alternative random points that fall in intertidal patches of 100 acres or smaller. This is required to make sure that the smaller patches are represented in the sample. In SF Bay, the random sample points will be allocated evenly between tidal flat, low tidal marsh, and mid-elevation tidal marsh, as required to represent the gradient of elevation of intertidal habitats.

[2] The WRMP is a partnership of 16 state and federal agencies plus local governments and NGOs working to develop a regional program of wetlands monitoring and assessment in the S.F. Bay area.
[3] So. California is defined to include the coastal region from Point Conception to the border with Mexico
[4] S.F. Bay area is defined as the estuarine tidal marsh of the San Francisco Estuary downstream of the delta.

Basic Conceptual Model for the Intensification Project

The following causal-link model provides the basis for the spatial sampling plan.

It is assumed that estuaries are landward extensions of marine influences, and marine-ward extensions of upland watershed influences. It is therefore assumed that the intertidal zone is transitional between the subtidal-open water estuarine environment and the fluvial-terrestrial environment. It is further assumed that physical conditions of both the estuarine environment and the terrestrial environment are due to geology (including topography and bathymetry), climate, and land use. It is assumed that the lower intertidal (i.e., the tidal flat) is influenced more by the subtidal-open estuarine water environment than by the fluvial-terrestrial environment, whereas the upper intertidal (i.e., tidal marsh) is influenced more by the fluvial-terrestrial environment. It is assumed that marine-estuarine influences enter the tidal flat on rising tidal waves first through intertidal channels and then across the plain of the tidal flat. It is likewise assumed that fluvial-terrestrial influences as well as marine-estuarine influences enter the tidal marsh on rising tides and during fluvial flood events first through intertidal channels and then across the marsh plain. It is assumed that the upland-tidal marsh ecotone is a separate place of connection between the terrestrial environment and the intertidal zone. It is assumed that the physical nature of the intertidal zone serves as a dynamic habitat template for ecological interactions.

Overall Analytical Approach to Intensification

The intensification project is designed to randomly sample intertidal habitats and their surrounding landscapes in two Project areas, southern California and San Francisco Bay.

The sample frame (a.k.a. sample universe) for each Project area is the intertidal zone below the elevation contour of approximate Mean High Tide, which is qualitatively estimated from field characters, such as vegetation type and location of the wrack line.

For each project area, geographic information systems (GIS) are used to randomly select 30 (thirty) 1-m^2 Core Stations from the population of all possible plots within the sample frame.

Each Core station is used to identify the unique intertidal drainage system to which each Core Station belongs, the habitat patch to which the drainage system belongs, and the local terrestrial watershed to which the habitat patch belongs. Different indicators are measured at each of these spatial scales (1-m^2 Core Station, drainage system, habitat patch, and watershed). This spatial plan of study will yield standard types of large-scale EMAP data, plus the plan will provide data needed to manage intertidal stresses and functional relationships between intertidal habitat and their watersheds.

Stratification of Intensification Data

In southern California, the Core Stations were intentionally distributed among small and large estuaries. All data can therefore be classified between small or large estuaries. In San Francisco Bay, the Core Stations were intentionally distributed among tidal flats, low tidal marsh, and high tidal marsh within each of four subregions, Suisun Bay, North Bay, Central Bay and South Bay. All data can therefore be classified by elevation and subregion.

Each patch of tidal marsh habitat has five internal sampling strata (A-E): mid-marsh plain along a tidal marsh channel, mid-marsh plain away from any channels, foremarsh along a channel, foremarsh away from any channels, and backshore away from any channels. All data collected within a drainage system or tidal marsh patch can be classified into these five strata. Data from these strata can be compiled for an overall assessment of each selected drainage system or patch.

Table 1: Indicators, Their Spatial Scale, Units of Assessment, and Data Sources

Intensification Indicators	Code	Spatial Scale of Data	Indicator Data Units	Units of Y-axis on Presentation Graphics	Basic Data Source
Plant community dominant species composition	1	Stratum[1] of Drainage system	Names or codes of taxa	% of each stratum	Field Transect
	2	Overall drainage system	Names or codes of taxa	% of drainage systems	Field Transect
Plant species richness	3	Stratum[1] of drainage system	N of species	% of each stratum	Field Transect
	4	Overall drainage system	N of species	% of drainage systems	Field Transect
Percent cover per dominant taxa	5	Stratum[1] of drainage system	% area	% of each stratum	Field Transect
	6	Overall drainage system	% area	% of drainage systems	Field Transect
Non-indigenous species (NIS) composition	7	Stratum[1] of Drainage system	Names or codes of Taxa	% of each stratum	Field Transect
	8	Overall drainage system	Names or codes of Taxa	% of drainage systems	Field Transect
Non-indigenous species (NIS) richness	9	Stratum[1] of Drainage system	N of species	% of each stratum	Field Transect
	10	Overall drainage system	N of species	% of drainage systems	Field Transect
Non-indigenous species (NIS) percent cover	11	Stratum[1] of Drainage system	% area	% of each stratum	Field Transect
	12	Overall drainage system	% area	% of drainage systems	Field Transect

[1] Stratum refers to each of the five sampling strata (A-E) for tidal marsh drainage systems: backshore, mid-marsh plain along mainstem channel, mid-marsh plain away from channels, foreshore near mainstem channel, foreshore away from channels, and backshore.

Table 1 (cont'd): Indicators, Their Spatial Scale, Units of Assessment, and Data Sources

Overall percent cover of trash in wrack line	13	Overall drainage system	% area	% of drainage systems	Field Transect
Threatened/endangered species richness	14	Habitat Patch	N of species	% of patches	Records/reports
Number of management objectives	15	Habitat Patch	N of objectives	% of patches	Records/reports
Type of management objectives	16	Habitat Patch	Names or codes of objectives	% of patches	Records/reports
Number of recreational facilities	17	Habitat Patch	N of facilities	% of patches	Records/reports
Annual number of visitors	18	Habitat Patch	N of people	% of patches	Records/reports
Habitat connectivity (Minimum distance to nearest patch)	19	Habitat Patch	Km	% of patches	GIS
Habitat connectivity (Number of patches within 5 km radius)	20	Habitat Patch	N of patches	% of patches	GIS
Habitat connectivity (CV of minimum distance within 5 km radius)	21	Habitat Patch	CV (coefficient of variation)	% of patches	GIS
Habitat connectivity (Index of Isolation)	22	Habitat Patch	Km/area	% of patches	GIS
Habitat connectivity (Percent intertidal zone composition by marsh or tidal flat)	23	Habitat Patch	% area	% of patches	GIS
Intertidal channel density	24	Habitat Patch	Km/area	% of patches	GIS
Total acreage	25	Habitat Patch	Sq km	% of patches	GIS
Total perimeter length	26	Habitat Patch	Km	% of patches	GIS
Shoreline development index (D)	27	Habitat Patch	% (unitless)	% of patches	GIS
Percent adjacent landcover by cover type	28	Adjacent Landscape Spatial Interval	% area	% of each interval type	GIS
	29	Overall Adjacent Landscape	% area	% of patches	GIS
Percent adjacent agricultural cover or undeveloped land	30	Adjacent Landscape Spatial Interval	% area	% of each interval type	GIS
	31	Overall Adjacent Landscape	% area	% of patches	GIS
Total annual POTW, industrial, power plant discharge per watershed	32	Local Watershed	MGD (million gallons per day)	% of watersheds	Records/reports

Table 1 (cont'd): Indicators, Their Spatial Scale, Units of Assessment, and Data Sources

Human population density per watershed	33	Local Watershed	N of people per area	% of watersheds	GIS
Median and CV of age of resident people per watershed	34	Local Watershed	N of people	% of watersheds	GIS
Median and CV of patch size	35	Habitat Patch	Sq km	Project area and subregions	GIS
Core Indicators for Each Core Station	**Code**	**Spatial Scale of Data**	**Indicator Data Units**	**Units of Y-axis on Presentation Graphics**	**Basic Data Source**
Tidal water temperature	36	Sq. meter	Degrees C	Percent of sample area	Field Plot
Tidal water depth	37	Sq. meter	Cm or inches	Percent of sample area	Field Plot
Tidal water salinity	38	Sq. meter	PPT	Percent of sample area	Field Plot
Sediment pore water salinity	39	Sq. meter	PPT	Percent of sample area	Field Plot
Sediment bulk density	40	Sq. meter	% volume	Percent of sample area	Field Plot
Sediment % organic carbon	41	Sq. meter	% wt	Percent of sample area	Field Plot
Sediment % N	42	Sq. meter	% wt	Percent of sample area	Field Plot
Sediment % P	43	Sq. meter	% wt	Percent of sample area	Field Plot
Mean sediment grain size	44	Sq. meter	Microns or mm	Percent of sample area	Field Plot
sediment inorganic contaminants (see Lamberson et al. 2002 for list)	45	Sq. meter	Units per volume	Percent of sample area	Field Plot
Sediment organic contaminants (see Lamberson et al. 2002 for list)	46	Sq. meter	Units per volume	Percent of sample area	Field Plot
Benthic species richness	47	Sq. meter	N of species	Percent of sample area	Field Plot
Benthic species biomass	48	Sq. meter	Gr wet wt	Percent of sample area	Field Plot
Emergent macrophyte species maximum stem or shoot length	49	Sq. meter	Cm or inches	Percent of sample area	Field Plot
SAV or macroalgal percent cover	50	Sq. meter	% area	Percent of sample area	Field Plot
SAV maximum shoot length	51	Sq. meter	Cm or inches	Percent of sample area	Field Plot
Emergent macrophyte species richness	52	Transect point	N of species	Percent of sample area	Field Transect
Percent of macrophyte species as NIS	53	Transect point	% of species	Percent of sample area	Field Transect

Expected Types of Graphs and Plots

Data for most indicators will be graphically presented as probability density functions (see Figure 1 below) for either percent of sampled area (i.e., Core Station indicators 36-53 in Table 1), percent of intra-patch stratum (i.e., indicators drainage systems (i.e., indicators 2,4,6,8,10,12,13,28,30 in Table 1), percent of habitat patches (i.e., indicators 14-27,29,31 in Table 1), or percent of watersheds or subregions (indicators 32-35 in Table 1). Indicators of composition among strata (i.e., indicators 1,3,5,7, 9,11, 28,30 in Table 1) will be summarized as stacked histograms (see Figure 2).

Figure 1: Idealized forms of probability density functions

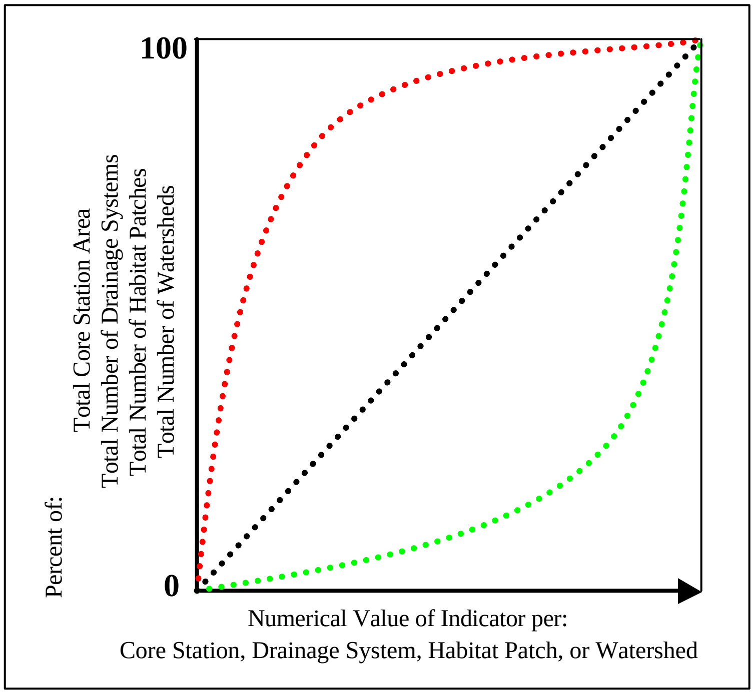
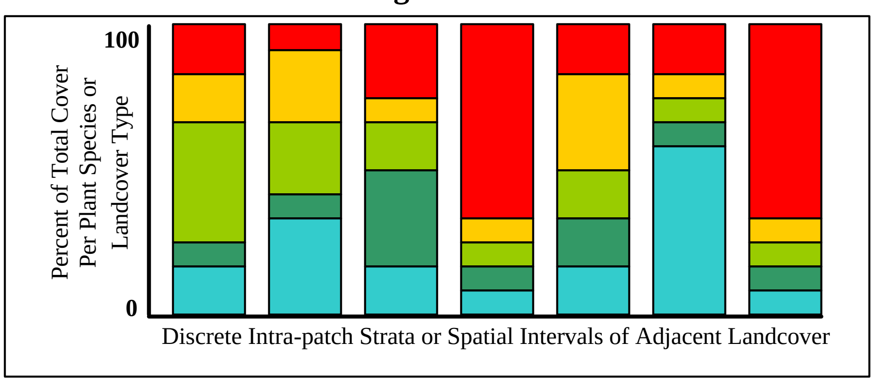


Figure 2: Idealized form of stacked histograms



Appendix A
List of Chemical Constituents for EMAP Core Indicators

CHEMICAL NAME	CHEMICAL FAMILY
Aluminum	METAL
Antimony	METAL
Arsenic	METAL
Cadmium	METAL
Chromium	METAL
Copper	METAL
Iron	METAL
Lead	METAL
Manganese	METAL
Mercury	METAL
Nickel	METAL
Selenium	METAL
Silver	METAL
Tin	METAL
Zinc	METAL
1-methylnaphthalene	PAH
1-methylphenanthrene	PAH
2,3,5-trimethylnaphthalene	PAH
2,6-dimethylnaphthalene	PAH
2-methylnaphthalene	PAH
Acenaphthene	PAH
Acenaphthylene	PAH
Anthracene	PAH
Benz(a)anthracene	PAH
Benzo(a)pyrene	PAH
Benzo(b)fluoranthene	PAH
Benzo(g,h,i)perylene	PAH
Benzo(k)fluoranthene	PAH
Biphenyl	PAH
Chrysene	PAH

Appendix A (continued)
List of Chemical Constituents for EMAP Core Indicators

CHEMICAL NAME	CHEMICAL FAMILY
Chrysene(C1-C4)	PAH
Dibenz(a,h)anthracene	PAH
Dibenzothiophene	PAH
Dibenzothiophene(C1-C3)	PAH
Fluoranthene	PAH
Fluorene	PAH
Fluorene(C1-C3)	PAH
Indeno(1,2,3-c,d)pyrene	PAH
Naphtalene(C1-C4)	PAH
Naphthalene	PAH
Pyrene	PAH
Toxaphene	PAH
2,4'-DDD	PCB
2,4'-DDE	PCB
2,4'-DDT	PCB
4,4'-DDD	PCB
4,4'-DDE	PCB
4,4'-DDT	PCB
Aldrin	PCB
Alpha-Chlordane	PCB
DDT	PCB
Dieldrin	PCB
Endosulfan I	PCB
Endosulfan II	PCB
Endosulfan sulfate	PCB
Endrin	PCB
Heptachlor	PCB
Heptachlor epoxide	PCB
Hexachlorobenzene	PCB
Lindane (gamma-BHC)	PCB
Mirex	PCB
PCB	PCB
PCB101	PCB

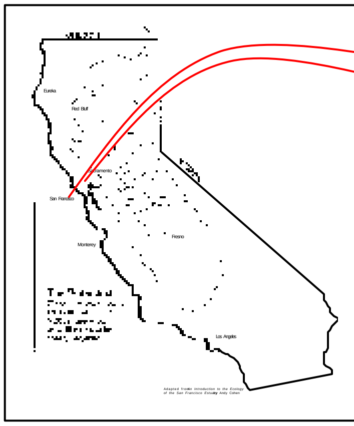
Appendix A (continued)
List of Chemical Constituents for EMAP Core Indicators

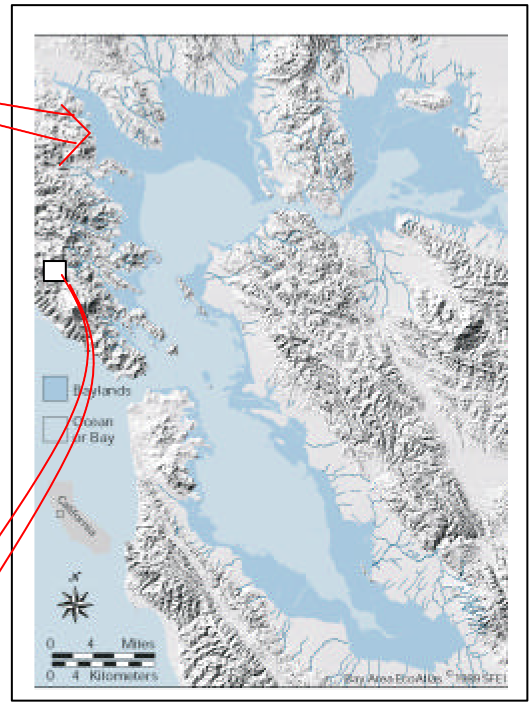
CHEMICAL NAME	CHEMICAL FAMILY
PCB105	PCB
PCB110	PCB
PCB110/77	PCB
PCB118	PCB
PCB126	PCB
PCB128	PCB
PCB138	PCB
PCB153	PCB
PCB170	PCB
PCB18	PCB
PCB180	PCB
PCB187	PCB
PCB195	PCB
PCB206	PCB
PCB209	PCB
PCB28	PCB
PCB44	PCB
PCB52	PCB
PCB66	PCB
PCB77	PCB
PCB8	PCB
Trans-Nonachlor	PCB
Total organic carbon	TOC
Total Nitrogen	Nutrient
Total Phosphorus	Nutrient

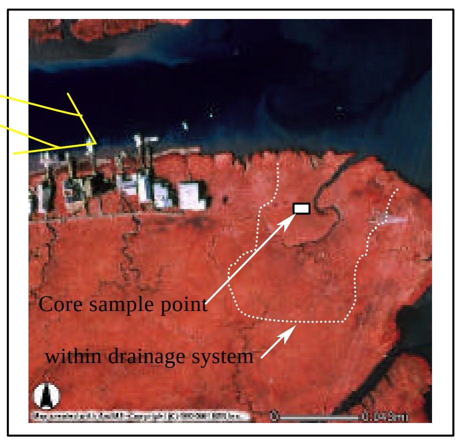
Appendix B

Spatial Hierarchy of EMAP California Intensification Project

The Bay Area project provides an example of the spatial design of the two CA projects. Each of the projects consists of a number of watersheds with their own estuaries, and each of these estuaries has tidal marshes and tidal flats. These marshes and flats are locally known *management units*, or *habitat patches*. Each patch of marsh or mudflat consists of a number of natural drainage systems of second-order or larger. Any randomly drawn point will fall within a drainage system.

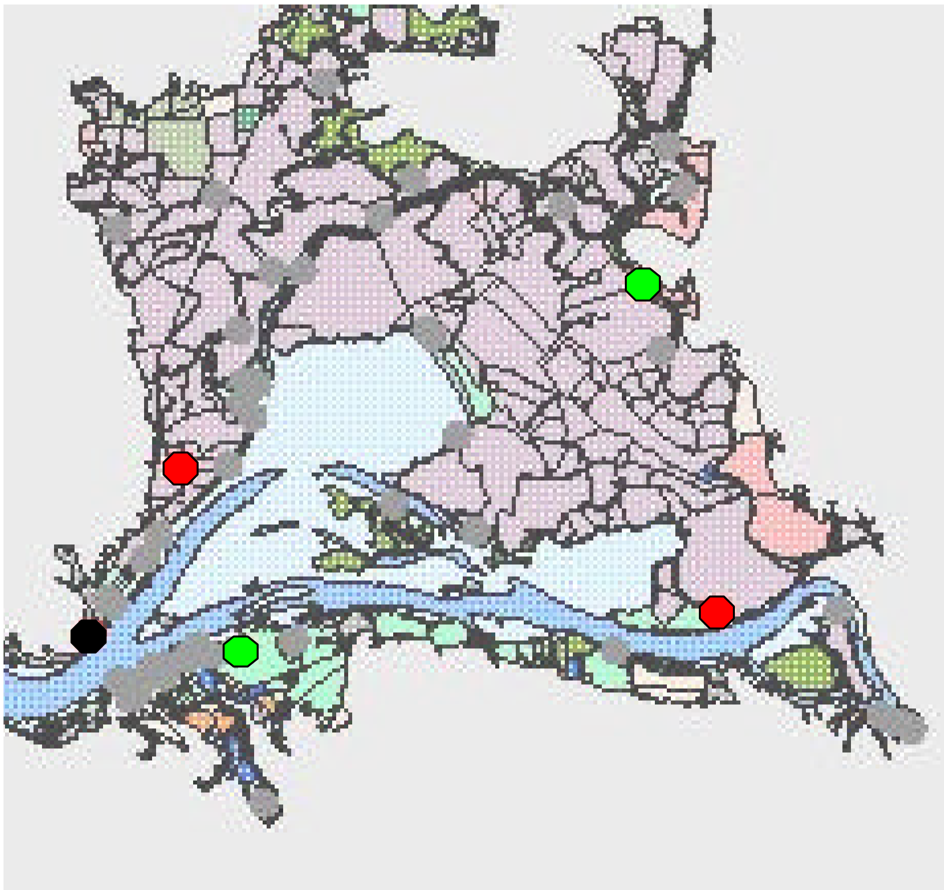






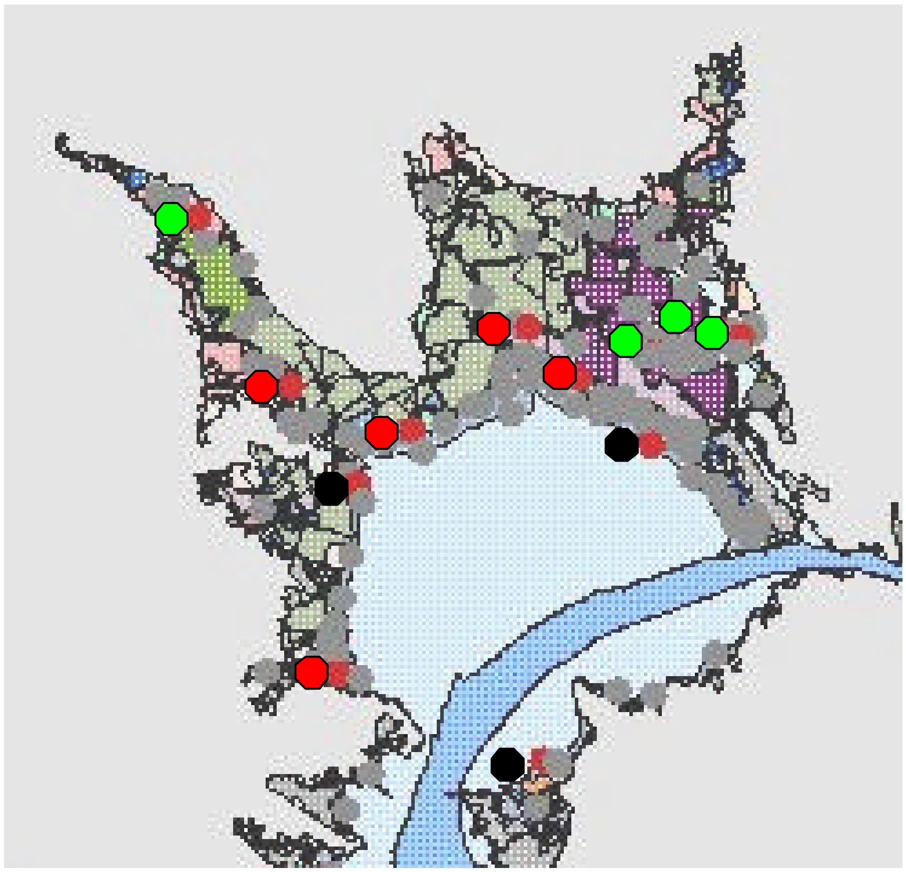
Different sets of management questions pertain to the different spatial scales. At the state level and for the project areas, the main questions are about the distribution, abundance, and size of marsh patches, including restoration and mitigation projects. Managers of the project areas also want to characterize stressors within and among watersheds, especially in the context of TMDLs. Local managers are concerned about the effects of these stressors on habitat patches, as assessed within and among drainage systems, which are viewed as the natural building blocks of tidal marshes and tidal flats. The beneficial uses of these important habitats are controlled by the conditions and functions of their internal drainage systems as linkages to their greater watersheds.

Appendix C
Suisun EMAP Sample Sites



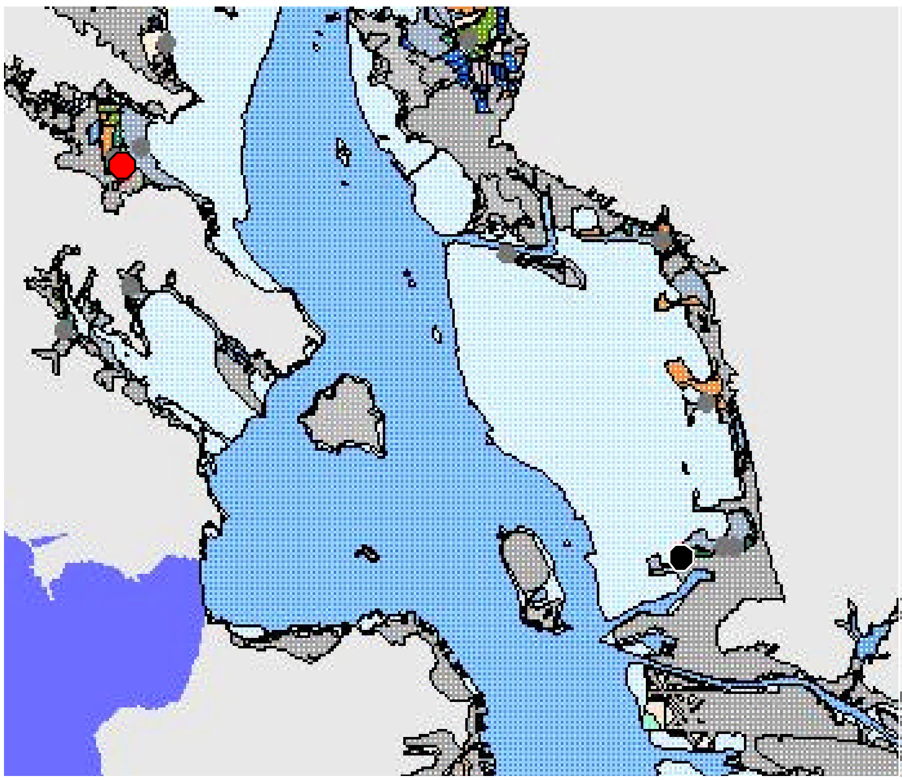
Suisun
High Marsh: 2 sites
Low Marsh: 2 sites
Tidal Flat: 1 site
(gray dots are alternative sites)

Appendix D
North Bay EMAP Sample Sites



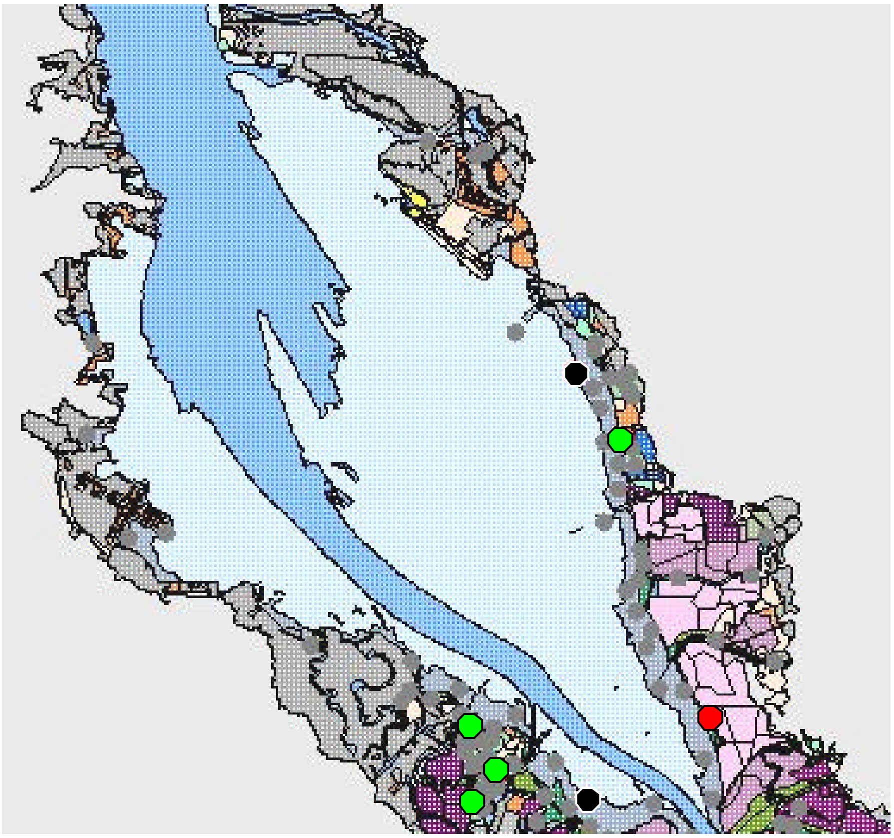
North Bay
High Marsh: 5 sites
Low Marsh: 4 sites
Tidal Flat: 3 sites
(gray dots are alternative sites)

Appendix E
Central Bay EMAP Sample Sites



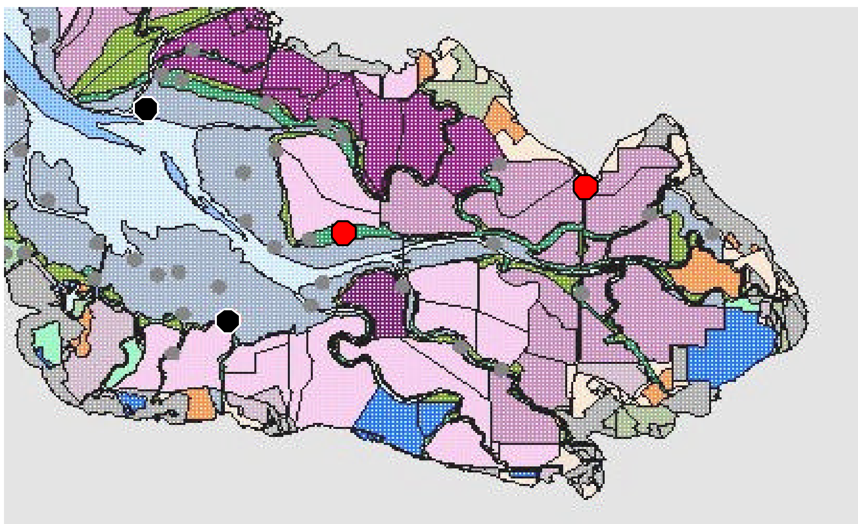
Central Bay
High Marsh: 1 site
Low Marsh: 0 sites
Tidal Flat: 1 site
(gray dots are alternative sites)

Appendix F
South Bay EMAP Sample Sites



South Bay
High Marsh: 1 site
Low Marsh: 4 sites
Tidal Flat: 2 sites
(gray dots are alternative sites)

Appendix G
Far South Bay EMAP Sample Sites



Far South Bay
High Marsh: 2 sites
Low Marsh: 0 sites
Tidal Flat: 2 sites
(gray dots are alternative sites)