7th Biennial State of the San Francisco Estuary Conference, October 4-6, 2005

Integrated Regional Wetland Monitoring Pilot Project – Overall Project Purpose

S. W. Siegel[1], P.A.M. Bachand[10], J. Lowe[2], N.M. Kelly[3], D. Stralberg[4], V.T. Parker[5], J. Callaway[6], M. Vasey[5], N. Nur[4], G. Page[4], J.N. Collins[7], M. May[7], S. Bollens[9,5], C. Simenstad[8], E. Carpenter[5], R. Dugdale[5], F. Wilkerson[5]

[1]Wetlands and Water Resources, [2]Philip Williams and Associates, [3]University of California, Berkeley, [4]Point Reyes Bird Observatory, [5]San Francisco State University, [6]University of San Francisco, [7]San Francisco Estuary Institute, [8]University of Washington, [9]Washington State University, Vancouver, [10] Bachand Associates

CALFED QUESTIONS

1. How are tidal marsh ecosystem restoration efforts throughout the region affecting ecological processes at different scales?

Have the investments made to date yielded the benefits intended for the ecosystem at large?

Have we made progress in restoring a variety of desirable ecosystem functions?

2. How best can we carry out cost-effective, informative monitoring of tidal marsh ecosystem restoration efforts to provide longer-term answers to the first question?

We need to understand how to apply our finite monitoring resources most effectively to gain the greatest insight into the fruits of our collective efforts.

IRWM PROJECT GOALS

1. **To provide initial answers to the first question above.**
2. **To determine methodological approaches at the site and regional scale for gathering and evaluating monitoring data.**
3. **To complete baseline conditions monitoring at selected field sites to form the basis of longer-term monitoring.**

IRWM APPROACH

1. Identify a set of questions important to the CALFED program (above) and create a multi-disciplinary team necessary to address those questions,
2. Create conceptual models identifying our understanding of tidal marsh ecosystems, their evolutionary trajectories, and their ecological processes,
3. Develop numerous hypotheses from these conceptual models and define regional and site-specific experimental designs.
4. Use the data generated from the experimental design to evaluate the hypotheses and conceptual models.
5. Identify potential field sites that fulfill the experimental design and obtain permission and permits to use selected field sites.
6. Implementing field data collection and analysis.

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FORMULATION OF THE IRWM INTEGRATED CONCEPTUAL MODELS

The IRWM conceptual models derive from the underlying CALFED question stated above – "*How do tidal marsh restoration efforts affect ecosystem processes at different scales?*". To formulate its conceptual models, the IRWM team drew upon principals from Pressure-State-Response models as a framework for identifying and characterizing model elements and used a tiered approach to integrate models across all project teams. The resulting conceptual models then served to inform our experimental designs at the regional scale (sites selected for the project) and at the site scale (placement of sampling stations within each site).

The Pressure-State-Response Model Framework

The Pressure-State-Response (PSR) model provides a widely used, robust framework for analyzing the interactions between environmental pressures, states and responses.

Human activities exert pressures on the environment, which can ***induce changes in the state of the environment***. ***Society then responds*** to changes in pressures or state with environmental and economic policies and programs intended to prevent, reduce or mitigate pressures and/or environmental damage.

For IRWM, we have added ***environmental responses*** to the conditions that exist, and are monitored through the measurement of biotic and abiotic indicators. Measurements of state indicators provide the information to make management responses. **Feedback mechanisms** in the marsh also create a set of natural responses that reflect outcomes of ecological processes. Marsh restoration, as a management response, addresses pressures and changes to the state of a system, resulting in changes in the ecosystem processes, a natural response.

Overarching Conceptual Model

The IRWM conceptual model framework consists of two main elements (Figure 1). The first element identifies the major forcing functions and biological outcomes important to tidal marsh restoration, and presents an overarching conceptual model of major regional, landscape, and within-site linkages. The second element is the detailed conceptual models of each IRWM biological team that are derived from and integrate with the overarching conceptual model.

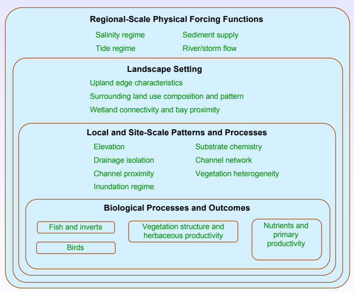


Figure 1: Elements of the IRWM integrated conceptual model relating key regional landscape- and site-scale processes to biological outcomes

Regional Forcing Functions

The physical and biological nature of every tidal wetland is fundamentally controlled by Its hydrologic and salinity regimes and by its setting within a landscape mosaic of natural and human land uses. The hydrologic regime defines the conditions in every wetland through its control on soil physical and chemical properties, habitat access and availability, and exchange of materials with waters outside the tidal marshes (Mitsch and Gosselink 2000). Salinity acts directly through physiological tolerances and requirements to control vegetation communities and water column organisms and indirectly to affect what higher trophic level species utilize tidal marshes (Weinstein and Kreeger 2001). Accretion acts to build and maintain intertidal marsh elevations (Warren and French 2001). Accretion results from deposition of suspended sediment and from accumulation of plant detritus. Suspended sediment concentrations, through its effect on water clarity, exerts control over algal primary production .

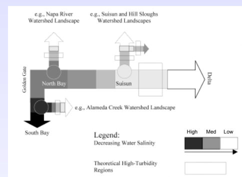


Figure 2. Diagram of primary (Golden Gate – Delta) and secondary (local watershed) salinity propagation gradients

Landscape Level Structure, Function and Change

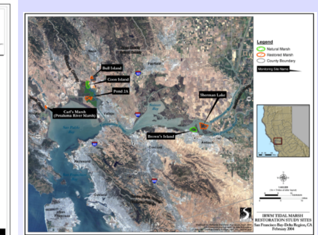
The San Francisco Estuary and Delta presents a unique setting due to its very large spatial scale, strong salinity and tidal amplitude gradients from the Golden Gate to the Delta, and extensive human modification to the landscape. Position along the estuarine salinity and tidal range gradients and proximity to sediment sources exert a strong control over the interacting biological and physical processes that affect tidal marsh restoration evolution and the resultant effects on ecological processes that support target biological resources. Figure 3 illustrates the estuarine salinity gradient element of this conceptual model.

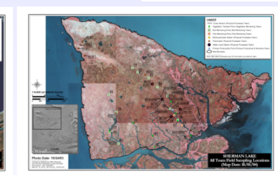
At landscape level, this conceptual model identifies landscapes in San Pablo and Suisun bays and the Delta by their structure (the spatial relationship among distinct wetland patches or their elements), their function (the flow of mineral nutrients, water, energy, or species among component patches or between landscapes), and change (the temporal alterations in the structure and function of landscapes or their components). Our premise is that the structure, function and change of patches across landscape mosaics affect fundamental ecosystem processes, which determine the trajectories of wetland restoration.

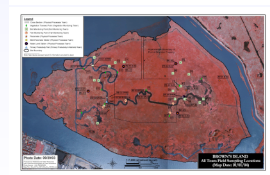
Local and Site-Scale Patterns and Processes

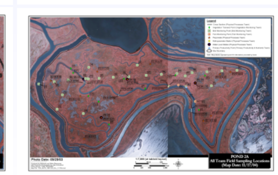
At this scale, physical processes, geomorphology, and vegetation heterogeneity define and control l the environmental conditions and architecture of the habitats available for marsh flora and fauna and provide feedback mechanisms for biological processes. **Inundation regime** is the single most important process affecting marsh ecology as **elevation,** tide regime, river and storm flows, **channel proximity, drainage isolation,** and **vegetation** collectively control and define the inundation regime (frequency, depth, and duration of inundation). **Channel network structure** controls two important aspects in tidal marshes – habitats for fauna and flora and the circulatory system for exchanging materials within a marsh and between its outside waters (Allen 2000, French and Reed 2001, Siegel 2002). **Substrate chemistry** along with the **inundation regime** controls the growing environment for marsh vegetation (Mahall and Park 1967a,b,c) , and the resulting **vegetation heterogeneity** defines the three-dimensional marsh architecture that provides habitats for birds, small mammals, and terrestrial invertebrates (Allen 2000, Mitsch and Gosselink 2000, Weinstein and Kreeger 2000).

FIELD SITE SAMPLING LOCATION MAPS









Acknowledgements

There is a long list of technicians, graduate students, and project managers we need to acknowledge who's hard work in the field and laboratory was integral to the success of this project.

This project is funded by the California Bay-Delta Authority Science Program