

**DEVELOPING  
A HYDROGEOMORPHIC APPROACH  
FOR ASSESSING WETLAND FUNCTIONS  
FOR TIDAL AND NON-TIDAL WETLANDS IN THE  
SAN FRANCISCO BAY-DELTA**

**FOR RESTORATION MONITORING  
AND ADAPTATIVE MANAGEMENT DECISION-MAKING**

**CALFED BAY-DELTA PROGRAM  
1997 CATEGORY III**

*Services-Habitat Restoration Assessment*

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## EXECUTIVE SUMMARY

**TITLE:** *DEVELOPING A HYDROGEOMORPHIC APPROACH FOR ASSESSING WETLAND FUNCTIONS FOR TIDAL AND NON-TIDAL WETLANDS IN THE SAN FRANCISCO BAY-DELTA*

**APPLICANT:** San Francisco State University, Romberg Tiburon Center (PI: Michael Josselyn, Ph.D.)

**PROJECT**

**OBJECTIVES:** The project goal is to develop a consistent, rapid habitat assessment method to achieve the following objectives:

- Assessment of the functions in existing tidal and seasonal wetlands
- Evaluation of restoration plans for tidal and seasonal wetlands
- Monitoring the success of implemented projects within the CalFed program
- Providing methodology for adaptive management decision-making

These objectives will be met through the development of Regional Guidebooks to the Hydrogeomorphic Assessment Methodology (HGM) for tidal wetlands and seasonal wetlands in the San Francisco Bay-Delta Estuary.

**APPROACH:** The proposed approach is based on the National Action Plan for HGM recently published by the Corps of Engineers (Federal Register 62:119 (Notices)). This approach utilizes guidance from National Guidebooks to tidal fringe wetlands and depressional (seasonal) wetlands as the basis for collecting and calibrating data from SFB reference wetlands. The reference data can then be used to refine assessment formulas so that relative indices can be developed. This project will do the following:

- Collect and collate available scientific literature on San Francisco Bay tidal and seasonal wetlands
- Select and evaluate reference wetlands of both hydrogeomorphic types
- Develop assessment formula consistent with National Guidebooks for these hydrogeomorphic types
- Follow the National Action Plan steps for the adoption of the Regional Guidebooks
- Utilize local scientific and regulatory expertise in the review and completion of the guidebooks

**JUSTIFICATION FOR**

**CALFED FUNDING:** It is essential at this stage of the CalFed program to develop this methodology. The HGM methodology will assist the CalFed program in evaluating restoration projects by identifying degraded wetlands based on relative indices of wetland function as determined from full functioning reference wetlands. It will also be a valuable tool in assessing the success of restoration efforts through the application of HGM over time. Because the HGM method is supported on a National level, the Regional Guidebooks will benefit from work being done elsewhere and will be consistent with wetland restoration programs throughout the nation. Finally, HGM can be incorporated within the long-term Comprehensive Monitoring, Assessment, and Research Program. The project proposed here will be consistent with this approach as it will provide baseline data from *reference wetlands* that can be utilized in a variety of monitoring efforts.

**BUDGET COST:** \$283,000 total for 2 years based on federal indirect cost rate.

**APPLICANT**

**QUALIFICATIONS:** San Francisco State University has the only University based research center on San Francisco Bay: the Romberg Tiburon Center. Dr. Michael Josselyn has been affiliated with Center since 1978 and has published extensively on the tidal wetlands of San Francisco Bay including a *San Francisco Bay tidal marshes: a Community Profile* published by the US Fish and Wildlife Service and the Corps of Engineers. Dr. Josselyn has published extensively on San Francisco Bay wetlands with a particular focus on wetland restoration. Dr. Josselyn has been a member of the National Team for the development of HGM for Tidal Fringe Wetlands.

**MONITORING  
EVALUATION:**

The project will be consistent with the National Action Plan (see Fed Reg. 62:119). It will be coordinated with the Corps of Engineers at Waterways Experiment Station. The final report will be consistent with WES guidelines and the outline required for Regional Guidebooks. A full description of the methodology used, the basis for calibration, and the verification methods will be provided. The use of an A-team of experts and the review in a Workshop format mid-way through the project will assure full review of this project.

**COORDINATION  
WITH OTHER  
PROGRAMS:**

The proposed work will be conducted within the format recommended by the National Action Plan for HGM. This Action Plan is being implemented by six federal agencies including the Corps, USFWS, NMFS, and EPA. The format requires advice and consultation with regional experts and regulatory staff to approve the final Regional Guidebooks.

## **PROJECT DESCRIPTION AND APPROACH**

The purpose of the proposed work is to develop a consistent habitat assessment method for:

- **Assessment of status of existing, degraded tidal and seasonal wetlands**
- **Evaluation of restoration plans for tidal and seasonal wetlands**
- **Monitoring success of implemented projects within the CalFed program**
- **Provide methodology for adaptive management decision-making**

The proposed assessment method has recently been announced as a National Action Plan by the Corps of Engineers (Federal Register: June 20, 1997) for the purpose of assessing wetland function. The National Action Plan to Implement the *Hydrogeomorphic Approach for Assessing Wetland Functions* identified a strategy that the US Army Corps of Engineers, US Department of Agriculture, US Environmental Protection Agency, US Fish and Wildlife Service, Federal Highway Administration, and the National Oceanic and Atmospheric Agency will follow to implement the Hydrogeomorphic Approach (HGM) through the development of Regional Guidebooks.

This proposal is consistent with the National Action Plan and proposes the development of two regional guidebooks:

- ***Hydrogeomorphic Assessment Method for Tidal Marshes of San Francisco Bay***
- ***Hydrogeomorphic Assessment Method for Seasonal Wetlands of San Pablo and Suisun Bays***

Work by this proposer has already been initiated on the first assessment method as part of a National Guidebook and will be developed to completion for the Regional Guidebook. Work on seasonal wetlands will be undertaken consistent with the National Guidebook on Depressional Wetlands and will be completed for the Regional Guidebook with local data and literature information.

The HGM approach is a procedure for measuring the capacity of a wetland to perform functions. It was designed to satisfy the need for better information on wetland functions compared to previous methodologies such as HEP and WET. Information obtained using HGM can assist in assessing the level of functioning of a wetland site, develop restoration strategies to improve wetland functioning and to assess restoration projects after completion. HGM is based on classification of wetlands based on their hydrogeomorphic characteristics (i.e. landscape setting, water source, hydrodynamics) and then uses reference wetlands and data to establish the range of functioning of the wetland. The outcome of the application of HGM is to

**assess wetland functions based on and calibrated with reference wetlands. HGM utilizes reference wetlands as the means for establishing the scale, or index, against which other wetlands can be compared to determine their functional capacity.**

**The basic approach to the project to collect scientific information relevant to the development of Regional Guidebooks and to develop formulas and assessment protocols for the application of HGM in the San Francisco Bay-Delta Estuary. The project will:**

- **Collect and collate available scientific literature on San Francisco Bay tidal and seasonal wetlands**
- **Select and evaluate reference wetlands of both hydrogeomorphic types**
- **Develop assessment formulae consistent with National Guidebooks for these hydrogeomorphic types**
- **Follow the National Action Plan steps for the adoption of the Regional Guidebooks**
- **Utilize local scientific and regulatory expertise in the review and completion of the guidebooks.**

**The outcome of this project will be two Regional Guidebooks for Tidal Wetlands and Seasonal Wetlands along with guidance on their use and application to the CalFed program. The Guidebooks will allow the use of remote sensed data and easily collected field data to develop functional evaluation of both existing and restored wetlands.**

## **GEOGRAPHIC BOUNDARIES OF THE PROJECT**

**For this proposal, two hydrogeomorphic classes of wetlands have been selected:**

- **Tidal fringe wetlands (tidal salt marshes of San Francisco, San Pablo, and Suisun Bays)**
- **Depressional wetlands (seasonal wetlands of San Pablo and Suisun Bays)**

**These wetland types are the most likely to be evaluated and restored by the CalFed Program and therefore are in need of assessment both before, during, and after project completion. The Regional Guidebooks to be developed in this effort will have application to other geographic areas and may be used in south San Francisco Bay, Humboldt Bay, and southern California wetlands with modifications.**

**The reference wetlands for this effort will include tidal and seasonal wetlands along the margins of central San Francisco Bay, San Pablo Bays, and Suisun Bays and may include areas under consideration for restoration implementation by the CalFed program.**

## **BACKGROUND AND TECHNICAL JUSTIFICATION**

**The primary goal for development of the Regional Guidebooks is to provide a standardization tool for consistently assessing wetland functions in San Francisco Bay tidal and seasonal wetlands. The HGM Guidebooks will use the best available technical and scientific information and maintain compatibility with the National Action Plan.**

**HGM is based on collection of data (either literature or new field data) from reference wetlands and applying those data to development of assessment criteria for various wetland functions. For example, sediment accumulation or deposition is a wetland function associated with tidal wetlands. This function is based, in part, on the elevation of a marsh, the frequency of its inundation, the location in relation to the sediment source, and the density of vegetation. Based on data collected or known for reference wetlands, a simple formula can be written that provides a relative ranking for sediment accumulation in a wetland based on the presence of these factors. Many of these formulas have been developed in draft form in National Guidebooks developed by the Corps of Engineers. However, they need to be refined and calibrated based on local data from reference wetlands.**

**The application of HGM to non-reference wetlands is designed to be straightforward and consistent. Data that can be readily collected or observed (either from aerial photographs or simple field observations) can then be placed in standardized spreadsheets that be calculated quickly and consistently based on the formulas developed from the reference wetlands. Relative rankings can then be determined for these non-reference wetlands.**

**The power of HGM is inherent in the development of the assessment using reference wetland data. Generally, twenty or more reference wetlands are evaluated and the formulas calibrated to these wetlands. In addition, 7 to 12 wetland functions are being evaluated so that wetlands are not ranked solely on a few attributes.**

**The benefits to the CalFed program are consistent with its objectives to restore tidal and seasonal wetlands to *improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species*. The proposed project, if approved and undertaken, will allow the CalFed program to:**

- Develop and utilize an assessment tool that is consistent with the National Action Plan for assessing wetlands as recently announced in the Federal Register**
- Develop a list of attributes and functions for tidal and seasonal wetlands that is consistent with National Guidance and is regionalized for San Francisco Bay wetlands**
- Provide target functions for tidal and seasonal wetland restoration through the**

- **study of reference wetlands in the San Francisco Bay region**
- **Provide a tool for evaluation of wetland functions prior to restoration, during restoration planning, and after project implementation.**
- **Assist in developing an Adaptive Management Strategy for future wetland restoration projects.**

**It is essential at this stage of the CalFed program to develop this methodology. It is understood that CalFed is developing guidelines for long-term Comprehensive Monitoring, Assessment, and Research Program. The project proposed here will be consistent with this approach as it will provide baseline data from *reference wetlands* that can be utilized in a variety of monitoring efforts.**

### **PROPOSED SCOPE OF WORK**

**The scope of work follows the guidance in the National Action Plan. Technical support and coordination for the development of the HGM Approach is being provided by the US Army Corps of Engineers Waterways Experiment Station. To facilitate development of Regional Guidebooks, WES will develop necessary support documents, technical information, and training materials. However, WES cannot support full development of the Regional Guidebooks and looks to local and state governments to assist in this area.**

**The HGM approach proposed here has the following steps as described in the National Action Plan:**

- ***Select members of an advisory team (A-team) to assist in selection of wetland functions, reference sites, and review of the selected formulas for the HGM method. No specific members have been identified at this time, but will include at least six individuals representing resource agencies, academia, and environmental services. These individuals will be experts in wetland ecology of San Francisco Bay.***
- ***Identify regional wetland subclasses and define reference domains. This step has already been completed, in part, by the proposer. Dr. Josselyn has participated with the National Team on Tidal Fringe Wetlands and has developed the Regional Profiles for San Francisco Bay wetlands (Corps of Engineers, Draft National Guidebook to Tidal Fringe Wetlands). Two subclasses will be developed in this proposal: Tidal Fringe Wetlands and Depressional (Seasonal) Wetlands.***
- ***Identify reference wetlands sites. For the two wetland types, various reference wetlands will be selected that are representative of the closest wetlands in the estuary that are naturally functioning and undisturbed. Given***

that the estuary is urbanized, pristine wetlands are not likely to be found. Dr. Josselyn has already conducted initial work on HGM in several tidal reference wetlands such as Corte Madera Ecological Reserve, China Camp, Southampton Marsh, Rush Ranch, and Lower Sherman Island and presented these results in several presentations. Additional sites will be identified with the A-team members. Seasonal wetland sites will also be selected.

- ***Identify and define functions for each tidal and seasonal wetlands.*** The National Guidebooks to Tidal Fringe Wetlands and Depressional Wetlands have developed initial formulas for these wetland types. Approximately 12 functions have been defined and formulas developed. The A-team will review these formulas and with literature data for San Francisco Bay wetlands (to be developed by SFSU), a definition for each wetland function will be developed that includes readily measured or observed geomorphic characteristics.
- ***Identify and define variables and construct assessment models.*** The assessment models are simple mathematical formulas that take readily observed features (i.e. vegetation density, elevation of marsh surface, density of marsh channels, watershed of seasonal wetland, or duration of seasonal ponding) to determine an indice of between 0 and 1 for each wetland function. Many of these formulas have been developed in the National Guidebooks and need refinement to San Francisco Bay-Delta systems.
- ***Conduct interagency and interdisciplinary workshops to critique models.*** A workshop will be held at the Romberg Tiburon Center to introduce HGM, provide background to the project, and request input on the use of the specific models developed for San Francisco Bay tidal and seasonal wetlands. Agency staff, academics, and environmental services personnel will be invited to attend.
- ***Collect data from reference wetlands sites and establish reference standards.*** Aerial photographs and field visits to reference wetlands will be undertaken by SFSU staff to collect the necessary data to complete the entry of data into the assessment formula. As noted above, approximately 20 sites (10 tidal and 10 seasonal wetlands) will be included in this initial reference domain. Data will be collected in standardized format for entry into spreadsheet formulas.
- ***Calibrate assessment models using reference wetland data.*** The primary goal of the assessment method is to develop functional indices for wetlands that are between 0 and 1, with 0 being lowest and 1 being highest for that function. The formulas will be adjusted and weighted so that high value reference wetlands will be at or near a value of 1.
- ***Verify and validate the assessment models.*** The formulas will be tested

against degraded wetlands to determine their sensitivity to modifications in the sites.

- **Complete draft Regional Guidebooks.** Draft Regional Guidebooks will be completed based on the Corps of Engineers guidance for such books. These guidebooks will be distributed to the A-team members and to agency staff, including Corps-WES for comment.
- **Complete final Regional Guidebooks.** Based on the comments from the A-team and other reviewers, the final guidebooks will be completed and published.

## **MONITORING AND DATA EVALUATION**

The project will be consistent with the National Action Plan. It will be coordinated with the Corps of Engineers at WES. The final report will be consistent with WES guidelines and the outline required for Regional Guidebooks (see Fed Reg. 62:119). A full description of the methodology used, the basis for calibration, and the verification methods will be provided. The use of an local experts and the review in a Workshop format mid-way through the project will assure full review of this project.

## **IMPLEMENTABILITY**

The proposed work is in compliance with the Final Rule on the National Action Plan for the use of HGM to assess wetland functions as issued by the Corps of Engineers. Dr. Josselyn is part of the National Assessment Team for the Tidal Fringe Wetland program development and will coordinate all efforts with the Corps-WES staff. This project will be conducted with advisement from local experts representing a variety of agencies and research organizations.

All field work will be conducted with appropriate access and collecting permits from the California Department of Fish and Game and US Fish and Wildlife Service.

Once the Regional Guidebooks are published, SFSU is willing to act as a Training Center to provide expert training to those individuals requiring instruction in HGM. The University already provides training in wetland delineation, wetland ecology, and wetland restoration at the Romberg Tiburon Center.

**COST AND SCHEDULE**

**Budget**

The estimated budget for this work is based on standard University policies as they relate to federally sponsored research. The primary costs are associated with faculty and student salaries, A-team expenses and fees, field data collection, and publication costs.

A proposed budget for the two year project is provided below:

| <b>SALARIES AND WAGES</b>                  |  |             |         |          |        |                  |                  |                  |
|--|--|-------------|---------|----------|--------|------------------|------------------|------------------|
| <b>SALARIED EMPLOYEES</b>                  |  |             |         |          |        |                  |                  |                  |
|  |  | BASE SALARY | % TIME  | SALARY   | FRINGE | YR01             | YR02             | TOTAL            |
| PROF D-4                                   | Michael Josselyn (Academic Year)                             | \$65,394    | 20%     | \$13,079 | 38%    | \$18,049         | \$18,590         | \$36,639         |
|  | Michael Josselyn (Summer)                                    | \$13,079    | 20%     | \$2,616  | 12%    | \$2,930          | \$3,018          | \$5,947          |
| <b>HOURLY EMPLOYEES</b>                    |  |             |         |          |        |                  |                  |                  |
|  |  | HOURLY RATE | # HOURS | WAGES    | FRINGE |                  |                  |                  |
|  | A-Team members (6 x 40 hours each)                           | \$80.00     | 240     | \$19,200 |        | \$19,200         | \$19,776         | \$38,976         |
|  | Graduate assistants (1 GA's at half time)                    | \$14.60     | 1040    | \$15,184 | 38%    | \$20,954         | \$21,583         | \$42,536         |
|  | Field assistants (summer intern students)                    | \$12.25     | 1200    | \$14,700 | 12%    | \$16,464         | \$16,958         | \$33,422         |
| <b>TOTAL SALARIES, WAGES, AND BENEFITS</b> |  |             |         |          |        | <b>\$77,596</b>  | <b>\$79,924</b>  | <b>\$157,521</b> |
| <b>SUPPLIES AND SERVICES</b>               |  |             |         |          |        |                  |                  |                  |
|  | Local transportation   |             |         |          |        | \$2,000          | \$2,060          | \$4,060          |
|  | Field supplies and aerial photographs for reference wetlands |             |         |          |        | \$8,000          | \$3,000          | \$11,000         |
|  | Workshop expenses  |             |         |          |        | \$3,000          | \$2,000          | \$5,000          |
|  | Telecommunications   |             |         |          |        | \$500            | \$500            | \$1,000          |
|  | Office supplies  |             |         |          |        | \$500            | \$500            | \$1,000          |
|  | Travel to National meeting on HGM                            |             |         |          |        | \$2,000          | \$2,000          | \$4,000          |
| <b>TOTAL DIRECT COSTS</b>                  |  |             |         |          |        | <b>\$93,596</b>  | <b>\$96,404</b>  | <b>\$190,001</b> |
| <b>TOTAL INDIRECT COSTS @</b>              |  | <b>49%</b>  |         |          |        | <b>\$45,862</b>  | <b>\$47,238</b>  | <b>\$93,100</b>  |
| <b>TOTAL PROJECT COSTS</b>                 |  |             |         |          |        | <b>\$139,459</b> | <b>\$143,642</b> | <b>\$283,101</b> |

Dr. Michael Josselyn will be the principal investigator. One graduate assistant will be assigned to this project. Student interns will be used for field work help during the summer months. The University overhead rate of 49% is the approved audited rate for federal contracts. State-sponsored research may have other applicable indirect cost rates.

## Schedule

The schedule for completion of this work is 2 years from initiation. An estimated schedule is given below (with estimated completion dates):

|                 |  |
|-----------------|--|
| November 1997:  | Start project and select A-team members  |
| January 1998:   | A-team meeting to review scope and HGM procedures  |
| March 1998:     | Complete selection of reference sites and wetland functions to be evaluated and meet with A-team |
| May 1998:       | Identify and define variables and construct formulas and meet with A-team                        |
| June 1998:      | Hold Interagency Workshops   |
| December 1998:  | Complete data collection at reference sites  |
| March 1999:     | Validate assessment models and meet with A-team  |
| June 1999:      | Publish Draft Regional Guidebooks  |
| September 1999: | Complete responses to comments and meet with A-team  |
| November 1999:  | Final Regional Guidebooks published.   |

## Third Party Impacts

No third party impacts are anticipated from this project.

## APPLICANT QUALIFICATIONS

San Francisco State University has the only University based research center on San Francisco Bay: the Romberg Tiburon Center. Dr. Michael Josselyn has been affiliated with Center since 1978 and has published extensively on the tidal wetlands of San Francisco Bay including a *San Francisco Bay tidal marshes: a Community Profile* published by the US Fish and Wildlife Service and the Corps of Engineers. Dr. Josselyn has published extensively on San Francisco Bay wetlands with a particular focus on wetland restoration. Dr. Josselyn has been a member of the National Team for the development of HGM for Tidal Fringe Wetlands.

Michael Josselyn received his Ph.D. from the University of New Hampshire in 1978, his Master's degree from the University of Miami in 1975, and his Bachelor's degree in Biology from Cornell University in 1972. He has been a faculty member at San Francisco State University since 1978, serving as Director of the University's field station at Tiburon from 1982 to 1989. He holds a dual appointment as Professor and Senior Research Scientist at the Romberg Tiburon Centers and teaches courses in estuarine and wetland ecology.

His research interests focus on wetland ecology and restoration. Dr. Josselyn maintains an active research program receiving grants and contracts from federal

and state agencies to investigate issues on wetland restoration effectiveness, wetland and riparian habitat management plans, and general wetland ecology. His work has been published in *Wetlands*, *Aquatic Botany*, *Estuaries*, and *Estuarine and Coastal Shelf Science*. Dr. Josselyn is also well known for his work on exotic species in San Francisco Bay wetlands, particularly *Spartina* spp.

He has lectured throughout the United States on wetland restoration techniques and regulatory issues. Dr. Josselyn is a Certified Professional Wetland Scientist, a Fellow of the California Academy of Sciences and a member of the National Research Council Panel on Coastal Oceans. He recently participated in a national panel on the efficacy of restoration efforts for the Louisiana Delta.

**Selected publications (from list of 50)**

Josselyn, M.N. (ed) 1982. Wetland restoration and enhancement in California. California Sea Grant College Program. Report #T-CSGCP-007. 116pp.

a. Josselyn, M.N. and J. Buchholz, Summary of past wetland restoration projects in California. pp1-10

b. Zedler, J.; Josselyn, M.; and Onuf, C. Restoration, techniques, research, and monitoring: vegetation. pp63-72.

Josselyn, M.N. 1983. Estuarine tidal marshes of San Francisco Bay: a community profile. US Fish and Wildlife Service, Division of Biological Services, Washington, DC FWS/OBS-83/23. 102pp.

Josselyn, M., J. Zedler, and T. Griswold. 1989. Wetland mitigation along the Pacific Coast of the United States. pp 1-36. In: Kusler, J. and M.E. Kentula (eds) *Wetland Creation and Restoration: The status of the science*. Vol 1. Environmental Protection Agency, Washington DC. EPA 600/3-89/038a.

Josselyn, M., S. P. Faulkner, and W.H. Patrick, Jr. 1990. Relationships between seasonally wet soils and the occurrence of wetland plants in California. *Wetlands* 10:7-26.

Boesch, D.F., M.N. Josselyn, A.J. Mehta, J.T. Morris, W.K. Nuttle, C.A. Simenstad, D.J.P. Swift. 1994. Scientific assessment of coastal wetland loss, restoration, and management in Louisiana. *Journal of Coastal Research*. 20:1-103.

**References:**

E.J. Clairain, Jr. US Army Waterways Experiment Station, Vicksburg, MS.  
Reed Holderman, State Coastal Conservancy, Oakland, CA