SEDIMENT DYNAMICS IN RESTORED MARSHES OF SOUTH SAN FRANCISCO BAY

Prepared for:

California Coastal Conservancy

Prepared by:

University of San Francisco
H. T. Harvey & Associates

Proposal # 5543A
December 2008

UNIVERSITY of SAN FRANCISCO

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

South Bay Salt Pond
Restoration Project
Restoring the Wild Heart of the South Bay

Restoration Funding Application
Cover Sheet

APPLICANT INFORMATION

Name of Organization(s) Requesting Funding: University of San Francisco and H.T. Harvey & Associates

Mailing Address: 2130 Fulton St., San Francisco, CA 94117

Federal Employee Identification Number: 94-1156628

Principal Investigator: John Callaway

Title: Assoc. Professor Institution: University of San Francisco

Telephone: 415.422.5702 Email address: callaway@usfca.edu

Grant Administrator: Pam Miller

Telephone: 415.422.5368 Email address: pmiller@usfca.edu

PROJECT INFORMATION

RFP Study Topic # 1

Project Title Sediment Dynamics in Restored Marshes of South San Francisco Bay

Funding Request per year $ 37,181 (yr 1), $ 21052 (yr 2) Number of years: 2

Confirmed in-kind or matching contributions: $ 0

Source of in-kind or matching contributions:

Purpose and Objectives: to identify threshold elevations for vegetation establishment in newly restored salt ponds in south San Francisco Bay and to measure sedimentation rates in these ponds so that better estimates of the time and conditions of vegetation recruitment for future pond restoration efforts will be possible.

Proposed starting date: July 1, 2009 Estimated completion date: December 31, 2011

Signature : [signature] Date: 12/5/08
Principal Investigator

Signature : [signature] Date: 12/5/08
Grant Administrator

VEGETATION THRESHOLDS AND SEDIMENT DYNAMICS IN RESTORED MARSHES OF SOUTH SAN FRANCISCO BAY

2. Proposal

Abstract

The University of San Francisco (USF) is submitting a joint proposal with H. T. Harvey & Associates (HTH) for the California Coastal Conservancy (Conservancy) to implement monitoring of sediment dynamics and to identify elevation thresholds for vegetation establishment in support of the South Bay Salt Pond Restoration project. The proposed sediment monitoring will occur at Ponds A6 and will augment current studies in progress at the Island Ponds; surveys of elevations for vegetation establishment will occur at Ponds A6 and A21. The proposed research will provide insight into conditions that are necessary for vegetation establishment and habitat evolution (priority research topic #1) and will increase our understanding of spatial variability in natural sediment accretion rates that will be critical in future restoration planning. Our proposal is complementary to proposed research that focuses directly on mapping of habitats using satellite imagery (submitted by SFEI, HTH, & USF). Our proposal will provide direct answers to the following specific questions from the RFP:

- *Will natural sediment accretion in restored tidal areas be adequate to create and to support emergent tidal marsh ecosystems, and will natural sediment movement into restored tidal areas significantly alter habitat area in the South Bay?*

Background and Justification

The South Bay Salt Pond (SBSP) Restoration Project encompasses approximately 15,100 acres of former salt ponds located around the edge of South San Francisco Bay, and is the largest proposed wetlands restoration project on the West Coast of the United States. The SBSP Project will restore and enhance wetlands in South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation.

In 2003, Cargill Inc. (Cargill) the owner of the commercial salt production facilities in the Project Area, sold the ponds to the U. S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG), with the USFWS acquiring 9,600 acres in two complexes, one at the western end of Dumbarton Bridge (the Ravenswood pond complex) and one along the Bay from Mountain View to Fremont (the Alviso pond complex) and CDFG acquiring the remaining 5,500 acres just south of the eastern end of the San Mateo Bridge (the Eden Landing pond complex).

The SBSP Project will be implemented in a series of phases over many years. The initial phase, Phase 1, includes restoration of a number of habitat types, including tidal habitat, enhanced managed ponds, and reconfigured managed ponds. In addition, early experiments for adaptive management have been designed to answer key uncertainties related to the restoration. The proposed research will be completed at Pond A6, which is targeted for restoration under the Phase 1 actions, as well as at Pond A21 (part of the Island Ponds, breached in 2006).

Pond A6 will be restored to tidal habitat by breaching and lowering the outboard levee, excavating pilot channels through the fringe marsh outboard of the breaches, and constructing ditch blocks in the perimeter borrow ditch Since the time Pond A6 was originally leveed to create a salt pond, it has subsided by approximately 5 ft (1.5 m) to an average elevation of 2.3 ft NAVD (0.70 m NAVD). The elevation of Pond A6 is below MTL (3.3 ft NAVD or 1.0 m NAVD) and below the elevation at which marsh vegetation typically colonizes emerging mudflats. The Pond A6 restoration will initially create large areas of emergent mudflat habitat. Over time, tidal channel and vegetated salt marsh habitats are expected to develop in Pond A6 as tidal channels reform and as sediment accumulates and vegetation establishes on the emerging mudflats.

Understanding Sediment Accretion in Restored Marshes

Natural sedimentation is a key component of habitat creation and restoration within the project. As ponds are restored to tidal action, sediments are expected to gradually accumulate within and outside of the restored ponds. The rate at which sedimentation occurs will determine the rate at which the marsh develops sufficient elevation to sustain tidal marsh plants. In order to make these determinations, several questions will need to be addressed and these questions form the basis of our hypotheses (below).

Understanding sediment accumulation within restored ponds is critical because sedimentation drives elevation change in intertidal habitats, along with sea-level rise and *in situ* organic matter production (Morris et al. 2002). Models have conceptualized the link between elevation, tidal inundation, and sedimentation rates (Krone 1987, French 1993), with the clear hypothesis that areas at lower elevations accumulate sediment more rapidly due to longer periods of tidal inundation. This has important implications for subsided ponds, with the prediction that “young” sites at low elevations will accumulate sediment most rapidly (e.g., see Figure 3 in Williams and Orr 2002). Data have been collected from San Francisco Bay marshes to evaluate this relationship (Williams and Orr 2002); however, a more quantitative understanding of this relationship is needed to fine tune predictions of the time period necessary for ponds to reach elevations appropriate for vegetation establishment. In addition, spatial variation in sediment processes within ponds is due not just to elevation, but to other factors including the distance from a tidal creek, suspended sediment concentrations, etc.

There are also concerns that the breaching of large salt ponds will create new sediment sinks that could shift sediment dynamics within the South Bay, potentially reducing sedimentation rates or eroding of sediments from adjacent marshes, mudflats, and creeks. These existing areas offer habitat for endangered species as well as foraging areas for large migratory bird populations, and their preservation is a concern for the Project.

Understanding sedimentation at Pond A6 is particularly important for the design of future tidal restoration phases of the SBSP Restoration project. Restoration design features such as the use of ditch blocks (to guide restored tidal flows into remnant slough channels instead of the deeper perimeter borrow ditches) and external levee lowering may influence the sedimentation patterns within a restored pond. The Island Pond restoration did not utilize either of these restoration techniques, while Pond A6 will use both methods. Furthermore, even within Pond A6, two external breaches will have ditch blocks (LB-GN and LB-AN) and the other two external breaches (LB-GS and LB-AS) will not. This study will enable us to better understand the implications on sedimentation patterns of installing ditch blocks in our tidal restoration projects.

Critical Elevations for Vegetation Establishment

Tidal marsh vegetation is highly sensitive to inundation rates and salinity, both of which are directly affected by relative elevation (relative to water/tidal elevation). Shifts in elevation of 10 cm or less cause changes in dominant plant communities within Pacific Coast tidal wetlands (Zedler et al. 1999, Sanderson 2000). Newly establishing vegetation is likely to be even more sensitive to inundation and salinity, given increased stresses on plants at germination and in early phases of growth. Inundation rates at a particular location within the marsh will be affected by the local tidal range (which increases substantially at the south end of the Bay [PWA 2006]), elevation, the proximity to tidal creeks, and any local features such as pans, natural levees, etc., that may impede drainage.

Given these sensitivities, it is critical to identify threshold elevations for plant recruitment across a range of tidal wetlands. Different plant species clearly have strong differences in terms of the elevation at which they occur in well developed marshes (Zedler et al. 1999, H. T. Harvey & Associates 2005, Schile et al. unpublished data from North San Francisco Bay), and this gives a good indication of where and when species are likely to establish in restored marshes. However, thresholds for recruitment may vary substantially from elevations within natural marshes, as plants spread vegetatively across elevations and substantial changes in elevation may occur as marshes develop and accumulate sediment. Therefore, it is not possible to directly predict elevations for recruitment in developing marshes from distributions of vegetation in well-developed natural marshes. Rather, it is essential to measure actual elevations for plant recruitment.

Justification for Research

Applied research studies such as this one will help to answer questions regarding key project uncertainties related to ecosystem restoration. Monitoring of sediment dynamics and vegetation recruitment in restored ponds will be an important component of the Adaptive Management Program in order to fully assess habitat and geomorphic evolution of restored marshes. The results of this monitoring will be valuable to inform restoration decisions in future phases of the restoration project. The proposed research will increase our understanding of spatial variability in natural sediment accretion rates that will be critical in future restoration planning and provide insight into conditions that are necessary for vegetation establishment and habitat evolution (priority research topic #1) and is complementary to proposed research that focuses directly on habitat mapping over time (submitted by SFEI, HTH, & USF). This proposal will provide direct answers to the following specific questions from the RFP:

- *Will natural sediment accretion in restored tidal areas be adequate to create and to support emergent tidal marsh ecosystems, and will natural sediment movement into restored tidal areas significantly alter habitat area in the South Bay?*

The information collected from this study will provide data to assist in management decisions for future pond restoration and will assist in management decisions to further SBSP Restoration Objective #1: to create, restore, or enhance habitats of sufficient size, function, and appropriate structure to promote restoration of native special-status plants and animals that depend on South Bay habitat for all or part of their life cycles.

The new sedimentation data from the proposed research, combined with previously collected data by USF from the Island Ponds sediment monitoring project, will provide insight into the spatial variation of sedimentation dynamics within the Project area. It will add to understanding of dynamics in the extreme South Bay, which will be very useful for future comparison with rates from tidal restoration at the Eden Landing ponds and other large-scale restoration efforts within the Bay. Furthermore, data on sedimentation rates and plant recruitment across various spatial locations will give a more comprehensive understanding of when vegetation can be expected to become established in ponds that are restored in the future. Given the interest in establishing vegetated wetlands for the Project, this information will be valuable for restoration planning in future phases of the Project.

Study Objectives

The overall goals of the SBSP Restoration Project are to restore and enhance a mix of wetland habitats, provide wildlife-oriented public access and recreation, and provide for flood management in the South Bay. One of the critical factors driving the development of restored tidal marshes is sediment accumulation, and the time that it takes restored marshes to reach elevations suitable for vegetation establishment. Current ongoing research in the Island Ponds complex indicates that sediment accretion is proceeding rapidly in these ponds (over 200 mm of accumulation in 2 years at the Northern sampling locations at Pond A21; see Fig. 1) and that vegetation is beginning to establish (Callaway and Schile, personal observations 2008). It is uncertain whether these rates of accretion will be consistent throughout the project area as additional ponds are restored to tidal action, or whether these rates will vary throughout the project area. Similarly, it will be very useful to evaluate spatial variation in threshold elevations for plant recruitment across the Bay, especially considering local variations in tidal ranges.

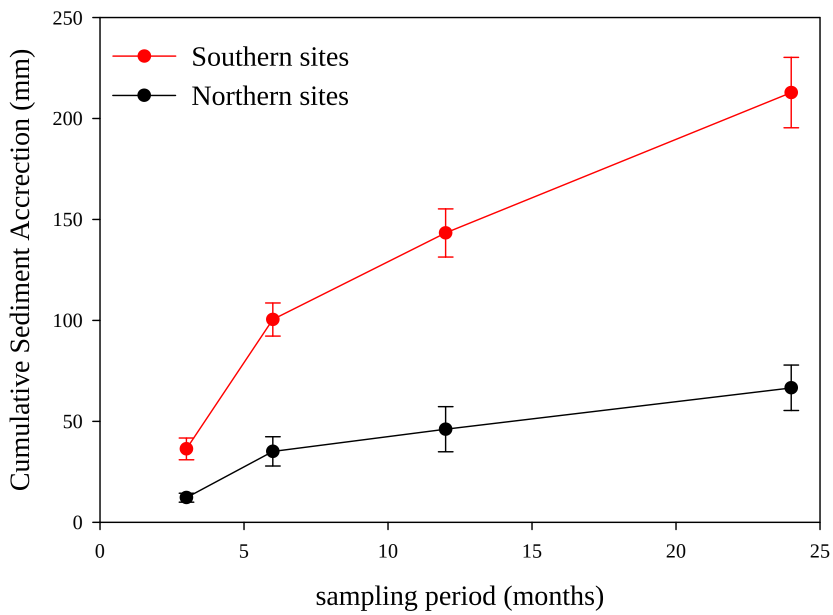

Figure 1. Cumulative sediment accumulation at Pond A21, as measured with sediment pins from 2006 to 2008. Southern sites were closer to the restored breaches at the pond and had substantially greater rates of sediment accumulation than the Northern sites.

The objective of this study is to address uncertainties for tidal marsh restoration and for future salt pond restoration projects, by testing two hypotheses related to sediment dynamics with our proposed research. In evaluating sediment issues, we focus on net sedimentation as measured over month to year time scales, as well as shorter-term (two week), mass-based measurements of sediment accumulation. Measurements at these scales will give the most insight into the uncertainties related to marsh development and sediment dynamics, both within ponds and in adjacent habitats. For plant recruitment, we focus on measuring elevations based on existing benchmarks and comparing these to tidal elevations across ponds A21 and A6 in order to determine threshold elevations for the establishment of dominant species within the Project area.

Hypothesis 1: Rates of sedimentation are greatest at lowest elevations and decrease asymptotically towards a minimum value at MHHW (e.g., see Figure 3 in Williams and Orr [2002]). Our specific objective will be to evaluate this relationship quantitatively so that it can be used as predictive tool in the South Bay. In addressing this hypothesis, we will answer the following questions: What are sedimentation rates in newly restored ponds? How do rates vary within the ponds, as a function of elevation, size of tidal creek, and distance from tidal creek? How do these rates compare with the rates in other areas of the Bay?

Hypothesis 2: Absolute elevations for plant recruitment will vary across sites A21 and A6; however, elevation ranges relative to tidal levels will remain relatively constant for a given species. In addition, we hypothesize that critical elevations for vegetation establishment will vary significantly among dominant species, with their relative order similar to that found in natural marshes. (Note: Although there is likely very little difference in tidal range from A21 to A6, setting up these data for future comparison with other ponds [e.g., Eden Landing ponds] will help to fine tune the likely timeframe for vegetation recruitment in various ponds across the Bay.)

The establishment of a network of sampling stations using permanent pins will allow for the comparisons outlined above and will remain in place to permit long-term evaluation of sediment dynamics. Furthermore, these data will be compared to results from on-going studies of accretion rates and elevation changes in marshes at Coyote Creek and Greco Island by Callaway, and to data from previous restoration efforts in SF Bay (e.g., Williams and Orr (2002) and a number of unpublished studies. The proposed studies will augment current research being done at the Island Ponds and will provide a broader evaluation of sediment dynamics throughout the SBSP Restoration project area.

Study Area

Sediment dynamics will be measured at Pond A6 (to be breached in 2009), and surveys of vegetation establishment will be completed at Pond A6 and Pond A21 (breached in 2006).

Approach

A critical dimension for understanding the spatial and temporal variation in sediment dynamics requires an appropriate network of sampling locations. Within Ponds A6, we will intentionally set up sediment sampling locations across gradients of existing elevation and distance from tidal creeks, using a similar approach to the design used at the Island Ponds, but with lower sampling intensity. By simultaneously measuring patterns across an elevation gradient, we will be able to use a "space-for-time" substitution (Pickett 1991) to test Hypothesis 1 that accretion rates are greater in "young" sites at lower elevations (Williams and Orr 2002). If higher elevation sampling locations are not available in the newly restored ponds, we will also set up locations in nearby areas to measure sedimentation rates at higher elevations.

1. Sedimentation Rates: We will use a series of methods to evaluate sedimentation rates and to test Hypothesis 1. Different methods are needed because of challenges in measuring sedimentation rates in unvegetated areas, as well as the fact that some methods measure slightly different processes, as discussed below. Short-term vertical accretion rates are relatively easy to measure in vegetated marshes using filter paper (Reed 1989) and marker horizons, primarily feldspar (Cahoon and Turner 1989). Surface Elevation Tables (SETs) can be used to measure changes in marsh surface relative elevation (Boumans and Day 1993, Cahoon et al. 2002). Both of these methods have been used widely in vegetated marshes (Cahoon et al. 1996, Roman et al. 1997, Scarton et al. 2000, Rybczyk and Cahoon 2002, DeLaune et al. 2003, Ward et al. 2003, Paquette et al. 2004); however, no widely accepted methods for measuring sediment dynamics in unvegetated areas have been established. Measurements are more difficult in unvegetated areas because of re-suspension and erosion of markers and invertebrate burrowing which can disturb feldspar marker horizons (Andersen et al. 2000). We will use sediment pins for measuring vertical sediment accretion and erosion in unvegetated areas, as well as a modification of the filter paper method for short-term, mass-based measurements of sediment accumulation. These methods have been used very successfully at the Island Ponds. The number of sediment pins installed may vary based on field conditions, but the original design will consist of 10 sediment pins installed across pond A6. Sediment stations will be set up prior to the breaching of Pond A6, and they will be monitored 3 mo, 6 mo, 12 mo, 18mo and 24 mo after breaching.

In addition, we will complete a number of targeted sampling periods using a modified filter paper method to measure mass-based accumulation of sediment (Reed 1989) in the restored ponds. Rubber disks will be used rather than filter paper, as this setup is more durable and allows sampling to be completed over an entire two-week tidal period. This method has been used successfully to measure seasonal accumulation rates at Pond A21 (see Fig. 2). We will collect sediments using the modified filter paper methods for a two-week sampling period every two months over the entire first year post-breach. For each sampling period, pre-weighed rubber disks are staked to the sediment surface. After two weeks, disks are collected, dried, and re-weighed to estimate mass-based inputs of sediments. These data will give insight into seasonal variations in sediment accumulation, and they will be directly comparable to similar measurements that were completed in the first year post-breach at Pond A21.

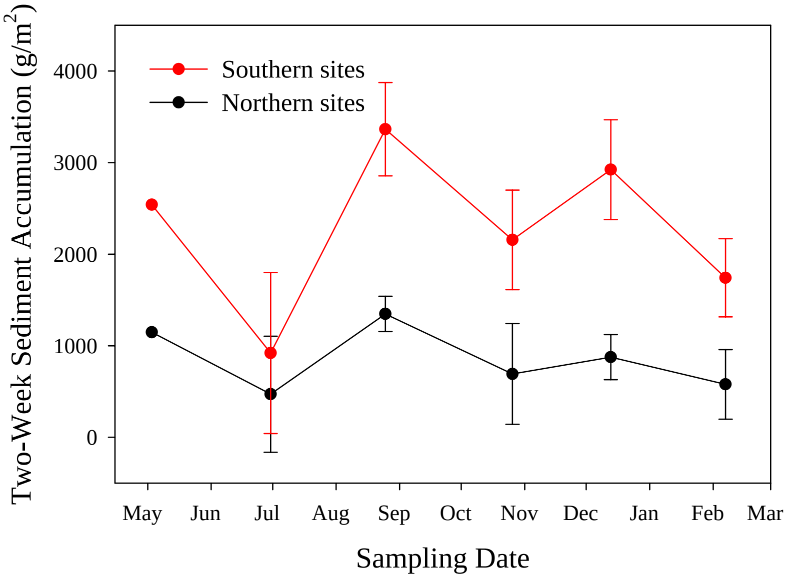

Figure 2. Mass-based sediment accumulation over two-week sampling intervals at Pond A21. Values are averages across the entire five sampling locations in the northern and southern portion of the pond (± standard error).

Locations of all sampling stations will be identified using a high-precision Leica Real Time Kinematic (RTK) GPS receiver so that they can be easily relocated during the two-year sampling period, as well as into the future. RTK GPS allows for surveying with an accuracy of approximately 1 cm horizontally and 2 cm vertically.

2. Elevations for Vegetation Recruitment*:* Throughout the growing season, we will survey both ponds A6 and A21 for newly establishing vegetation. Whenever new patches of plants are found at the ponds, we will survey their locations and elevations using RTK GPS and identify the particular species that are establishing. Surveys will be conducted on all dates when sediment pins are measured at A6. In addition at both A6 and A21, specific reconnaissance surveys will be completed in spring in order to find newly recruiting plants at both locations (most wetland plants typically establish in late winter or early spring). We will complete a second round of reconnaissance surveys in the summer in order to identify any small seedlings that may have been missed in the spring are located. This sampling will ensure that we are measuring threshold elevations for plant recruitment and not just elevation ranges of well established adult plants.

For each newly established plant that we find, we will collect the horizontal and vertical location. Each elevation survey will be calibrated with multiple USGS benchmarks in the surrounding area to ensure maximum accuracy.

Data Analysis

We will determine vertical accretion rates over time that will be compared statistically to rates from A21 and other restored and natural tidal wetlands using multiple linear regressions. Additionally, we will calculate mass-based rates of accumulation and convert these to mineral and organic matter accumulation rates, using on organic content of soils (based on LOI measurements from the collected sediments). These data will be analyzed using analysis of variance.

Work Schedule

The Project will take place over the next 50 years in a series of subsequent phases, each of which will have a separate monitoring plan that will have common elements over time but will be adapted as more data are gathered and the overall restoration trajectory becomes more evident. The Pond A6 Phase 1 restoration is anticipated to be implemented beginning in 2009 and completed in February 2010. The proposed work schedule will depend on the timeline for the Phase 1 restoration activities. We propose to collect data for 2 seasons post-breach. If restoration activities progress as planned, we anticipate the following schedule (which may be adjusted depending on the construction schedule) (Table 1). This schedule also assumes that monitoring sites will be established prior to construction in order to establish a baseline for subsequent monitoring, unless construction activities will impact the monitoring sites.

Table 1. Proposed Timeline of Vegetation and Sediment Monitoring Activities. Vegetation surveys will take place at Pond A21 (already restored) and Pond A6 (targeted for construction completion in summer 2009), and sediment monitoring will take place at Pond A6.

Date	Vegetation Surveys	Sediment Pins	Short-term mass-based sediment measurements
July 2009	only at A21	set-up and initial data collection	two-week sample period
Sept 2009			two-week sample period
Oct 2009		3-mo measurement	
Nov 2009			two-week sample period
Jan 2010	A21 & A6		two-week sample period
Jan 2010		6-mo measurement	two-week sample period
Mar 2010			two-week sample period
May 2010			two-week sample period
July 2010	A21 & A6	12-mo measurement	
Jan 2011	A21 & A6	18-mo measurement	
July 2011	A21 & A6	24-mo measurement	

Expected Products

Report: USF and H. T. Harvey & Associates will prepare a brief report summarizing the results of the tasks described above. The report shall include an executive summary, methodology, data tables, results and discussion. This report shall also include a map(s) of the Study Area that displays the location of sediment study sites. Subsequent reports will analyze the changes from the baseline established prior to construction.

- Report Review by Conservancy: 15 November to 1 December
- Final Report Due: 31 December

The report will be submitted in draft form for review by the Conservancy by 15 November of each monitoring year. USF and H. T. Harvey & Associates will provide the Conservancy with five (5) color copies of the final report after the Conservancy has commented on the draft report and the comments incorporated into the final report. USF and H. T. Harvey & Associates will provide the Conservancy with a single file internet-ready copy of the final report in a computer format acceptable to the Conservancy.

3. Literature Cited

Andersen, T. J., O. A. Mikkelsen, A. L. Moller, and M. Pejrup. 2000. Deposition and mixing depths on some European intertidal mudflats based on Pb-210 and Cs-137 activities. Continental Shelf Research **20**:1569-1591.

Boumans, R. M. J., and J. W. Day, Jr. 1993. High precision measurements of sediment elevation in shallow coastal areas using a sedimentation-erosion table. Estuaries **16**:375-380.

Cahoon, D. R., J. C. Lynch, P. Hensel, R. Boumans, B. C. Perez, B. Segura, and J. W. Day. 2002.
High-precision measurements of wetland sediment elevation: I. Recent improvements to the sedimentation-erosion table. Journal of Sedimentary Research **72**:730-733.

Cahoon, D. R., J. C. Lynch, and A. N. Powell. 1996. Marsh vertical accretion in a southern California estuary, U.S.A. Estuarine, Coastal and Shelf Science **43**:19-32.

Cahoon, D. R., and R. E. Turner. 1989. Accretion and canal impacts in a rapidly subsiding wetland: II. Feldspar marker horizon technique. Estuaries **12**:260-268.

DeLaune, R. D., A. Jugsujinda, G. W. Peterson, and W. H. Patrick. 2003. Impact of Mississippi River freshwater reintroduction on enhancing marsh accretionary processes in a Louisiana
estuary. Estuarine Coastal and Shelf Science **58**:653-662.

French, J. R. 1993. Numerical simulation of vertical marsh growth and adjustment to accelerated sea-level rise, North Norfolk, U.K. Earth Surface Processes and Landforms **18**:63-81.

H. T. Harvey & Associates. 2005. Island Ponds (Ponds A19, A20, A21) Tidal Marsh Establishment Projections. Prepared with Philip Williams & Associates for the Santa Clara Valley Water District. Project No. 2456-01.

H. T. Harvey & Associates. 2008. South Bay Salt Pond Restoration Project Phase 1 Monitoring Plan. Prepared for the California State Coastal Conservancy. HTH Project No. 2346-04.

Krone, R. B. 1987. A method for simulating historic marsh elevations. Pages 316-323 *in* N. C. Krause, editor. Coastal Sediments '87. American Society of Civil Engineers, New York, NY.

Morris, J. T., P. V. Sundareshwar, C. T. Nietch, B. Kjerfve, and D. R. Cahoon. 2002. Responses of coastal wetlands to rising sea level. Ecology **83**:2869-2877.

Paquette, C. H., K. L. Sundberg, R. M. J. Boumans, and G. L. Chmura. 2004. Changes in saltmarsh surface elevation due to variability in evapotranspiration and tidal flooding. Estuaries **27**:82-89.

Patrick, W. H., Jr., and R. D. DeLaune. 1990. Subsidence, accretion, and sea level rise in south San Francisco Bay marshes. Limnology and Oceanography **35**:1389-1395.

Pickett, S. T. A. 1991. Space-for-time substitution as an alternative to long-term studies. Pages 110-135 *in* G. E. Likens, editor. Long-term studies in ecology: Approaches and alternatives. Springer-Verlag, New York, NY.

PWA 2006. Hydrodynamic Modeling Report: Alternatives Analysis. San Francisco, CA.: Prepared for: California State Coastal Conservancy, U.S. Fish and Wildlife Service, California Department of Fish and Game.

Reed, D. J. 1989. Patterns of sediment deposition in subsiding coastal salt marshes, Terrebonne Bay, Louisiana: The role of winter storms. Estuaries **12**:222-227.

Roman, C. T., J. A. Peck, J. R. Allen, J. W. King, and P. G. Appleby. 1997. Accretion of a New England (USA) salt marsh in response to inlet migration, storms, and sea-level rise. Estuarine Coastal and Shelf Science **45**:717-727.

Rybczyk, J. M., and D. R. Cahoon. 2002. Estimating the potential for submergence for two wetlands in the Mississippi River Delta. Estuaries **25**:985-998.

Sanderson, E. W., S. L. Ustin, and T. C. Foin. 2000. The influence of tidal channels on the distribution of salt marsh plant species in Petaluma Marsh, CA, USA. Plant Ecology **146**:29-41.

Scarton, F., J. W. Day, A. Rismondo, G. Cecconi, and D. Are. 2000. Effects of an intertidal sediment fence on sediment elevation and vegetation distribution in a Venice (Italy) lagoon salt marsh. Ecological Engineering **16**:223-233.

Ward, K. M., J. C. Callaway, and J. B. Zedler. 2003. Episodic colonization of an intertidal mudflat by native cordgrass (*Spartina foliosa*) at Tijuana Estuary. Estuaries **26**:116-130.

Williams, P. B., and M. K. Orr. 2002. Physical evolution of restored breached levee salt marshes in the San Francisco Bay estuary. Restoration Ecology **10**:527-542.

Zedler, J. B., J. C. Callaway, J. S. Desmond, G. Vivian-Smith, G. D. Williams, G. Sullivan, A. E. Brewster, and B. K. Bradshaw. 1999. Californian salt marsh vegetation: An improved model of spatial pattern. Ecosystems **2**:19-35.

4. Qualifications

John Callaway: John Callaway has long-term experience in wetland research with a large number of peer-reviewed publications. Most recently, he has worked with Tom Parker to coordinate the vegetation component (along with Mike Vasey) of the Integrated Regional Wetland Monitoring (IRWM) Project, a multi-team, CALFED-sponsored research effort evaluating six wetlands in northern San Francisco Bay and the Delta (http://www.irwm.org).

John has substantial experience measuring sediment dynamics. He has published peer-reviewed papers evaluating wetland sedimentation rates in northern Europe, the Gulf Coast, Southern California, and San Francisco Bay, including a number of papers with students on these projects. He has measured sedimentation using $_{137}$Cs and $_{210}$Pb profiles, as well as feldspar markers, SETs, erosion control cloth, and rods. Currently he is conducting research using feldspar markers and SETs at Coyote Creek and Greco Island in the Don Edwards San Francisco Bay National Wildlife Refuge, Crissy Field, and Morro Bay. He has used a variety of methods for measuring dynamics on mudflats at Crissy Field and Morro Bay. As part of the research at Coyote Creek and Greco Island, Callaway collected cores for $_{137}$Cs and $_{210}$Pb dating, and analysis of these cores is currently underway via collaboration with Judy Drexler at USGS. He is currently involved in an on-going project to provide valuable data for comparison and context in interpreting sediment dynamics at the Island Ponds. Callaway, Parker, and Vasey also completed EMAP field sampling for San Francisco Estuary Institute in 2002, devising a sampling approach for vegetation as part of the EMAP wetlands "intensification" effort in California and evaluating approximately 20 wetlands in the Bay. Callaway has also served as co-PI on a project with the State Water Resources Control Board (SWRCB) to evaluate wetland mitigation sites throughout California.

Lisa Schile: Lisa Schile is a wetland ecologist who has five years experience working in tidal marshes of the San Francisco Bay-Delta. She was the vegetation team project manager on a CALFED-funded grant tasked to understand ecosystem functions in restored and natural marshes in the Bay-Delta and is in charge of the field operations for monitoring sediment dynamics in the South Bay Salt Pond Island Ponds that were restored in 2006. She is currently a CALFED Science doctoral fellow at the University of California, Berkeley. Her dissertation research focuses on the effects of salinity and inundation on tidal wetland plant growth and distribution in the Bay-Delta and spatially modeling changes in distribution with predicted climate change. Prior to her research in the Bay-Delta, Lisa studied plant-insect interactions in a wetland system in Louisiana for her Masters degree. Through her graduate and professional work, Lisa has become adept at conducting vegetation surveys, boat operation, managing field crews, installing monitoring equipment, conducting topographic surveys using total stations and RTK GPS units, GIS and remote sensing techniques, data analysis, and report and journal writing.

Donna Ball: Donna Ball is a salt marsh ecologist in restoration ecology group at H. T. Harvey & Associates who specializes in tidal marsh restoration. One of her key roles is habitat mapping using aerial photography and geographic information systems (GIS). She is also trained as a wetland ecologist and works on a variety of wetland restoration projects. Since joining H. T.

Harvey & Associates, she has worked on a broad array of salt marsh restoration projects including the South Bay Salt Pond and Bair Island Marsh projects, as well as mapping marsh plant associations in South San Francisco Bay. She has also worked on multiple wetland and riparian projects throughout the Bay Area, including vernal pool wetland monitoring and riparian restoration design and monitoring. As a graduate student, Donna studied effectiveness of *Spartina* removal methods, and the relationship of post-removal sediment habitat to pre-invasion habitat in Padilla Bay and Willapa Bay in Washington State. She has extensive field experience using surface elevation tables (SETs), feldspar marker horizons to study sediment accretion, and radioisotope dating using 210Pb analysis. Through her professional and academic experience, she has acquired skills in restoration design and field data collection and analysis, and writing scientific and technical reports.

John Bourgeois: John is a restoration ecologist with experience in a wide array of coastal settings, from the San Francisco Bay, to the outer continental shelf and coastal marshes of the Gulf of Mexico, to mangrove swamps in the western Pacific. At H. T. Harvey & Associates, John has been project manager for over 75 projects, including numerous coastal restoration and enhancement programs, large-scale (>1,000 acres) habitat mapping efforts, and in-depth monitoring programs. Before arriving the Bay Area in 1999, John conducted extensive monitoring of marsh management, shoreline protection, and hydrologic restoration projects, including measurements of hydrology, vegetation health and cover, marsh accretion and subsidence (marker horizon and SET work), and shoreline movement, and developed management decisions based on this monitoring. This included serving as a monitoring manager on large managed marsh systems for the Louisiana Department of Natural Resources' Coastal Restoration Division. During his time as a biologist at the USGS National Wetland Research Center, John worked for Dr. Don Cahoon and was involved in understanding the relative effectiveness of various coastal wetland mitigation techniques associated with oil and gas production throughout the Gulf Coast. John also spent five months on the island of Kosrae (Federated States of Micronesia) as an ecologist for the U.S. Forest Service where he establishing permanent research plots and collected ecological data on mangrove vegetation, as well as soil and water characteristics.

Equipment: The group owns three boats (a zodiac, a small flatbottom aluminum boat, and a 15-foot V-Hull outboard) and a canoe for field work. In addition, they have a Trimble GPS, several Toughbook computers, a number of smaller hand-held GPS units, and other basic equipment for wetland field work.

Describe Roles

John Callaway will serve as Principal Investigator (PI) for this project and will coordinate the USF component of the project. In addition he will oversee the work of Lisa Schile and any USF staff or students who may work on the project.

Lisa Schile will lead the field work and will coordinate with H. T. Harvey & Associates staff to perform monitoring tasks.

John Bourgeois will be the project manager for the H. T. Harvey & Associates component of the project. He will oversee the work of any H. T. Harvey & Associates staff that may work on the project and will coordinate with John Callaway regarding management tasks.

Donna Ball will be the lead staff scientist for H. T. Harvey & Associates and will coordinate monitoring and field work tasks assigned to H. T. Harvey & Associates.

JOHN C. CALLAWAY
Department of Environmental Science
University of San Francisco
2130 Fulton Street
San Francisco, CA 94117
(415) 422-5702; (415) 422-6387 fax
callaway@usfca.edu

PROFESSIONAL EXPERIENCE

Department of Environmental Science, University of San Francisco
- **Graduate Program Director**, 2006-present
- **Associate Professor**, 2005 - present
- **Assistant Professor**, 1999 - 2005

Pacific Estuarine Research Laboratory, San Diego State University
- **Associate Director**, 1998 - 1999
- **Assistant Director**, 1996 - 1997
- **Post-doctoral Fellow**, 1994 - 1996

EDUCATION

Louisiana State University
- Ph.D., Oceanography and Coastal Sciences, 1994

San Francisco State University
- M.A., Biology, 1990

University of California, Berkeley
- B.A., Biology (Marine Biology Field Major), 1985
- B.A., Slavic Languages and Literature, 1985

SELECTED PEER-REVIEWED PUBLICATIONS

Callaway, J.C. and J.B. Zedler. In Press. Salt marsh conservation along the leading edge of the continent. *In:* B.R. Silliman, M.D. Bertness, and D. Strong, editors. *Anthropogenic Modification of North American Salt Marshes*. University of California Press, Berkeley, CA.

Rybczyk, J.M., and J.C. Callaway. In Press. Wetland surface elevation models. *In*: G.M.E. Perillo, D.R. Cahoon, and E. Wolanski, editors. *Coastal Wetlands: An Ecosystem Integrated Approach*. Elsevier, New York, NY.

Callaway, J.C., V.T. Parker, M.C. Vasey, and L.M. Schile. 2007. Emerging issues for the restoration of tidal marsh ecosystems in the context of predicted climate change. *Madroño* 54:234-248.

Sullivan, G., J.C. Callaway, and J.B. Zedler. 2007. Plant assemblage composition explains and predicts how biodiversity affects salt marsh functioning. *Ecological Monographs* 77:569-590.

Grewell, B.J, J.C. Callaway, and W.R. Ferren, Jr. 2007. Estuarine wetlands. Pages 124-154 *in:* M.G. Barbour, T. Keeler-Wolf, and A. Schoenherr, editors. *Terrestrial vegetation of California*, 3rd edition. University of California Press, Berkeley, CA.

Callaway, J.C. 2005. The challenge of restoring functioning salt marsh ecosystems. *Journal of Coastal Research*. Special Issue 40: 24-36

Callaway, J.C., and J.B. Zedler. 2004. Restoration of urban salt marshes: Lessons from southern California. *Urban Ecosystems* 7: 107-124.

Callaway, J.C., G. Sullivan, and J.B. Zedler. 2003. Species-rich plantings increase biomass and nitrogen accumulation in a wetland restoration experiment. *Ecological Applications* 13: 1626-1639.

Weis, D. A., J.C. Callaway, and R.M. Gersberg. 2001. Vertical accretion rates and heavy metal chronologies in wetland sediments of the Tijuana Estuary. *Estuaries* 24: 840-850.

Zedler, J.B., and J.C. Callaway. 1999. Tracking wetland restoration: Do mitigation sites follow desired trajectories? *Restoration Ecology* 7: 69-73.

Zedler, J.B., J.C. Callaway, J.S. Desmond, G. Vivian-Smith, G.D. Williams, G. Sullivan, A. Brewster, and B. Bradshaw. 1999. Californian salt marsh vegetation: An improved model of spatial pattern. *Ecosystems* 2: 19-35.

Callaway, J.C., R.D. DeLaune, and W.H. Patrick, Jr. 1997. Sediment accretion rates from four coastal wetlands along the Gulf of Mexico. *Journal of Coastal Research* 13: 181-191.

Callaway, J.C., R.D. DeLaune, and W.H. Patrick, Jr. 1996. Chernobyl ^{137}Cs used to determine sediment accretion rates at selected northern European coastal wetlands. *Limnology and Oceanography* 41: 444-450.

Callaway, J.C., J.A. Nyman, and R.D. DeLaune. 1996. Sediment accretion in coastal wetlands: A review and a simulation model of processes. *Current Topics in Wetland Biogeochemistry* 2: 2-23.

Callaway, J.C., and M.N. Josselyn. 1992. The introduction and spread of *Spartina alterniflora* in south San Francisco Bay. *Estuaries* 15: 218-226.

SELECTED GRANTS AND CONTRACTS

Callaway, J.C., and J.Z. Drexler. Measuring carbon sequestration and sediment accretion rates in tidal wetlands of the San Francisco Bay Estuary. Moore Foundation and Coastal Conservancy Association. $300,000. November 2008 - October 2010.

Parker, V.T., and J.C. Callaway. Predicting tidal marsh plant community response to climate change: A Pacific coast perspective using field experiments. National Institute for Climatic Change Research, Coastal Center. $119,941. April 2008 - August 2010.

Parker, V.T., J.C. Callaway, D. Talley, and M. Kelley. Climate change impacts to San Francisco Bay-Delta wetlands: Links to pelagic food webs and predictive responses based on landscape modeling. CALFED Bay-Delta Science Program. $647,000. April 2007 - March 2010.

Callaway, J.C., and V.T. Parker. Sediment and gypsum dynamics following dike breaching at the Island Ponds: Implications for future restoration of wetland systems. Coastal Conservancy Association. $60,192. January 2006 - May 2007.

Ambrose, R. F., and Callaway, J.C. Wetland mitigation in California: Assessment of compliance with Clean Water Act Section 401(c) permits and wetland functions. State Water Resources Control Board, Division of Water Quality. $500,000. June 2004 - March 2006.

Zedler, J.B., S.P. Madon, and J.C. Callaway. Manipulation of vertical and horizontal heterogeneity in a large-scale restoration experiment. National Science Foundation. Grant # DEB 02-12005. $390,000. September 2002 - August 2006.

LISA MARIE SCHILE

Environ. Science, Policy, & Management
University of California, Berkeley
137 Mulford Hall #3114
Berkeley, CA 94720-3114

PhD Student
510.642.8322
510.642.1477 (FAX)
lschile@nature.berkeley.edu

EDUCATION

M.S.	University Louisiana at Lafayette, 2003 (Biology)
B.S.	University California, San Diego, 2001 (Ecology, Behavior, and Evolution)

PROFESSIONAL EXPERIENCE

2007-present	CALFED Science Doctoral Fellow & Graduate Researcher, University of California, Berkeley
2004-2007	Research Technician II, Department of Biology, San Francisco State University *Projects:* Integrated Regional Wetland Monitoring Program South Bay Salt Pond Restoration Project – Sediment Dynamics
2006-present	Fireworks Handler, Pyro Spectaculars – apprenticing for Pyrotechnician license
2005-2006	Independent Contractor, San Francisco Bay National Estuarine Research Reserve
2002-2003	Graduate Researcher and Teaching Assistant, University of Louisiana at Lafayette

RESEARCH INTERESTS

Wetland and plant ecology: restoration ecology and vegetation management of wetlands; sediment dynamics in restoring tidal wetlands; remote sensing

PUBLICATIONS

Tuxen, K., **L. Schile**, M. Kelly, and S. Siegel. 2008. Vegetation colonization in a restoring tidal marsh: A remote sensing approach. *Restoration Ecology* 16(2):313-323.

Schile, L. and S. Mopper. 2006. The deleterious effects of salinity stress on leafminers and their freshwater host. *Ecological Entomology* 31:345-351.

Leck, M. A., A. Baldwin, V. T. Parker, **L. M. Schile**, and D. Whigham. In press. Freshwater tidal wetlands of North America. In: A. Barendregt, A. Baldwin, P. Meire, and D. Whigham (eds.) Tidal Freshwater Wetlands. Backhuys Publ; Leiden, The Netherlands.

Lank, E., K. Withee, **L. Schile**, and V. T. Parker. 2006. User centered rapid application development. in Rapid Integration of Software Engineering Techniques: Second International Workshop, RISE 2005. N. Guelfi and A. Savidis (Eds). Springer Berlin / Heidelberg, pp 34-49.

Mancera, J., G. Meche, P. Cardona-Olarte, E. Castañeda-Moya, R. Chiasson, N. Geddes, **L. Schile**, H. Wang, G. Guntenspergen, and J. Grace. 2004. Fine-scale spatial variation in plant species richness and its relationship to environmental conditions in coastal marshlands. *Plant Ecology* 178:39-50.

SELECTED PROFESSIONAL ACTIVITIES

American Society for Photogrammetry and Remote Sensing (ASPRS) (2008-present)
Western Pyrotechnic Association (2008-present)
California Native Plant Society (2004-present)
Ecological Society of America (2003-present)
Estuarine Research Federation (2003-present)
Society of Wetland Scientists (2003-present)

Donna Ball, M. S.

Wetland Restoration Ecologist

dball@harveyecology.com
(408) 458-3200 x 233

Areas of Expertise

- GIS resource mapping/analysis
- Vegetation mapping and monitoring
- Ecology of tidal wetland environments

Education

- M.S. Environmental Science, Marine/Estuarine Science Program, Western Washington Univ., 2005
- B.S. Environmental Science, Western Washington Univ., 2001

Prior Professional Experience

- Field Technician, Padilla Bay National Estuarine Research Reserve 2004
- Chemistry Group Technician, Battelle Marine Science Laboratory, Sequim 2001-2005

Key Projects

- South Bay marsh vegetation monitoring
- South Bay Salt Pond restoration project
- San Jose Water Pollution Control Plant opportunities & constraints
- Foster City wetland restoration monitoring
- Matadero Creek wetland mitigation

Professional Profile

Donna Ball is a salt marsh ecologist in our restoration ecology group who specializes in habitat mapping and tidal marsh restoration. One of her key roles at H. T. Harvey & Associates involves habitat mapping of marsh plant associations using aerial photography and GIS. For the past 4 years, she has used GIS to map marsh plant associations of the South Bay marshes for the City of San Jose. She is also trained as a wetland ecologist and works on a variety of wetland restoration projects. As part of her work on the opportunities and constraints for the San Jose WPCP, Donna mapped habitat in the field and helped design restoration opportunities.

She has assisted in the development of marsh restoration plans for several large scale regional wetland projects, with emphasis on the South Bay Salt Pond and Bair Island Restoration Projects. She also has provided oversight over the restoration installation, maintenance, and monitoring of numerous tidal marsh restoration sites including the Foster City Consolidated Wetland Mitigation Project, the Island Ponds water level monitoring, Bayside Business Park mitigation site, and the Matadero Creek wetland mitigation sites.

Donna has ecological experience in several estuaries on the west coast and has assisted with eelgrass habitat mapping and species distribution using GIS and photo-interpretation in Padilla Bay, WA, sediment dynamics monitoring in Willapa Bay, WA, and has assisted in design of tidal restoration projects in Elkhorn Slough and Humboldt Bay, CA.

As a graduate student, Donna studied the effectiveness of methods used to control *Spartina alterniflora* in Willapa and Padilla bays in Washington State. In particular, she studied the effectiveness of *Spartina* eradication efforts in returning the sediment profile of the marsh to pre-invasion conditions. Her work involved establishment of long-term study sites to monitor elevation change in Pacific Northwest mudflats and at *Spartina* invasion sites, data collection for sediment characterizations, and estuarine plant community dynamics.

In addition to vegetation mapping, her professional skills include estuarine ecology, data analysis, project design, long term monitoring, and report preparation and presentation. Through her professional and academic experience, Donna has acquired skills in GIS mapping and analysis, field data collection and analysis, restoration design, experience in invasive species monitoring, techniques for monitoring sediment accretion, radioisotope dating using Pb-210, and writing scientific and technical reports. Her work has been presented at local, regional, and national meetings.

John Bourgeois, M.S.

Associate Restoration Ecologist

jbourgeois@harveyecology.com
408-458-3221

Areas of Expertise

- Ecology of tidal wetlands
- Habitat restoration planning/monitoring
- Ecology of riparian environments
- Environmental impact assessment (NEPA/CEQA)
- Aquatic nutrient dynamics

Education

- M.S. Biology, Univ. of Louisiana, Lafayette, 1994
- B.S. Ecological, Evolutionary, and Organismal Biology, Tulane Univ., 1992

Prior Professional Experience

- Biologist, National Wetlands Research Center, 1997-1999
- Geoscience Specialist, Louisiana Dept. of Natural Resources, 1996-1997
- Ecologist, U.S. Forest Service, Institute of Pacific Island Forestry, 1995

Key Projects

- South Bay Salt Ponds restoration
- Bair Island restoration & management plan
- South Bay marshes long-term monitoring
- Alameda Flood Control Channel experimental dredging program

Key Publications

Bourgeois, J. A. 2004. Alameda flood control channel experimental dredging project. Ecesis 14(2-3).

Bourgeois, J. A., and E. C. Webb. 1999. Effects of weirs on the depth and duration of flooding in a Louisiana marsh. Recent Research in Coastal Louisiana.

Complete list of publications available upon request

References

- Neal Van Keuren, Environmental Services Specialist, City of San Jose. 408-945-5126

Professional Profile

John is an estuarine ecologist with experience in a wide array of coastal settings, such as the San Francisco Bay, the continental shelf in the Gulf of Mexico, and mangrove swamps in the western Pacific.

He has extensive experience monitoring marsh management, shoreline protection, and hydrologic restoration projects and making management decisions based on this monitoring. The projects include measurements of hydrology, vegetation health and cover, marsh accretion and subsidence, and shoreline movement. He is well-versed in a variety of field collection methods such as continuous water level and salinity recorders, horizon marker techniques, cryogenic coring equipment, sediment elevation tables, submersed aquatic vegetation sampling, equipment, and techniques for measuring soil salinity, nutrients, bulk density, and redox potential. While with the U.S. Forest Service, John also spent five months on the island of Kosrae (Federated States of Micronesia) to establish permanent research plots and collect ecological data on mangrove vegetation, as well as soil and water characteristics. His Master's research addressed the benthic nutrient dynamics of the Mississippi River bight.

John has wide-ranging experience throughout the Gulf Coast. In the coastal marshes, he has been involved in long-term monitoring of large-scale wetland restoration projects, understanding the impacts and mitigation associated with outer continental shelf pipeline and navigation canals and the relationships between marsh accretion and elevation. He has served as a monitoring manager for large-scale coastal wetland restoration projects, including large (3,000+ acre) managed marshes, sediment diversion projects, hydrologic restoration efforts, and experimental shoreline protection methods. John was also involved in understanding the relative effectiveness of various coastal wetland mitigation techniques associated with oil and gas production, including the evaluation of various methodologies of pipeline installation (both current and historical) for their and the effectiveness of mitigation techniques. John's experience includes tasks such as design input; monitoring plan development; interagency coordination under the Coastal Wetlands Planning, Protection, and Restoration Act guidelines; field data collection (including hydrologic, vegetation and sedimentation data) and management; report preparation, and adaptive management recommendations.

At H. T. Harvey & Associates, John has managed and been involved in numerous Bay Area coastal restoration and enhancement programs, extensive habitat mapping efforts, and in-depth monitoring programs. Key projects in which he has been involved include the development of the South Bay Salt Pond Restoration Project, the Bair Island Restoration and Management Plan, and South Bay marshes vegetation mapping and monitoring of hydrologic and edaphic characteristics.

John is also very active is his local community and currently serves on the Planning Commission and General Plan Committee for the Town of Los Gatos. John strives to integrate his planning experience and ecological expertise to optimize project designs and recently appeared on a panel at the 2007 national ASLA conference on *The Integration of Science and Design*, where he spoke on wetland restoration projects in San Francisco Bay.

5. Budget and Staff Allocations

Project Budget Worksheet*

Timeframe: Year 1: July 1, 2009 to June 30, 2010; Year 2: July 1, 2010 to Dec. 31, 2011

Budget Categories	**Total Project Budget**		**Total Grant Request**		**Total Proposed From Other Sources** *(please specify the source, if known)*
	Year 1	**Year 2**	**Year 1**	**Year 2**	
Labor (includes salary & fringe benefits)					
John Callaway	2679	2933	2679	2933	
Lisa Schile	5664	3776	5664	3776	
Research Asst. (To be named)	7080	4248	7080	4248	
Consultant fees/ Contractual Services	15610	7846	15610	7846	
Travel	2106	1053	2106	1053	
Project specific equipment, supplies/materials	2500	100	2500	100	
Overhead (not to exceed 10%)	1542	1096	1542	1096	
TOTAL	**37181**	**21052**	**37181**	**21052**	

Date Created: 12/5/2008

* This form is meant to assist you in developing a proposed grant budget, summarizing the use of all grant funds on a single page. Should you need to add line-items—or additional work sheets to delineate budgets for multiple projects within the proposal—please do so. A detailed budget will be required if approved for funding.

** Please indicate the timeframe which this budget covers (for example: May 2009 - April 2010).

South Bay Salt Pond Restoration Project
Restoring the Wild Heart of the South Bay

Other

6. List of Potential Reviewers

Denise Reed
Department of Eary & Environmental Sciences
University of New Orleans
2000 Lakeshore Dirve
New Orleans, LA 70148
dreed@uno.edu

Don Cahoon
USGS Patuxent Wildlife Research Center, Beltsville Lab, c/o
BARC-East, Building 308, Rm 223
10300 Baltimore Avenue
Beltsville, MD 20705
dcahoon@usgs.gov

Ron Thom
Battelle Memorial Institute
1529 West Sequim Bay Road
Sequim, WA 98382
ron.thom@pnl.gov

7. Necessary Assessments, Certifications and Permits

A Special Use Permit from the Refuge will be required. Special access agreements will be requested as necessary with private properties (e.g., landfills). HTH acquires a SUP annually for the mapping performed for the City of San Jose and has on-going relationships to secure access with most of the required entities in the South Bay.

8. Animal Care and Use Certification

Not applicable.