Project Title:

Sea-level rise modeling across the California salt marsh gradient for resource managers: evaluation of methodology

Proposal by:

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Scope & Budget:

Location: Across LCCs
Duration in months: 18
Requested Funding: $95,000.00
Leveraged Funding: $226,059.00

Briefly summarize the goals of the project, what products will result, and how the products support decision-making and conservation delivery for natural resource management within the CA LCC.

The effects of sea-level rise (SLR) on coastal ecosystems and tidal salt marshes are not well understood; however, managers need decision-making tools and validated methods to determine impacts to their local resources for long-term adaptive management. Global and regional IPCC projections are of limited value for area managers attempting to develop local adaptation plans; thus, we will address that critical need through bottom-up modeling at a parcel scale. Of the 41 LCC full proposals, this is the only study directly addressing sea-level rise effects on tidal marsh habitats, working in both southern and northern California, 1 of the 5 spanning LCCs (see R1 letter), and partially supported by the FWS R8 I&M Program. At selected tidal marshes, we will measure several parameters with our methods developed under the USGS National Climate Change and Wildlife Science Center (FY08-FY11): 1) detailed (<3cm) elevation data (RTK GPS, echosounder); 2) inundation frequency (water level loggers)and microclimate including extreme events; 3) sediment supply (bottles, optical backscatter, cores); 4) plant; and 5) vertebrates surveys. These will be incorporated into ArcGIS models including intertidal and upland transition areas, creating comparable datasets across the Pacific coast tidal gradient with a focus on 2-4 sites in the California LCC (San Diego, SFB Refuges, NERR sites), coordinated with similar studies in the North Pacific LCC (Humboldt, Bandon, Willapa, Nisqually NWRs), and supported by the FWS Region 1 and 8 Inventory and Monitoring Program and both LCCs and submitted to the NERRs Science Collaborative. Our studies also will allow us to integrate our databases with available regional datasets such as LiDAR coverages and plant or animal surveys and establish their utility for these analyses. Our ultimate goal is to provide science support tools for local adaptation planning from the bottom-up that may be implemented under a structured decision-making framework.

For continuing 2010 CA LCC projects, describe the accomplishments and outcomes to date, why additional funds are needed, and what this proposal will add to the project.

NEW PROJECT

Identify which National LCC Performance Measure(s), if any, your project addresses.

1. A risk and vulnerability assessment developed or refined for priority species and habitats. 2. Inventory and monitoring protocols developed or refined to capture data on fish and wildlife populations and their habitats to detect changes resulting from climate change. 3. A population and habitat assessment developed or refined to predict changes in species populations and habitats. 4. A biological planning and conservation design project developed in response to climate change. 5. A management evaluation action evaluated for effectiveness in response to climate change and research activities conducted to address information needs in response to climate change.

List Partners

FWS North Pacific LCC (proposal endorsed, in prep) FWS Inventory and Monitoring Program, R8 (K. Laing, G. Block, equipment support $20K) FWS Inventory and Monitoring Program, R1 (K. Kilbride, B. Root, E. Stockenberg; proposal endorsed, in prep) NOAA National Estuary Research Reserves -- Pacific coast (J. Crooks, K. Wasson, M. Ferner, S.Rumrill, D. Bulthuis; proposal in review, $783K, 3yr) San Diego National Wildlife Refuges (B. Collins, in-kind logistics) San Francisco Bay National Wildlife Refuges (M. Stewart, in-kind logistics) San Francisco Bay Joint Venture (B. Huning, C. Sloop) South Bay Salt Pond Restoration Project (J. Bourgeois, L. Valoppi) University of California, Davis -- Center for Spatial Technology and Remote Sensing, Geography (S. Ustin, in-kind, LiDAR data) USGS Western Ecological Research Center (J. Takekawa, K. Thorne, I. Woo, K. Spragens; USGS NCCWSC FY11 grant $176K, Wetland Restoration Program $50K) USGS California Water Science Center (K. Swanson)

Briefly describe how the project team (main PIs) provides the range of experience, expertise, and organizational capacity needed to accomplish the project. List recent and current projects (names, time-periods, PI time commitments, and total budgets). Also attach 1 page CVs for the principle investigator and/or project leaders per below under additional information.

The lead investigator (J. Takekawa) established the USGS Western Ecological Research Center station on SFB in 1995 and has conducted research on wetlands and waterbirds on the Pacific coast for the past 25 years. He is the PI for the 3-year SFB tidal marsh study supported by the USGS National Climate Change and Wildlife Science Center in 2009 (1 of 17 in the nation) that formed the basis for this proposal (FY11 funding 139K, 10% time). In addition he is a PI for the USGS Priority Ecosystems Science salt pond restoration studies in SFB (FY11 funding 126K, 5% time). The research team includes K. Thorne, UC Davis geography PhD candidate working on climate change adaptation and a member of the National Climate Change Adaptation Strategy Committee for coastal ecosystems; S. Ustin, UCD Professor and Director of the Spatial Technologies and Remote Sensing and an expert in LiDAR; I. Woo, wetland biologist with over 10 years experience in tidal wetland research, K. Spragens, wildlife biologist and field coordinator, and K. Swanson research hydrologist who is modeling tidal marsh sedimentation processes (in association with D. Schoellhamer and J. Drexler). The work will be conducted in cooperation with FWS R8 Inventory and Monitoring (K. Laing, G. Block), San Diego (A. Yuen, B. Collins) and SFB (M. Stewart, J. Albertson) NWRs, and in collaboration with the West Coast NOAA National Estuarine Research Reserves (J. Crooks, K. Wasson, M. Ferner, S. Rumrill, D. Bulthuis), FWS R1 Inventory and Monitoring (K. Kilbride, E. Stockenberg, B. Root) and the North Pacific LCC (M. Mahaffy).

Project Description: Coastal areas are high risk zones to impacts of global climate change. Projected sea-level rise (SLR) up to 1.9 m by 2100 is expected to alter coastal estuaries (IPCC 2007, Jevrejeva *et al.* 2008, Vermeer and Rahmstrof 2009) resulting in loss of tidal salt marshes and their associated species (Takekawa *et al.* 2006). Loss of salt marsh habitats along the Pacific coast tidal gradient will impact demographic and community structure of these sensitive communities, and targeted restoration and triage will be required to save remnant areas. Rather than downscaling global climate models that are difficult to interpret at a particular site, our approach is working with local managers and communities to assess parcel-scale information from the bottom-up.

Our project goals include improving data collection tools and collaboration along the Pacific coast tidal gradient (Fig. 1) to apply sea-level rise (SLR) modeling at a parcel scale relevant to land managers. Our design will include providing resource managers with information on the value of different datasets and methods including their uncertainty, as well as determining their usefulness in climate change adaptation planning in tidal marsh habitats. At selected demonstration parcels in northern and southern California under the California LCC and with proposed sites in the North Pacific LCC, we will establish baseline data and collection techniques for assessing detailed habitat elevations; tidal ranges, microclimate, and extreme weather events; sediment supply sources; vegetation community composition; and vertebrate population indices. We will evaluate and compare existing inventory and monitoring data, such as LiDAR and vegetation samples to the techniques demonstrated here relative to their value in understanding SLR vulnerability for tidal marsh parcels.

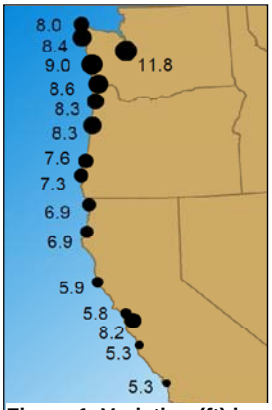

Figure 1. Variation (ft) in Pacific coast tidal range.

The synthesis of these data sets and projections of ecosystem response to SLR will be developed in coordination with parallel work proposed to the NOAA National Estuarine Research Reserves (NERR) collaborative science program to develop structured decision-making (SDM) tools (Runge et al. 2009) for Pacific coast estuaries. Deliverables will include highly accurate elevation models; annual water inundation patterns recording extreme events and area microclimate; evaluation of available sediment; detailed maps of the vegetation community structure and indices of vertebrate populations; and the synthesis of these producing models of SLR impacts. These models will be at a level of detail relevant to local managers however applicable at a larger landscape scale. Development of these techniques will demonstrate initial costs and effort for long-term monitoring programs to evaluate ecosystem changes under future SLR. Partnerships will leverage USGS climate change funds, FWS R8 I&M support, North Pacific LCC and R1 I&M support, and UC Davis spatial imagery to accomplish the work.

CA LCC Priorities Addressed: Our project address the 2011 CA LCC priorities under the following areas: (1) Ecosystem Response and Habitat -- development of SLR models including elevation, inundation, vegetation, and habitat sub-models at parcel scales relevant to land managers; risk assessment to tidal and sub-tidal marsh biodiversity and the variable impacts across northern and southern CA LCC sites; and modeling climate-driven extreme weather and tide events and development of methods for long-term monitoring programs. (2) Decision-support -- SLR scenario planning at sites in the California LCC (and coordinated with the North Pacific LCC); science support (eg. SLR models) for scenario evaluation and resource allocation

and adaptive management; developing and standardizing metrics at a parcel scale; and establishment of methods for collection of baseline data and long-term monitoring to track changing trends. This study will complement SDM processes undertaken through the NERR collaborative science program at five sites along the Pacific coast.

CA LCC Criteria addressed: (1) Applicability to Conservation and Adaptation Decisions – our motivation for undertaking this work is the difficulty in applying existing climate change science to on-the-ground conservation and adaptation. Applying a bottom-up, parcel-based approach will provide concrete information for land managers attempting to develop adaptation plans for SLR impacts. (2) Ecological or Ecosystem Response to Climate Change– currently-used methods (eg. LiDAR) and models (Sea Level Affecting Marshes Model or SLAMM) often do not include assessment of errors or uncertainty that are critical to understand community response. A focus of our work is increasing accuracy of elevation and inundation modeling to appropriately address changes in vegetation and vertebrate communities found in tidal marshes. (3) Breadth of Understanding– our approach integrates biophysical data obtained through relatively simple data collection methods including detailed elevations, tidal inundation, sediment supply, vegetation structure, and vertebrate response. These datasets provide a comprehensive understanding of current conditions in tidal marshes that span the geographic extent of the California LCC and allow for future projections. (4) Accessibility– detailed coverages will be provided to land managers, while assessment of tools and reports will be provided online in cooperation with the FWS R8 I&M. These data will be used as the basis of discussions under proposed NERR collaborative workshops including both managers and stakeholders. (5) Scope and Transferability– our project is focused on developing easily-used tools directly comparable across sites along the Pacific tidal gradient in both the California and North Pacific LCC. (6) Partnerships and Leveraging—our multi-disciplinary partnership includes USGS and university scientists of different specialties, land managers from southern and northern California, USGS National Climate Change and Wildlife Science Center funds and equipment, monetary support from the FWS R8 I&M, and proposed support from the R1 I&M, North Pacific LCC, and NOAA NERR science collaborative program. This project builds a new collaboration between SFB and San Diego land managers facing similar SLR impacts. (7) Timeliness and Urgency – this is the only 2011 California LCC proposal that directly addresses methods to assess SLR impacts at a parcel scale. It is urgently needed to provide science support for adaptation plans that currently lack detailed information.

Approach and Scope of Work:

Climate change scenarios typically address top-down global to continental scale changes; thus, few are easily interpretable or contain a vertical resolution that is useful at the local level for planning adaptation. Our studies are directed at a bottom-up approach to evaluating SLR effects at the parcel scale (however relevant at a landscape scale), providing information and databases useful in assessing local responses (Fig. 2). We will evaluate the availability of and develop the following datasets required for a comprehensive assessment of SLR impacts to tidal and sub-tidal marsh

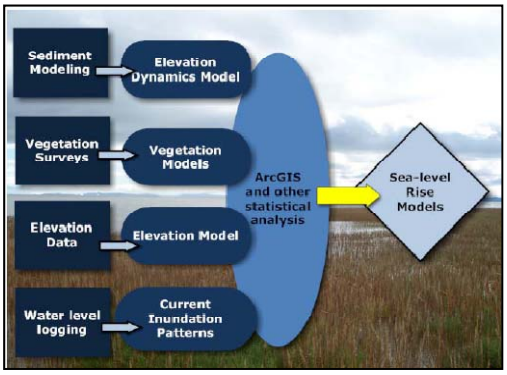

Figure 2. Parcel-based model to examine sea-level rise effects on tidal salt marsh habitats

habitats: detailed elevation and plant community surveys, sediment availability and deposition assessments, tidal range and extreme climate event profiling (including local climatic condition monitoring), and wildlife habitats. The following methodology has been developed by the USGS under a grant from the National Climate Change and Wildlife Science Center at 12 salt marsh sites in San Francisco Bay estuary. Products and SOPs will be made available online in partnership with FWS R8 I&M and will be presented to local land managers. In addition results will be shared with the North Pacific LCCs and FWS R1 I&M group.

Dataset Assessment, Collection and Synthesis:

(1) Elevation: develop high-resolution digital elevation models (DEMs). A high-resolution vertical and horizontal DEM is needed to evaluate current and future inundation patterns. We developed a survey methodology (Fig. 3) to produce high resolution elevation models using a Real Time Kinetics GPS (RTK Smart Pole, Leica Systems, +/- 3 cm vertical accuracy). DEMs will be created from the surveys and cross-validated for each site. Parcel surveys with RTK GPS will be supplemented with available LiDAR or remote-sensing imagery of subtidal and upland transitions.

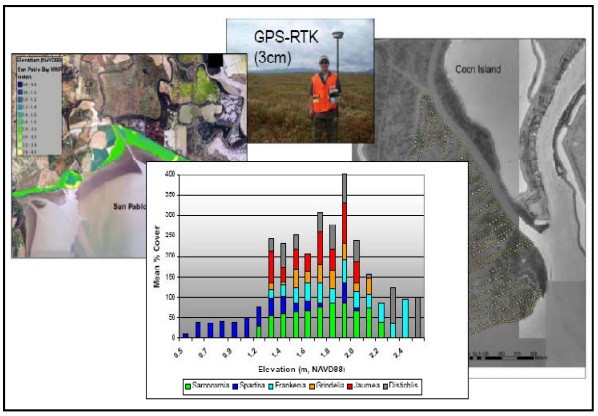

Figure 3. Elevation and vegetation coverage created from RTK GPS surveys

(2) Tidal range and extreme events: monitor water levels and tidal cycles to assess parcel level inundation patterns and extreme water events. To understand current tidal flooding patterns and cycles at local scale, we will deploy water-level loggers, placed in channel networks. The water-level monitoring provides detailed information on salt marsh flooding and drainage patterns including depth during tidal cycles, inundation periods of the marsh plain, and characteristics of flooding during storm events. Collection of microclimate data will be obtained from local weather stations to incorporate into inundation models.

(3) Sediment: evaluate sediment and organic matter processes to model salt marsh persistence through time. We are currently developing a vertical model (Fig. 4) that incorporates biological and physical components of marsh accretion processes and incorporates inorganic and organic deposition to compare with projected sea-level rise. We will apply this model (Callaway et al. 1996) including components of inorganic sediment deposition, organic matter production, decomposition, and compaction (K. Swanson et al., unpubl. data). Data collection will include existing suspended sediment concentration data, benthic cores, bottle traps, and optical backscatter meters.

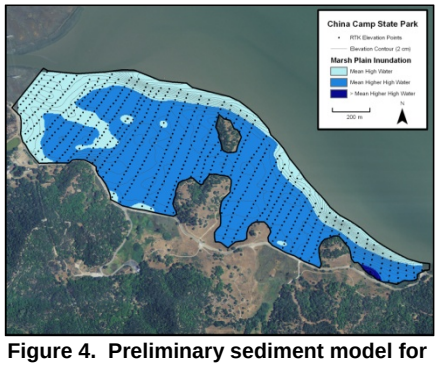

Figure 4. Preliminary sediment model for SLR effects on China Camp incorporating organic and mineral sedimentation (K. Swanson, unpubl. data).

(4) Vegetation: inventory vegetation species composition and relationship to elevation and tidal ranges. We will conduct vegetation surveys (including invasive species) at elevation survey points to examine habitat structure. A relationship between plant distribution and tidal datum will be developed integrating DEMs with habitat characteristics. We will assess the temporal and spatial availability of habitats under current tidal inundation (Fig. 5) as well as under future extreme tide levels and varying SLR scenarios. Plant species composition and structural relationship to tidal range directly impacts tidal marsh vertebrate species' vulnerability and risk to predation and reproductive failure.

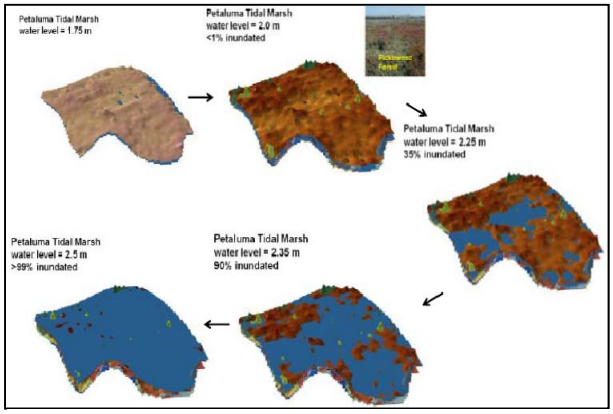

Figure 5. Changes in tidal marsh inundation and habitat availability with current and project sea-level rise

(5) Wildlife: determine and quantify wildlife species and their habitats at local and regional landscape scale. Wildlife may be the most sensitive indicators of SLR effects. We will evaluate pre-existing wildlife surveys to unify definitions of acceptable biological response metrics to changing habitats and landscapes. Species presence and abundance is the most common metric used to determine habitat quality. We will identify with managers wildlife species of concern and identify key ecosystem structure, function and survey to evaluate those species impacts.

Products/Data Sharing: Products for each site will include: (1) Detailed high resolution DEMs (2) inundation patterns, microclimate weather data and sediment supply summaries and estimates; (3) vegetation and vertebrate indices for tidal marsh habitats; and (4) models of SLR inundation patterns. Products for each parcel will include inventory of currently available data that will be compared to collected datasets. ArcGIS models, products, summary reports and SOPs will be made available online in partnership with FWS I&M. Quarterly update will be provided by email for project partners including FWS I&M, pilot area managers, and the California LCC. These data will be used to populate SDM processes under the NOAA NERR collaborative science program.

Project 18-month timeline

	FY11		**FY12**				**FY13**
	Summer	Fall	Winter	Spring	summer	Fall	Winter
Product 1							
Assessment, synthesis of existing data	X	X					
Field Planning	X	X					
Elevation data collection			X	X			
Analysis					X	X	
Product 2							
Water data			X	X			
Weather data			X	X			
Sediment data			X	X			

Analysis					X	X	
Product 3							
Vegetation data			X	X			
Vertebrate assessment			X	X			
Analysis					X	X	
Product 4							
SLR model development					X	X	
Reporting							
Updates				X			
Final						X	X

Measuring Results: Success will be measured by providing land managers with (1) high resolution DEMs of tidal marsh parcels; (2) site-specific inundation data and information on timing and frequency of inundation by elevation including extreme events and microclimate weather data; (3) sediment and organic matter data related to the surveyed parcel (4) vegetation structure summaries including information on species distribution, composition and height related to elevation; (5) tidal marsh species indices, and (6) synthesized datasets under current and projected SRL scenarios. Compilation of these will provide site managers with an explicit and comparable assessment of lands pertinent to conservation and restoration objectives at the local scale for regional coordinators to compare across important tidal marsh sites along the Pacific coast. The datasets will be used to support SDM workshops under the NERR collaborative science program.

Literature Cited:

Callaway, JC, JA Nyman, and RD DeLaune. 1996. Sediment accretion in coastal wetlands: a review and a simulation model of processes. Current Topics in Wetland Biogeochemistry 2: 2-23.

IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning,Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jevrejeva, S., Moore J.C., Grinsted, A. and Woodworth, P.L. 2008. Recent global sea level acceleration started over 200 years ago? *Geophysical Research Letters*, 35, L08715.

Runge, M.C., J.F. Cochrane, S.J. Converse, J.A .Szymanski, D.R. Smith, J.E. Lyons, M.J. Eaton, A. Matz, P. Barrett, J.D. Nichols, and M.J. Parkin. 2009. *An overview of structured decision making, pilot edition.* U.S. Fish and Wildlife Service, National Conservation Training Center, Shepherdstown, West Virginia, USA.

Takekawa, J. Y., I. Woo, H. Spautz, N. Nur, J. L. Grenier, K. Malamud-Roam, J. C. Nordby, A. N. Cohen, F. Malamud-Roam, and S. E. Wainwright-De La Cruz. 2006. Environmental threats to tidal-marsh vertebrates of the San Francisco Bay estuary. Studies in Avian Biology 32: 176-197

Vermeer, M. and Rahmstrof S. 2009. Global sea level linked to global temperature. *Proceedings of the National Academy of Science of the United States of America*, 106(51), 21527-21532.

California Landscape Conservation Cooperative 2011 Proposal Budgets

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)[b]	Partner(s) Contribution(s) (non-monetary value/in-kind)[b]	**Total**
Salaries	$ 67,000.00	$ -	$ 137,259.00	$ 204,259.00
Supplies	$ 2,124.00	$ -	$ 3,800.00	$ 5,924.00
Overhead[a]	$ 17,131.00	$ -	$ -	$ 17,131.00
Equipment	$ 7,245.00	$ 20,000.00	$ 50,000.00	$ 77,245.00
Other (specify)	$ 1,500.00	$ -	$ 15,000.00	$ 16,500.00
Total	$ 95,000.00	$ 20,000.00	$ 206,059.00	$ 321,059.00

a = Indirect cost calculated at DOI client 22% for FY11

b = equipment support (monetary) is pending from the FWS R8 I&M. Matching funds sources are USGS National Climate Change and Wildlife Science Center ($254K, awarded) and USGS Western Ecological Research Center program support ($89K, in-hand).

Other:

Project requests $1,500 for travel to partner meetings and research sites. In-kind contribution of $15,000 representing specialized equipment trainings, data collection, analysis, and synthesis during development of survey protocols and methodologies.

California Landscape Conservation Cooperative 2011 Proposal Budgets

Detailed digital elevation model.

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 16,750.00	$ -	$ 43,727.00	$ 60,477.00
Supplies	.	$ -	$ 1,900.00	$ 1,900.00
Overhead[a]	$ 3,795.00	$ -	$ -	$ 3,795.00
Equipment		$ 20,000.00	$ 25,000.00	$ 45,000.00
Other (specify)	$ 500.00	$ -	$ 5,000.00	$ 5,500.00
Total	$ 21,045.00	$ 20,000.00	$ 75,627.00	$ 116,672.00

a = Indirect cost calculated at DOI client 22% for FY11

Other:

Project requests $500 for travel to partner meetings and research sites. In-kind contribution of $5,000 representing specialized equipment trainings, data collection, analysis, and synthesis during development of survey protocols and methodologies.

California Landscape Conservation Cooperative 2011 Proposal Budgets

Inundation patterns and sediment supply estimates.

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 16,750.00	$ -	$ 23,081.00	$ 39,831.00
Supplies	$ 550.00	$ -	$ 1,900.00	$ 2,450.00
Overhead[a]	$ 5,048.00	$ -	$ -	$ 5,048.00
Equipment	$ 5,145.00		$ 25,000.00	$ 30,145.00
Other (specify)	$ 500.00	$ -	$ 5,000.00	$ 5,500.00
Total	$ 27,993.00	$ -	$ 54,981.00	$ 82,974.00

a = Indirect cost calculated at DOI client 22% for FY11

Other:

Project requests $500 for travel to partner meetings and research sites. In-kind contribution of $5,000 representing specialized equipment trainings, data collection, analysis, and synthesis during development of survey protocols and methodologies.

California Landscape Conservation Cooperative 2011 Proposal Budgets

Vegetation and vertebrate indices in tidal marsh habitats.

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 16,750.00	$ -	$ 30,421.00	$ 47,171.00
Supplies	$ 1,574.00	$ -		$ 1,574.00
Overhead[a]	$ 4,603.00	$ -	$ -	$ 4,603.00
Equipment	$ 2,100.00			$ 2,100.00
Other (specify)	$ 500.00	$ -	$ 2,000.00	$ 2,500.00
Total	$ 25,527.00	$ -	$ 32,421.00	$ 57,948.00

a = Indirect cost calculated at DOI client 22% for FY11

Other:

Project requests $500 for travel to partner meetings and research sites. In-kind contribution of $2,000 representing specialized equipment trainings, data collection, analysis, and synthesis during development of survey protocols and methodologies.

California Landscape Conservation Cooperative 2011 Proposal Budgets

Projected models of inundation under SLR.

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 16,750.00	$ -	$ 40,030.00	$ 56,780.00
Supplies		$ -		$ -
Overhead[a]	$ 3,685.00	$ -	$ -	$ 3,685.00
Equipment				$ -
Other (specify)		$ -	$ 3,000.00	$ 3,000.00
Total	$ 20,435.00	$ -	$ 43,030.00	$ 63,465.00

a = Indirect cost calculated at DOI client 22% for FY11

Other:

In-kind contribution of $3,000 representing specialized equipment trainings, data collection, analysis, and synthesis during development of survey protocols and methodologies.

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Tijuana Slough National Wildlife Refuge
San Diego Bay National Wildlife Refuge
301 Caspian Way
Imperial Beach, California 91932

April 14, 2011

Debra Schlafmann, Coordinator
California Landscape Conservation Cooperative
3020 State University Dr. East #2007
Sacramento, CA 95819

Dear Debra,

I am pleased to send this letter of support for this interdisciplinary research project entitled "Sea-level rise modeling for California salt marsh gradient for resource managers, evaluation of methodology." The proposed study will address adaptation planning needs of Pacific coastal marshes by employing a bottom-up approach to evaluating sea-level rise effects at the parcel scale. It will provide information and databases useful for assessing local response of tidal marsh communities to sea-level rise, as well as allowing for comparisons across the tidal gradient found on the Pacific coast.

At Tijuana Slough and San Diego Bay NWRs we are working towards implementation of various projects that will use a combination of remote-sensing and ground-based monitoring to create an accurate map and geo-database of the extant habitats and topography of the tidal wetlands and adjacent transitional zones of the Tijuana River Estuary and South San Diego Bay. For the San Diego Bay Refuge, this effort will provide a baseline for assessing future changes to restored salt ponds. These ponds are currently being converted to tidal salt marsh habitat (with expected completion later this year), and it is vital that we be able to track future changes in this system, and understand the hydrologic conditions that will drive the topographic changes over time as the wetland develops. By combining this integrated work with the specific basin modeling to be developed through this proposed research project including elevation, sediment availability and deposition rates, vegetation development and tidal inundation patterns, we have the opportunity to accurately characterize and monitor changes in the bathymetry and hydrology of these important coastal wetlands so we can more effectively manage and restore them now and into the future.

The development of GIS layers that include parcel specific hydrology modeling will be provide a tool for us to evaluate conditions under different predicted sea level rise scenarios. The proposed methodology and process will also be applicable across a larger landscape including other Landscape Conservation Cooperatives with tidal habitats.

I would like to recommend this research team and grant proposal for funding consideration. This effort represents an important step in unifying concepts, methodologies and datasets to address climate change effects and sea-level rise threats to coastal salt marshes and adjacent lands. This project's results will contribute to on-the-ground management and provide information needed to develop regional management plans addressing climate change for the coastal estuarine ecosystem.

Sincerely yours,

Brian Collins

Brian Collins
Wildlife Biologist
San Diego Bay and Tijuana Slough NWR
USFWS
(619) 575-2704 x.318

TAKE PRIDE® IN AMERICA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay National Wildlife Refuge Complex
9500 Thornton Avenue
Newark, California 94560

April 8, 2011

Debra Schlafmann
Coordinator, California Landscape Conservation Cooperative
3020 State University Drive East, # 2007
Sacramento, CA 95819

Dear Debra Schlafmann:

This is a letter of support for the interdisciplinary research project entitled "Sea-level rise modeling for California salt marsh gradient for resource managers, evaluation of methodology." The proposed study will address adaptation planning needs of Pacific coastal marshes by employing a bottom-up approach to evaluating sea-level rise effects at the parcel scale. It will provide information and databases useful for assessing local response of tidal marsh communities to sea-level rise, as well as allowing for comparisons across the tidal gradient found on the Pacific coast.

Resource managers charged with the protection of tidal habitats and communities at risk of impact from sea-level rise cannot afford to be reliant upon regional climate change scenarios when parcel-level decisions are required for future management planning. The proposed study will assess the availability of complementary datasets including: elevation, sediment availability and deposition rates, vegetation, tidal inundation patterns, and species communities. Development of GIS coverages will be provided as a tool for managers to evaluate impacts to their parcels under different predicted sea-level rise scenarios linking site-specific information that will be critical for adaptation decisions in regards to restoration, conservation, and enhancement of tidal marsh fragments. The proposed methodology and process will not only provide useful information to site managers, but, more importantly, is applicable across a larger landscape including other Landscape Conservation Cooperatives with tidal habitats.

I would like to recommend this research team and proposal for consideration. This effort represents an important step in unifying concepts, methodologies and datasets to address climate change effects and sea-level rise threats to coastal salt marshes and adjacent lands. The results will contribute to on-the-ground management and provide information needed to develop regional management plans addressing climate change for the coastal estuarine ecosystem. If you have any questions, please call Joy Albertson at (510)792-0222, Ext. 131.

Sincerely,

G. Mendel Stewart
Project Leader

TAKE PRIDE IN AMERICA

735 B Center Blvd
Fairfax, CA 94930
415-259-0334 phone
415-259-0340 fax

April 11, 2011

Debra Schlafmann
Coordinator
California Landscape Conservation Cooperative
3020 State University Dr. East #2007
Sacramento, CA 95819

Dear Debra:

I am pleased to send this letter of support by the San Francisco Bay Joint Venture for the interdisciplinary LCC research project entitled "Sea-level rise modeling for California salt marsh gradient for resource managers, evaluation of methodology."

The San Francisco Bay Joint Venture is one of 17 wetland habitat Joint Ventures operating under the certification of the North American Waterfowl Management Plan, a Congressional agreement between the United States, Canada, and Mexico. It is a partnership of non-governmental organizations, utilities, landowners, and non-voting agencies. The goal of the San Francisco Bay Joint Venture is to protect, restore, increase and enhance all types of wetlands, riparian habitat and associated uplands throughout the San Francisco Bay region to benefit birds, fish and other wildlife. The Management Board consists of 27 agencies and private organizations whose members agree to support and promote the goal of the Joint Venture and who represent the diversity of wetlands interests found in the San Francisco Bay region.

Resource managers charged with the protection of tidal habitats and communities at risk of impact from sea-level rise cannot afford to be reliant upon regional climate change scenarios when parcel-level decisions are required for future management planning. The proposed study will address adaptation-planning needs of Pacific coastal marshes by employing a bottom-up approach to evaluating sea-level rise effects at the parcel scale. It will provide information and databases useful for assessing local response of tidal marsh communities to sea-level rise, as well as allowing for comparisons across the tidal gradient found on the Pacific coast.

The proposed study will assess the availability of complementary datasets including: elevation, sediment availability and deposition rates, vegetation, tidal inundation patterns, and species communities. Development of GIS coverage will be provided as a tool for managers to evaluate impacts to their parcels under different predicted sea level rise scenarios linking site-specific information that will be critical for adaptation decisions with regards to restoration, conservation, and enhancement of tidal marsh fragments. The proposed methodology and process will not only provide useful information to site managers, but more importantly, is

South Bay Salt Pond Restoration Project

Restoring the Wild Heart of the South Bay

7 April 2011

Debra Schlafmann, Coordinator
California Landscape Conservation Cooperative
3020 State University Dr. East #2007
Sacramento, CA 95819

Subject: LCC Proposal "Sea-level rise modeling for California salt marsh gradient for resource managers, evaluation of methodology"

Dear Ms. Schlafmann,

The South Bay Salt Pond Restoration Project (SBSP) is pleased to send this letter of support for the interdisciplinary research project entitled "Sea-level rise modeling for California salt marsh gradient for resource managers, evaluation of methodology" by John Takekawa and others. The proposed study will address adaptation planning needs of Pacific coastal marshes by employing a bottom-up approach to evaluating sea-level rise effects at the parcel scale. It will provide information and databases useful for assessing local response of tidal marsh communities to sea-level rise, as well as allowing for comparisons across the tidal gradient found on the Pacific coast.

Most of the studies and research to date have focused on a top-down approach of down-scaling climate change and sea level rise models for use in local areas. While such a top-down approach has its uses, the proposed bottom-up approach of the subject study provides a perspective that is not otherwise being provided. We believe both approaches are useful, and together provide for a more robust assessment of our restoration and management options.

The proposed study will assess the availability of complementary datasets including: elevation, sediment availability and deposition rates, vegetation, tidal inundation patterns, and species communities. Development of GIS coverages will be provided as a tool for managers to evaluate impacts to their parcels under different predicted sea level rise scenarios linking site-specific information that will be critical for adaptation decisions in regard to restoration, conservation, and enhancement of tidal marsh fragments. The proposed methodology and process will not only provide useful information to site managers, but, more importantly, is applicable across a larger landscape including other Landscape Conservation Cooperatives with tidal habitats.

The SBSP is the largest tidal wetland restoration project on the West Coast. When complete, the project will restore 15,100 acres of industrial salt ponds to a rich mosaic of tidal wetlands and other habitats. Restoration of South Bay salt ponds provides an opportunity to begin to reverse the loss and degradation our wetlands have suffered by improving the health of San Francisco Bay for years to come. The SBSP will achieve its goals through an adaptive management framework wherein Project Managers measure and analyze changes on the ground and fold that new information back into the management process.

This integrated approach will lead to an understanding of how the South Bay ecosystem responds to management changes. Key to this process is current information on how climate change and sea-level rise will affect the restoration trajectory. The SBSP will work closely with USGS and its partners, as well as other researchers, to use decision support tools such as will come from this study, to make informed restoration and management decisions within the context of accelerating climate change and sea level rise.

Please feel free to contact me if you have further questions at jbourgeois@scc.ca.gov or 408.314.8859.

Sincerely,

John Bourgeois
Executive Project Manager
South Bay Salt Pond Restoration Project

cc: Laura Valoppi, USGS
Cheryl Strong, USFWS
John Krause, CDFG
John Takekawa, USGS

applicable across a larger landscape including other Landscape Conservation Cooperatives with tidal habitats.

The San Francisco Bay Joint Venture Management Board would like to recommend this proposal as a priority for achieving the goals of the Joint Venture. This effort represents an important step in unifying concepts, methodologies and datasets to address climate change effects and sea-level rise threats to coastal salt marshes and adjacent lands. As such it will directly contribute significant information to future wetland conservation planning, and the effective implementation of restoration and enhancement actions to benefit tidal wetlands within our region. Further, this project's results will contribute to on-the-ground management and provide information needed to develop regional management plans addressing climate change for the coastal estuarine ecosystem.

Sincerely,

Bettina Ring
Vice Chair, SFBJV Management Board

11 April 2011

Debra Schlafmann, Coordinator
California Landscape Conservation Cooperative
3020 State University Dr. East #2007
Sacramento, CA 95819

Dear Debra,

I am pleased to send this letter of support for this interdisciplinary research project entitled "Sea-level rise modeling for California salt marsh gradient for resource managers, evaluation of methodology." The proposed study will address adaptation planning needs of Pacific coastal marshes by employing a bottom-up approach to evaluating sea-level rise effects at the parcel scale. It will provide information and databases useful for assessing local response of tidal marsh communities to sea-level rise, as well as allowing for comparisons across the tidal gradient found on the Pacific coast. The Region 8 Inventory and Monitoring Program will partner and provide support for this project since it helps accomplish goals of the program.

Resource managers charged with the protection of tidal habitats and communities at risk of impact from sea-level rise can not afford to be reliant upon regional climate change scenarios when parcel-level decisions are required for future management planning. The proposed study will assess the availability of complementary datasets including: elevation, sediment availability and deposition rates, vegetation, tidal inundation patterns, and species communities. Development of GIS coverages will be provided as a tool for managers to evaluate impacts to their parcels under different predicted SLR scenarios linking site-specific information that will be critical for adaptation decisions in regards to restoration, conservation, and enhancement of tidal marsh fragments. The proposed methodology and process will not only provide useful information to site managers, but, more importantly, is applicable across a larger landscape including other Landscape Conservation Cooperatives with tidal habitats.

I would like to recommend this research team and proposal for consideration. This effort represents an important step in unifying concepts, methodologies and datasets to address climate change effects and sea-level rise threats to coastal salt marshes and adjacent lands. This project's results will contribute to on-the-ground management and provide information needed to develop regional management plans addressing climate change for the coastal estuarine ecosystem.

Sincerely yours,

Karen Laing
Regional Inventory and Monitoring Coordinator

JOHN Y. TAKEKAWA, Research Wildlife Biologist, USGS Western Ecological Research Center, San Francisco Bay Estuary Field Station, 505 Azuar Drive, Vallejo, CA 94592 USA, Tel: 1-707-562-2000; Email: john_takekawa@usgs.gov

(A) PROFESSIONAL PREPARATION

University of Washington, Seattle, WA, USA	Wildlife Science	B.Sc.	1975-1979
University of Idaho, Moscow, ID, USA	Wildlife Ecology	M.Sc.	1979-1982
Iowa State University, Ames, IA, USA	Animal Ecology	Ph.D.	1982-1987

(B) APPOINTMENTS:

1995-present Research Biologist, San Francisco Bay Estuary Field Station, USGS Western Ecological Research Center (WERC), Vallejo, CA

1986-1995 Research Biologist, USGS WERC, Dixon Field Station, Dixon, CA

(C) RELEVANT EXPERIENCE: I established the SFBE field station in 1995 to conduct research on waterbirds and their habitats. Our studies have shown that tidal flats are critical habitats for many migratory bird species, yet there are few studies on the importance of tidal flats or on their ecological function supporting foraging resources for waterbirds. Restoration of bayland habitats may result in changes in sensitive adjacent tidal flat foraging habitats, and the effects of such change are largely unknown. Thus, we have been focusing our research on the relationship of migratory birds to their estuarine habitats and better understand how these resources provide support for wintering and migrating populations. Climate change is expected to have major effects on western estuaries as changes in snowpack and sea level rise alter current hydrology and sediment processes. Our project will use existing data to model changes in tidal flats, and we will extend those models to predict likely effects on migratory birds. We are working with scientists in the CASCaDE project (Computational Assessments of Scenarios of Change for the Delta Ecosystem) that will provide supporting climate change modeling on the estuary.

(D) PUBLICATIONS: (Out of 140+ peer-reviewed journal publications and book chapters)

Takekawa, J. Y., A. K. Miles, D. H. Schoellhamer, D. C. Tsao-Melcer, S. Fregien, and N. D. Athearn. 2009. Dietary flexibility in three representative waterbirds across salinity and depth gradients in salt ponds of San Francisco Bay. Hydrobiologia 626:155-168.

De La Cruz, S. E., J. Y. Takekawa, M. T. Wilson, D. R. Nysewander, J. R. Evenson, D. Esler, W. S. Boyd, and D. H. Ward. 2009. Spring migration routes and chronology of surf scoters (*Melanitta perspicillata*): a synthesis of Pacific coast studies. Canadian Journal of Zoology 87: 1069-1086.

Foxgrover, A. C., P. Dartnell, B. E. Jaffe, J. Y. Takekawa, and N. D. Athearn. 2007. High-resolution bathymetry and topography of south San Francisco Bay, California: U. S. Geological Survey Scientific Investigations Map 2987, 1 sheet. [http://pubs.usgs.gov/sim/2007/2987].

Takekawa, J. Y., A. K. Miles, D. H. Schoellhamer, N. D. Athearn, C. Jannusch, M. K. Saiki, W. D. Duffy, and S. Kleinschmidt. 2006. Trophic structure and avian communities across a salinity gradient in evaporation ponds of the San Francisco Bay estuary. Hydrobiologia 567: 307-327.

Poulton, V.K., J. R. Lovvorn, and J. Y. Takekawa. 2004. Spatial and overwintering changes in clam populations of San Pablo Bay, a semiarid estuary with highly variable freshwater inflow. Estuarine, Coastal, and Shelf Science, 59: 459-473.

KAREN M. THORNE, Climate Change Biologist, USGS Western Ecological Research Center, San Francisco Bay Estuary Field Station, 505 Azuar Drive, Vallejo, CA 94592, Tel: (707) 562-3003; Email: kthorne@usgs.gov

(A) PROFESSIONAL PREPARATION

B.S., 2000, Wildlife, fish, and Conservation Biology, University of California, Davis, CA
M.S., 2008 Geography, University of California, Davis
Ph.D., Candidate, Geography, University of California, Davis

(B) APPOINTMENTS

2011-present	Coastal Technical Team member, The National Fish, Wildlife, Plants, Climate Adaptation Strategy Team
2005-present	Biologist, USGS Western, Ecological Research Center (WERC), Vallejo, CA
2002-2005	Fisheries Biologist, U.S. Fish & Wildlife Service, Fairbanks, AK
2000-2002	Endangered Species Biologist, Jones & Stokes Associates, Sacramento, CA

(C) RELEVANT EXPERIENCE

My masters from the University of California, Davis, in geography were focused on environmental global change and remote sensing techniques. My current dissertation research focuses on an interdisciplinary approach of combining field ecology techniques with climate change adaptation questions. I currently work with Dr. Deborah Elliott-Fisk and Dr. Susan Ustin at UC Davis in developing new approaches to synthesize traditional field data, remote sensing, and climate change information to asses landscape level change from global climate change and how it relates to wildlife habitat.

I currently lead the climate change program at the USGS San Francisco Bay Estuary Field Station where we are evaluating the impacts from projected sea-level rise on salt marsh habitats and endangered species. Current research focuses are: *Landscape level scale of salt marsh impacts from sea-level rise* at 13 salt marsh site around the San Francisco Bay area, including elevation, tidal datum, and vegetation distributions at each marsh; *Modeling inundation patterns* for salt marsh habitats; *High tide predation surveys:* Field data collection of avian predator activity during high tide events. This is used to evaluate risk to endangered salt marsh species during high water events as analogs of future sea levels; and *Evaluate the applicability of Remote Sensing techniques for sea-level rise modeling*.

(D) RELEVANT PRODUCTS

Thorne, K.M., J.Y. Takekawa, and D. Elliott-Fisk. *Submitted*. Ecological effects of climate change on salt marsh vertebrates: a case study from a highly urbanized estuary. *Journal of Coastal Research.*

Thorne, K.M., D. Elliott-Fisk, J.Y. Takekawa, G. Wylie, and W. Perry. *In prep*. Landscape level approach to evaluating subsidence and accretion rates of a salt marsh. *Geomorphology.*

Thorne, K.M., J.Y. Takekawa, K. Spragens, and D. Elliott-Fisk. *In prep*. A case study of the impacts from contemporary sea-level rise on the San Pablo Bay National Wildlife Refuge, CA. *Journal of Wildlife Management*.

Thorne, K.M., S. Ustin, and J.Y. Takekawa. *In prep*. Application of aerial LiDAR in sea-level rise evaluations of salt marsh ecosystems. *Journal of Remote Sensing of the Environment.*

Takekawa, J.Y., K. M. Thorne, K. Spragens, C. Overton, and M. Cassazza. *In prep*. Landscape level effects of sea-level rise on salt marsh habitats of the greater San Francisco Bay. *Diversity and Distributions.*

SUSAN L. USTIN, Department of Land, Air, and Water Resources; University of California, Davis, CA 95616;
Phone office: (916) 752-0621; lab (916) 752-5092; slustin@ucdavis.edu; http://www.cstars.ucdavis.edu

(A) PROFESSIONAL PREPARATION

Cal. State Univ., Hayward, B.S. Biology, 1974
Cal. State Univ., Hayward, M.A. Biology, 1978
UC Davis, Ph.D. Botany, 1983; UC Davis
Postdoctoral (with Jet Propulsion Laboratory), landscape ecology, 1983-1986.

(B) APPOINTMENTS

1999-present Professor of Resource Science, Dept. of Land, Air, and Water Resources (LAWR), UC Davis, 95616
2001-2006 Director, California Space Institute Center of Excellence, University of California, Davis, CA 95616
2001-2005 Associate Director California Space Institute (CalSpace) UC San Diego
2001-2007 Director, DOE's Western Regional Center for Global Environmental Change (WESTGEC)
1995-2001 Associate Director, DOE's WESTGEC Program, UC Davis
1991-1999 Assistant & Associate Professor of Resource Science, Dept. of L.A.W.R., U.C., Davis, CA 95616
1990-1991 Assistant Research Resource Scientist, Dept. of L.A.W.R., U.C., Davis, CA 95616

(C) Relevant Experience (collaborators and coauthors):

M. Andrew, Y.B. Cheng, D. Darling, S.Z. Dobrowski, M. Falk, P.G. Green, J.A. Greenberg, J. Kefauver , S. Kefauver, M. Lay, V. Lay, L. Li (I.U. Indianapolis), M. Multisch, E. McPherson, K. Olmstead, J. Quinn, D. Pyles, K.T. Paw U, C. Ramirez (USFS Sacramento), D. Riano, J.R. Simpson, R. Snyder, H.C. Stimson (U. Toronto), J.L. Tuil, S. Warton, A. Wexler, S. Williams (Bodega Marine Lab), M. Whiting, S. Anderson (Bodega Marine Lab), M. Gertz. **US Co-Authors:** G.P. Asner, Carnegie Inst. Wash, Stanford U, D.D. Breshears, U. AZ, Tucson, J.Q. Chen, U. Toledo, OH, C.B. Field, Carnegie Inst. Wash. Stanford U., R.O. Green JPL, Pasadena, CA, A.F.H. Goetz, U. CO, Boulder, CO, E.R. Hunt, USDA Remote Sensing & Hydrology Laboratory, Beltsville, MD, T.J. Jackson, USDA Remote Sensing & Hydrology Laboratory, Beltsville, MD, R. Kokaly, USGS Denver, CO, W.P. Kustas, USDA Remote Sensing & Hydrology Laboratory, Beltsville, MD, M.J. Montes, Naval Research Lab, Washington DC, H.A. Mooney, Stanford U., W. Oechel, CSU San Diego, G. Okin, U. VA Charlottesville, S. Ogunjemiyo, CSUF, C.M. Ramirez, USFS, Sacramento, D.A. Roberts, UCSB, M. Tugrul Yilmaz (USDA, Beltsville, MD, V.C. Vanderbilt, NASA Ames, Moffitt Field, CA.

(D) PUBLICATIONS (OF 187 REVIEWED PUBLICATIONS AND 121 SCIENTIFIC PROCEEDINGS)

Santos MJ, LW Anderson & SL Ustin 2011. Effects of invasive species on plant communities: an example using submerged aquatic plants at the regional scale. Biol. Invasions 13 (2), 443-457, DOI 10.1007/s10530-010-9840-6.

Khanna S, MJ Santos & SL Ustin 2011. An integrated approach to a biophysiologically based classification of floating aquatic macrophytes. Int. J. Remote Sens.32 (4): 1067–1094.

Zona D, WC Oechel, KM Peterson, RJ Clements, KT Paw U & SL Ustin 2010. Characterization of the carbon fluxes of a vegetated drained lake basin chronosequence on the Alaskan Arctic Coastal Plain. Global Change Biol.16:1870-1882.

Andrew ME & SL Ustin 2010. The effects of temporally variable dispersal and landscape structure on invasive species spread. Ecol. Appl. 20: 593-608.

Andrew ME, & SL Ustin 2009. Spatiotemporal variation in phenology of Lepidium latifolium: Effects of microtopography and hydrology. Ecography 32:860-870.

Santos MJ, S Khanna, EL Hestir, ME Andrew, SS Rajapakse, JA Greenberg, LWJ Anderson & SL Ustin 2009. Use of Hyperspectral Remote Sensing to Evaluate Efficacy of Aquatic Plant Management. Invasive Plant Sci. and Manag. 2: 216–229.

Ustin SL, S Jacquemoud, A Palacios-Orueta, L Li, & ML Whiting 2009. Remote Sensing Based Assessment of Biophysical Indicators for Land Degradation and Desertification. In Remote Sensing and Geoinformation Processing in the Assessment and Monitoring of Land Degradation and Desertification, Trier, Germanay, 2005. Edited by A. Röder and J. Hill. Pp. 15-44. CRC Press, International Society for Photogrammetry and Remote Sensing (ISPRS) Book Series.

ISA WOO, Wetlands Biologist, USGS Western Ecological Research Center, San Francisco Bay Estuary Field Station, 505 Azuar Drive, Vallejo, CA 94592; Phone: (707) 562-2001; Email: iwoo@usgs.gov; URL: http//www.werc.usgs.gov

(A) PROFESSIONAL PREPARATION

University of Wisconsin, Madison**.** M. S. Botany, Wetland Restoration emphasis. 2000
University of California, Berkeley**.** B. A. Integrative Biology, minor in Forestry. 1997

(B) APPOINTMENTS

2003 – current. Wetland Restoration Lead. USGS. WERC, Vallejo CA
2001 – 2003. Wetland Restoration Coordinator. Humboldt State University Foundation and USGS. WERC, Vallejo CA

(C) EXPERIENCE-- Mrs. Woo has 10 years of professional wetland research and monitoring experience as the Wetland Restoration program lead for the San Francisco Bay Estuary Field Station. The wetland restoration program focuses on applied science and monitoring to inform land managers and topics are far-ranging such as: monitoring the effectiveness of large scale estuarine restorations, design experiments to test restoration hypotheses, integration of science in restoration monitoring plans, methods development to measure rapidly changing restoring wetlands, tidal marsh vegetation, inundation and salinity effects on tidal marsh vegetation, meHg in tidal marsh foodwebs, recovery of tidal marsh vegetation after varying levels of all-terrain vehicle impacts, long term datasets and monitoring for endangered tidal marsh species, and prey availability studies within San Francisco Bay estuary and Southern Puget Sound. Mrs. Woo also understands the complexities of collaborations and has built and maintained strong partnership with fellow research scientists as well as Tribal, federal, state, and local managers and stakeholders. Mrs. Woo has authored or co-authored over 75 reports and presentations.

(D) SELECT PUBLICATIONS

Woo, I. and J. Y. Takekawa. In revision. Effects of inundation period and salinity on growth of *Sarcocoria pacifica* (common pickleweed): implications for future sea level rise scenarios and tidal marsh restoration. Wetlands.

Takekawa, J. Y., **I. Woo**, N. D. Athearn, S. Demers, R. J. Gardiner, W. M. Perry, N. K. Ganju, G. G. Shellenbarger, and D. H. Schoellhamer. 2010. Measuring sediment accretion in early tidal marsh restoration. Wetlands Ecology and Management 18: 297-305.

Woo, I, R. Storesund, J. Y. Takekawa, R. J. Gardiner, and S. Ehret. 2009. Integrating Terrestrial LiDAR and Stereo Photogrammetry to Map the Tolay Lakebed in Northern San Francisco Bay [in] Webb and Semmens, eds., Planning for an uncertain future—Monitoring, integration, and adaptation. Proceedings of the Third Interagency Conference on Research in the Watersheds: U.S. Geological Survey Scientific Investigations Report 2009-5049, p. 279-284.

Tsao, D., J. Y. Takekawa, **I. Woo**, J. Yee, and J. Evens. 2009. Home range, habitat selection and movements of California Black Rails at tidal marshes at San Francisco Bay, California. The Condor 111(4): 599-610

Tsao, D., K. Miles, J. Y. Takekawa, and **I. Woo**. 2008. Potential effects of mercury on threatened California black rails. Archives of Environmental Contamination and Toxicology Online First 10.1007/s00244-008-9188-4

Takekawa, J.Y., **I. Woo**, H. Spautz, N. Nur, J. L. Grenier, K. Malamud-Roam, J. C. Norby, A. Cohen, F. Malamud-Roam, S. E. Wainwright-DeLa Cruz. 2006. Environmental threats to tidal marsh vertebrates of the San Francisco Bay Estuary. Studies in Avian Biology.

Takekawa, J.Y., B. Sacks, **I. Woo**, M.B. Johnson, and G.D. Wylie. 2006. Effects of Tidal Marsh Fragmentation on Survival of San Pablo Song Sparrows in the San Francisco Bay Estuary. Studies in Avian Biology.

Woo, I., T. Drlik, L. Swaidon, and W. Quarles. 2002. Integrated management of Knapweed. The IPM Practitioner. 24(4).

Woo, I. and J. B. Zedler. 2002. Can nutrients alone shift a sedge meadow towards the invasive *Typha* x *glauca*? Wetlands. 22:509-521.

Zedler, J. B., R. Lindig-Cisneros, C. Bonilla-Warford, and **I. Woo**. 2001. Restoration of biodiversity: An overview. Pp. 203-212 in S. Levin, editor. Encyclopedia of Biodiversity, Vol. 5. Academic Press, San Diego.

KYLE A. SPRAGENS, Wildlife Biologist, U.S. Geological Survey, Western Ecological Research Center, San Francisco Bay Estuary Field Station, 505 Azuar Drive, Vallejo, CA 94592, 707-562-3003, Email: kspragens@usgs.gov

(A)PROFESSIONAL PREPARATION

M.S., 2010, Natural Resources, Humboldt State University, CA
B.S., 2004, Wildlife Management, Humboldt State University, CA

(B)APPOINTMENTS

2008-present	Wildlife Biologist, USGS SFBE Field Station, Vallejo, CA
2007-2008	Scientific Aide, CDFG, Eureka, CA
2006-2008	Graduate Researcher, Humboldt State University, Arcata, CA
2005-2006	Biological Science Technician, USGS SFBE, Vallejo, CA

(C)RELEVANT EXPERIENCE

Primary research has focused on habitat use and spatial landscape modeling with emphasis on waterbird capture, sampling, implementation and analysis of radio and satellite-telemetry, with respect to landscape movements, use and population demographics. Climate change field coordinator at the San Francisco Bay Estuary Field Station overseeing activities related to tidal inundation monitoring and winter predation surveys to assess the impacts of seasonal tide events on habitat availability and predation risk to San Francisco Bay tidal marsh vertebrates. Field technician during 2005 field season that included capture, marking, and tracking movements of California black rail at three tidal marsh sites in the Petaluma River system. Has recently conducted capture of black rails at sites in the Napa River, China Camp State Park, Rush Ranch in the Suisun marsh, and the Sierra foothills in collaboration with researchers at U.C. Berkeley to aid in collection of genetic samples for California black rail. A Northern Bay Area native with valuable site knowledge of the Petaluma River, Napa-Sonoma Marshes and Suisun marsh which include the two San Francisco Bay NERR sites. Current permits authorize capture and marking of federally listed (endangered) salt marsh harvest mouse and state listed (threatened) California black rail in addition to other non-sensitive species.

(D)RELEVANT PRODUCTS

Spragens, K.A., K.M. Thorne, and J.Y. Takekawa. Exceptional tides, devastating effects: tidal marsh dynamics and species' habitats. Bay-Delta Conference 2010.

Thorne, K.M., J.Y. Takekawa, **K. Spragens**, and D. Elliott-Fisk. *In prep*. A case study of the impacts from contemporary sea-level rise on the San Pablo Bay National Wildlife Refuge, CA. *Journal of Wildlife Management*.

Takekawa, J.Y., K. M. Thorne, **K. Spragens**, C. Overton, and M. Cassazza. *In prep*. Landscape level effects of sea-level rise on salt marsh habitats of the greater San Francisco Bay. *Diversity and Distributions.*

J.Y. Takekawa, K. Thorne, **K. Spragens**, D. Schoellhamer, J. Drexler, J. Calloway, M. Casazza, C. Overton. Evaluating the effects of projected sea-level rise on endemic tidal marsh species in the San Francisco Bay estuary: an interdisciplinary approach. USGS Global Change Conference, Denver, CO. March 2010.

K. Thorne, **K. Spragens**, J.Y. Takekawa, and D. Elliott-Fisk. Evaluating the effects of projected sea-level rise on endemic tidal marsh species of the San Pablo Bay NWR. USGS Global Change Conference, Denver, CO. March 2010.

T. Suchanek, J. Takekawa, K. Thorne, **K. Spragens**, D. Drexler, D. Shoellhamer, M. Casazza, C.Overton. Evaluating the effects of projected sea-level rise on the tidal marsh species in San Francisco Bay estuary. USGS Downscaling Meeting, Raleigh NC, February 23-25, 2010.

Kathleen Swanson PhD, Hydrologist and postdoctoral scholar, USGS California Water Science Center, 6000 J. St., Placer Hall, Sacramento, CA 95819; kathswan@usgs.gov

(A) Education

Ph.D., 2011 Civil and Environmental Engineering, University of California, Berkeley, Berkeley, CA
M.S., 2003 Civil and Environmental Engineering, University of California, Berkeley, Berkeley, CA
B.S.E. 2002 Civil and Environmental Engineering, Duke University, Durham, NC

(B) Relevant Experience

Hydrologist, U.S.G.S., Sacramento, CA 2009-Present
- Development and application of wetland accretion model to SF Bay wetlands
- SSC sampling and analysis within SF Bay wetlands
- Collection and synthesis to wetland datasets to inform wetland modeling

Hydrologist, U.S.G.S., Sacramento, CA 2003, 2004
- Analysis of chemical, hydrological and physical changes in Napa Salt Pond 3 following breaching
- Science support for salt pond restoration

Ph.D. Student, University of California, Berkeley 2003-2011
- Chemical and physical analysis of sediment including ICP-AES and GF techniques
- ADCP operation and data analysis
- Numerical modeling using Matlab

NSF Research Experience for Undergraduates, University of Oklahoma 2001
- Field research investigating hydrology of a wetland in the Tar Creek Superfund Site
- Developed remediation proposal to treat mine discharge and reclaim contaminated sediment

(C) Selected publications and presentations

Swanson, K. M., E. Watson, R. Aalto, J. W. Lauer, M. T. Bera, A. Marshall, M. P. Taylor, S. C. Apte, and W. E. Dietrich (2008), Sediment load and floodplain deposition rates: Comparison of the Fly and Strickland rivers, Papua New Guinea, J. Geophys. Res., 113, F01S03.

Shellenbarger, G.G., K.M. Swanson, D.H. Schoellhamer, J.Y. Takekawa, N.D. Athearn, A.K. Miles, S.E. Spring, and M.K. Saiki. Desalination, erosion, and tidal and ecological changes following the breaching of a levee between a salt pond and a tidal slough. Wetlands, In Prep.

Swanson, K.M., M.T. Stacey, and W.E. Dietrich. Modeling the pattern of deposition on a large lowland river floodplai: Lessons from the Fly and Strickland Rivers, PNG. Geomorphology. In Prep.

Swanson, K.M., J.Z. Drexler, D.H. Schoellhamer, K. Thorne, K. Spragens and J.Takekawa (2010), Sensitivity analysis of the Wetland Accretion Rate Model for Ecosystem Resilience (WARMER), Poster, American Geophysical Union, San Francisco, CA. December 13-17.

Swanson, K.M., J.Z. Drexler, D.H. Schoellhamer, K. Thorne, K. Spragens and J.Takekawa (2010), Integrating biological and physical models to predict the impact of sea-level rise on tidal marsh habitat, Poster, Bay Delta Science Conference, Sacramento, CA. September 27 – 29

Swanson, K.M., M.T. Bera, and W.E. Dietrich (2005), Velocity profiles and turbulent structure over the sand bed of the lower Strickland River, Papua New Guinea, Poster, American Geophysical Union, San Francisco, December 5-9.

Swanson, K.M., G.G. Shellenbarger, D.H. Schoellhamer, N.K. Ganju, N. Athearn, and P. Buchanan (2003), Desalinization, erosion, and tidal changes following the breaching of Napa salt pond 3, Poster, The 6th biennial State-of-the-Estuary Conference, Oakland, California, October 21-23.

Awards and Fellowships

Environmental Engineering Master's Fellowship, University of California, Berkeley 2002-2003

Professional Credentials

Engineer In Training (EIT) Certification