

**Project Leader/Agency/Contact Information:** Grant Ballard, PRBO Conservation Science  
3820 Cypress Drive #11, Petaluma, CA 94954, 707.781.2555 x340, [gballard@prbo.org](mailto:gballard@prbo.org)

**Title:** Tidal Marsh Bird Population and Habitat Assessment for SF Bay Under Future Climate Change Conditions

**Project Summary:** PRBO Conservation Science (PRBO) will project the effects of climate change scenarios on tidal marsh habitats and bird populations in the San Francisco Bay Estuary and communicate specific recommendations for addressing conservation priorities.

**Project Goals:** Our overall goal is to help ensure the conservation of San Francisco Bay tidal marsh habitats and the birds and other wildlife dependent upon them in the context of sea level rise, changing salinity, and other rapidly changing climate change related conditions. We will accomplish this goal by providing planners and managers with detailed information about the future effects of climate change on tidal marshes with specific recommendations for addressing conservation priorities in the area from San Francisco Bay (including San Pablo Bay) to Suisun Bay. Specifically, we will (1) assess the potential effects of climate change on tidal marsh habitats and bird populations, (2) identify priority sites for tidal marsh conservation and restoration, (3) develop a web-based mapping tool for managers to interactively display and query results, readily updatable as more information becomes available, and (4) communicate conservation priorities to management agencies, conservation organizations and the public.

**Conservation Partners:** SF Bay Joint Venture (SFBJV), Bay Area Ecosystem Climate Change Consortium (BAECCC), US Fish and Wildlife Service (USFWS), CA Department of Fish and Game (CDFG), CA Coastal Conservancy (CCC), SF Estuary Institute, SF Estuary Partnership (SFEP), BCDC, Sonoma Land Trust.

**Research Partners:** Philip Williams and Associates (PWA; Steve Crooks, Matt Brennan), UC Berkeley (Maggi Kelly, Lisa Schile), San Francisco State University (SF State; Tom Parker), University of San Francisco (USF; John Callaway), USGS (Noah Knowles, Bruce Jaffe, Dave Schoellhamer, John Takekawa, Judy Drexler).

**How project will advance LCC goals:** This project will provide an assessment of tidal marsh habitat and associated bird populations under current conditions as well as future climate change scenarios. By addressing the dynamic nature of tidal marsh habitats and modeling spatially explicit changes over time, we can improve understanding and guide management actions for habitat- and species-level response to climate change. The products we develop (fine-scale marsh elevation and salinity GIS layers) constitute downscaled climate projections for SF Bay, which can be used by a variety of researchers and conservation partners for other climate change assessment projects. The on-line tool (beta version already developed) will facilitate sharing of information and provide opportunities for site-specific assessments. When complete, it will represent a significant informatics product for the LCC. Our findings will directly inform planning efforts of LCC partners, including the SFBJV (Implementation Plan) and USFWS (Tidal Marsh Recovery Plan).

#### **Methods:**

**1. Assess potential effects of climate change on tidal marsh habitats and bird populations.** Working with our research partners, we have developed a set of geographically based climate change scenarios based on a dynamic marsh accretion model. We have developed preliminary projections for potential changes in tidal marsh elevation and extent over five time frames (20, 40, 60, 80 and 100 years from now) under eight scenarios representing different assumptions about sea-level rise, salinity, and sediment supply. We have also developed public-land and diked-area overlays that allow results to be

partitioned by ownership and levee constraints.<sup>1</sup> These elevation scenarios may be updated if new information on sediment supply and organic accumulation potential are provided by ongoing research projects conducted by partners at USGS, USF, SF State, and PWA. A National Center for Ecological Analysis and Synthesis (NCEAS) workshop focused on tidal marsh carbon sequestration potential, and involving several of our research collaborators, will also build on this work.

We are currently developing salinity change scenarios linked to the same non-linear SLR scenarios used in the accretion models (NRC-I and NRC-III, developed by the National Research Council and adopted by the Army Corps of Engineers). We are applying (100-year) salinity change projections—generated by Noah Knowles (USGS) as part of the CASCaDE project—to current estuarine salinity conditions interpolated from a wide range of monitoring stations around the bay.<sup>2</sup>

We are also refining statistical models for percent cover and height of dominant tidal marsh plant species, as well as models of abundance for avian focal species (Black Rail, Clapper Rail, Song Sparrow, Common Yellowthroat, Marsh Wren). For the vegetation, we are using generalized additive models based on variables characterizing salinity, elevation, levee distance, and channel distance. For bird models, which assume dependence on specific vegetation types as well as physical environmental characteristics, we are using boosted regression trees, deemed more suitable for representing complex variable interactions.

We will apply plant and bird models to existing marsh elevation and salinity change scenarios to project future species distributions, community structure, and population trends. We will use these models to estimate current population sizes of the focal species by region as well as future population sizes, and thus will estimate anticipated population change; current numbers will be calibrated using monitoring data hosted at the California Avian Data Center (CADC). These results will be used by the companion project “Monitoring protocol for detecting changes in San Francisco Bay tidal marsh bird populations resulting from climate change.”

## **2. Identify priority sites for wetland conservation and restoration in SF Bay.**

We will identify (a) wetland areas of conservation importance, vulnerable to change and (b) land acquisition priorities based on marsh sustainability and potential future marsh migration. Our results will include maps of wetland habitat types (elevation with respect to MHHW), vegetation cover/height, and bird abundance under various climate change scenarios for the entire SF Bay. We will identify potential future wetland areas that are currently unprotected (e.g., subsided agricultural and grazing lands in San Pablo Bay). We will assess the potential of planned restoration projects to result in high quality wetland habitats, including possibilities for project enhancement via levee removal or placement of fill material. We will also evaluate and highlight conservation opportunities for target special-status plant and bird species, including likely high tide refugia.

## **3. Develop a web-based mapping tool for managers to interactively display and query results.**

We will develop a system to enable evaluation of restoration potential for specific sites given user-selected sediment inputs and sea-level rise scenarios. Interactive maps derived from our research results will allow users to retrieve information about a particular site or region and perform site-specific (e.g., user-

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<sup>1</sup> Marsh accretion was modeled by PWA using the Marsh98 model (Orr et al. 2003) for a range of starting elevations and sediment concentrations. Model outputs were interpolated for starting elevations ranging from -3.7 to 1.7 m (relative to mean higher high water, MHHW), and applied to a composite 5-m elevation grid for SF Bay, referenced to the MHHW tidal datum. Results for each combination of sea level rise, sediment and organic accumulation assumptions were combined by geographic subregion to produce individual scenario layers.

<sup>2</sup> To adapt salinity projections based on IPCC SLR scenarios, which are widely considered too conservative, we statistically separated out the effect of delta outflows (precipitation - water consumption), calculated the effect due to SLR, and predicted the combined effect of SLR and precipitation changes under higher SLR scenarios (0.52 – 1.65 m/century).

drawn polygons) restoration feasibility queries, such as the starting elevations needed to achieve marsh sustainability under different climate change scenarios. This system will be maintained as a “living” public resource hosted by CADC, with updates made available as new data are incorporated.

**4. Communicate conservation priorities to management agencies, conservation organizations and the public.** We will summarize our findings in a report and work with our partners to include our recommendations in new versions of the Bayland Ecosystem Habitat Goals Report, BCDC’s SF Bay Adaptation Plan, and updates of the SFBJV Implementation Plan. We will provide comments on the USFWS Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. These plans will set the overall strategy, goals and targets for wetland conservation and restoration in SF Bay. Our analyses and recommendations will provide essential information to wetland planners and managers, including the CCC, SFBJV, BCDC, Association of Bay Area Governments, Bay Area Open Space Council, CDFG, USFWS SF Bay National Wildlife Refuge Complex, county agencies, land trusts, and other land owners. We will communicate results with planners and managers through our participation in the technical committees of the SFBJV, the South Bay Salt Pond Restoration Project and the Wetlands Monitoring Group, as well as BAECCC. We will consult with these partners and integrate our information into their plans and habitat management activities. We will work with the SFEP to include our findings in their State of the Estuary Report 2011. We will also present our findings to the research and conservation community at conferences such as the State of the Estuary Conference, Bay-Delta Science Conference, and Wildlife Society meetings.

**Products and timeline:**

- Draft report of methods, findings and recommendations (Sep. 30, 2010)
- Spatial data layers for current and future elevation (habitat type), salinity, and plant and bird species distributions (Sep. 30, 2010)
- Online map viewer and decision-support tool (ongoing, with updates Sep. 30 and Dec. 31 2010)
- Current and future population estimates for tidal marsh avian focal species integrated into final report (Dec. 31, 2010)
- Contributions to conservation planning efforts, participation in meetings, and other direct outreach to partners (ongoing)

**Is the Project on-going?** Yes. This is the second phase of this project. In Phase I (November 2008-May 2010), we developed a set of geographically based climate change scenarios for SF Bay (with collaborators), making spatially-explicit projections of changes in tidal marsh extent under various sea-level rise, salinity, sediment supply and levee scenarios. To display these results, we constructed a beta-version online map viewer and query tool (<http://data.prbo.org/apps/sfbslr>), and are now soliciting and incorporating feedback from partners. We have completed significant data compilation and preparation work for the plant and bird modeling component of the project. The preliminary analysis provides a broad overview of future tidal marsh extent and location in SF Bay as well as a basis for developing more detailed estimates, recommendations and more sophisticated tools to guide planning and management in the second phase of the project (proposed here). The products outlined in the current proposal will use results from Phase I to highlight conservation opportunities and facilitate decision making to ensure long-term benefits for special-status plant and bird species. We will conduct a comprehensive, spatially-explicit analysis of potential climate change impacts to San Francisco Bay tidal marsh habitats, and create robust distribution and abundance models for tidal marsh species, and current and future population estimates. This proposal will also fund final development and refinement of sophisticated decision-support tools and conservation and restoration recommendations that are in high demand from Bay Area managers and conservation organizations.

The first phase of this project (\$120,000) was funded by the Bay Fund of The San Francisco Foundation. The bird and plant modeling work in progress would not be possible without the 14 years of

bird and vegetation survey data collected by PRBO, which has been funded by numerous entities and is valued at over > \$1,000,000.

**Literature Cited:**

Orr, M., S. Crooks, and P. B. Williams. 2003. Will restored tidal marshes be sustainable? San Francisco Estuary and Watershed Science. 1:Article 5.  
<http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art5>.

**Performance Metrics with Timeline for each (all 2010):**

Performance Metric	Jul	Aug	Sep	Oct	Nov	Dec
Meetings with partners to get feedback on products	XXXX	XXXX	XXXX			
Release draft online tool, solicit more comments	XXXX	XXXX	XXXX			
Incorporate comments, draft report		XXXX	XXXX			
Incorporate comments for online tools, two releases			XXXX		XXXX	XXXX
GIS layers for elevation, habitat & salinity available for download			XXXX	XXXX	XXXX	XXXX
GIS layers for current & future plans & bird distributions available for download			XXXX	XXXX	XXXX	XXXX
Avian population projections and final report available for download						XXXX
Web tool in use by all identified conservation partners						XXXX

**Conservation Outcomes:**

Our findings and recommendations will inform decisions that will shape efforts to conserve and restore SF Bay wetlands, such as: Which sites should be protected and/or restored, and by when in the context of increasing SLR and sedimentation availability? How much fill is needed for subsided sites to keep pace with sea level rise? Which levees and other barriers to tidal marsh migration should be removed? Which management actions would likely be most effective in maintaining or restoring bird populations? What are effective targets for future wetland habitat acreage and bird populations?

**Budget- (by outcomes): Total Funds Requested: \$100,241**

**Products #1 & 5: Report of methods, findings and recommendations; communication to partners**

EXPENSES	Amount
Salaries and Benefits	
Nadav Nur (analysis, report author) [\$9,520/mo. x 1.0 mos.]	\$9,520
Julian Wood (report author) [\$5,844/mo. x 1.5 mos.]	\$8,766
Diana Stralberg / Sam Veloz (spatial ecologist, report authors) [\$7,730/mo. x 1.75 mos.]	\$13,528
Sub-total	\$31,814
Travel (meeting attendance)	\$500
Total Direct Costs	\$32,314
Indirect Costs (33.5%)	\$10,825
Total Outcome Expenses	\$43,139
<b>FUNDING</b>	
Requested from CA LCC (pending)	\$23,139
Anonymous Donor (in-hand)	\$10,000
J.M. Long Foundation (pending)	\$10,000
Total Outcome Funding	\$43,139

(budget continued next page)

**PRODUCT #2: Spatial data layers for current and future elevation (habitat type), salinity, and plant and bird species distributions**

<b>EXPENSES</b>	Amount
Salaries and Benefits	
Diana Stralberg / Sam Veloz (spatial ecologist) [\$7,730/mo. x 1.25 mos.]	\$9,663
Dennis Jongsomjit (GIS specialist) [\$5,401/mo. x 2.0 mos.]	\$10,802
Leo Salas (modeling) [\$6,542/mo. x 1.0 mos.]	\$6,542
Total Direct Costs	\$27,007
Indirect Costs (33.5%)	\$9,047
Total Outcome Expenses	\$36,054
<b>FUNDING</b>	
Requested from CA LCC (pending)	\$36,054
Total Outcome Funding	\$36,054

**Product #3: Current and future population estimates for tidal marsh avian focal species**

<b>EXPENSES</b>	Amount
Salaries and Benefits	
Nadav Nur (analysis, monitoring study design) [\$9,520/mo. x 0.50 mos.]	\$4,760
Diana Stralberg / Sam Veloz (spatial ecologist) [\$7,730/mo. x 1.0 mos.]	\$7,730
Leo Salas (programming, models, simulations) [\$6,542/mo. x 0.50 mos.]	\$3,271
Total Direct Costs	\$15,761
Indirect Costs (33.5%)	\$5,280
Total Outcome Expenses	\$21,041
<b>FUNDING</b>	
Requested from CA LCC (pending)	\$16,041
Anonymous Donor (in-hand)	\$5,000
Total Outcome Funding	\$21,041

**Product #4: Online map viewer and decision-support tool/downloadable layers**

<b>EXPENSES</b>	Amount
Salaries and Benefits	
Grant Ballard (project coordination, CADC lead) [\$9,949/mo. x 0.75 mos.]	\$7,462
Leo Salas (programming, models, simulations) [\$6,542/mo. x 0.50 mos.]	\$3,271
Michael Fitzgibbon (lead engineer) [\$7,745/mo. x 2 mos.]	\$15,490
Total Direct Costs	\$26,223
Indirect Costs (33.5%)	\$8,785
Total Outcome Expenses	\$35,008
<b>FUNDING</b>	
Requested from CA LCC (pending)	\$25,008
NOAA SARP (awarded)	\$10,000
Total Outcome Funding	\$35,008

**Total Funds Requested from LCC: \$100,241**

**Matching Funds:** \$35,000 (see Budget above for details).

**Letters of Support:** (1) Will Travis, Bay Conservation and Development Commission, (2) Nadine Hitchcock, Coastal Conservancy, and (3) Ralph Benson, Sonoma Land Trust.



Making San Francisco Bay Better

May 28, 2010

Debra L. Schlafmann  
California Landscape Conservation Cooperative  
Pacific Southwest Region (Region 8)  
U.S. Fish and Wildlife Service  
2800 Cottage Way, Suite W-2606  
Sacramento, CA 95825

SUBJECT: PRBO Conservation Science Funding Requests for Assessing Climate Change Impacts on SF Bay Tidal Marsh Bird Populations and Habitats

Dear Ms. Schlafmann:

I am writing to support the requests for funding from PRBO Conservation Science for two projects entitled: *Tidal Marsh Bird Population and Habitat Assessment for SF Bay Under Future Climate Change Conditions* and *Monitoring Protocol for Detecting Changes in SF Bay Tidal Marsh Bird Populations Resulting from Climate Change*.

Our Commission is very concerned regarding the impact of climate change on the San Francisco Bay Region. The Commission's report "*Living with a Rising Bay, Vulnerability and Adaptation in the San Francisco Bay and on the Shoreline*," assessed the vulnerabilities of the Bay's natural and built environment to the impacts of sea level rise. It concludes that the Bay's wetlands, both tidal and diked, face serious threats from sea level rise.

PRBO's analysis will help identify opportunities to secure remaining habitat areas that will provide future value for tidal marsh plant and bird communities. In addition, they will design an associated monitoring protocol for detecting changes in SF Bay tidal marsh bird populations resulting from climate change.

We believe that the work proposed by PRBO is highly relevant to the Commission's efforts to plan for sea level rise and I urge you to fund the studies. Please feel free to call me (415.352.3653, [travis@bcdc.ca.gov](mailto:travis@bcdc.ca.gov)) or my Deputy Director for Climate Change Steve Goldbeck (415.352.3611, [steveg@bcdc.ca.gov](mailto:steveg@bcdc.ca.gov)) with any questions.

Sincerely,

A handwritten signature in blue ink, appearing to read 'WILL TRAVIS', with a stylized flourish at the end.

WILL TRAVIS  
Executive Director

WT/SG/rca



Debra L. Schlafmann  
California Landscape Conservation Cooperative  
Pacific Southwest Region (Region 8)  
U.S. Fish and Wildlife Service  
2800 Cottage Way, Suite W-2606  
Sacramento, CA 95825

May 26, 2010

RE: PRBO Conservation Science Funding Requests for Assessing Climate Change Impacts on SF Bay Tidal Marsh Bird Populations and Habitats

Dear Ms. Schlafmann:

I am writing to strongly recommend that the California Landscape Conservation Cooperative approve the requests for funding from PRBO Conservation Science for two projects entitled, "Tidal Marsh Bird Population and Habitat Assessment for SF Bay Under Future Climate Change Conditions" and "Monitoring Protocol for Detecting Changes in SF Bay Tidal Marsh Bird Populations Resulting from Climate Change."

Climate change will affect wetlands in the San Francisco Bay through sea level rise and seasonal salinity increases. These changes will transform tidal, freshwater and brackish wetlands into more saline systems and result in greater tidal inundation, thereby changing the plant species composition and habitat structure for birds and other wildlife. Bayland areas already filled, diked, and developed will severely restrict upslope migration of wetlands, resulting in smaller, more fragmented tidal marsh systems. PRBO's analysis will help identify opportunities to secure remaining viable habitat areas that will provide future value for tidal marsh plant and bird communities. In addition, their proposed associated monitoring protocol for detecting changes in SF Bay tidal marsh bird populations resulting from climate change can be applied to monitoring and to adaptive management decisions at many sites where public funding has or will be expended for marsh restoration projects.

This information will also be helpful to our efforts as we work to craft a regional strategy for adapting to the impacts of climate change in the Bay Area. Therefore, I fully support PRBO's proposal to predict the effects of sea level rise and salinity changes on San Francisco Bay wetlands and I urge the California Landscape Conservation Cooperative to fund it in full.

Sincerely,

A handwritten signature in blue ink that reads "Nadine P. Hitchcock".

Nadine P. Hitchcock  
Deputy Executive Officer, CA Coastal Conservancy

1330 Broadway, 13th Floor

Oakland, California 94612-2530

510-286-1015 Fax: 510-286-0470





## SONOMA LAND TRUST

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May 27th, 2010

Debra L. Schlafmann  
California Landscape Conservation Cooperative  
Pacific Southwest Region (Region 8)  
U.S. Fish and Wildlife Service  
2800 Cottage Way, Suite W-2606  
Sacramento, CA 95825

966 Sonoma Avenue  
Santa Rosa, CA 95404  
Tel: 707-526-6930  
Fax: 707-526-3001

[www.sonomalandtrust.org](http://www.sonomalandtrust.org)

RE: PRBO Conservation Science Funding Requests for Assessing Climate Change Impacts on SF Bay Tidal Marsh Bird Populations and Habitat

Dear Ms. Schlafmann:

I am writing to urge your support for the proposals from PRBO Conservation Science entitled, "Tidal Marsh Bird Population and Habitat Assessment for SF Bay Under Future Climate Change Conditions" and "Monitoring Protocol for Detecting Changes in SF Bay Tidal Marsh Bird Populations Resulting from Climate Change." PRBO's analysis will help identify opportunities to secure remaining habitat areas that will provide future value for tidal marsh plant and bird communities. In addition, they will design an associated monitoring protocol for detecting changes in SF Bay tidal marsh bird populations resulting from climate change. As a frequent collaborator with and partner in the mission of PRBO Conservation Science, Sonoma Land Trust strongly recommends that the California Landscape Conservation Cooperative approve their requests for funding for two projects.

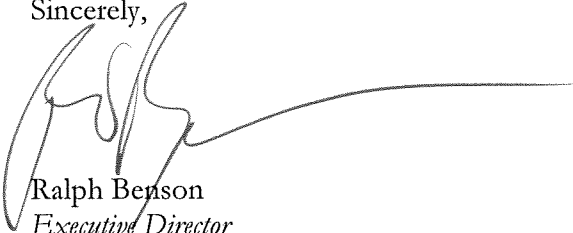
Sonoma Land Trust, a non-profit organization dedicated to protecting the varied scenic, natural, agricultural and open landscapes of Sonoma County, has played an active role in acquiring property and restoring wildlife habitat along San Francisco Bay. We are currently implementing a 1,000 acre tidal marsh restoration project on San Pablo Bay as well as exploring additional opportunities to implement the recommendations of the 1999 Baylands Ecosystem Habitat Goals Report which calls for a continuous band of tidal marsh along San Pablo Bay. Restoration of tidal marsh in this region provides habitat for recovery of many endangered plants and animals.

We are, however, facing new and unprecedented challenges, including the effect of climate change which will affect wetlands in San Francisco Bay through sea level rise and seasonal salinity increases. These changes will transform tidal, freshwater and brackish wetlands into more saline systems and result in greater tidal inundation, thereby changing the plant species composition and habitat structure for birds and other wildlife. Bayland areas already filled, diked, and developed will severely restrict upslope migration of wetlands, resulting in smaller, more fragmented tidal marsh systems.



PRBO has emerged as a leader in providing critical data and analysis to land trusts and other conservation practitioners that is helping us craft a regional conservation strategy for adapting to the impacts of climate change in the Bay Area. We look forward to a continued collaboration with PRBO and encourage you to fully fund PRBO's proposal to predict the effects of sea level rise and salinity changes on San Francisco Bay wetlands.

Sincerely,

A handwritten signature in black ink, appearing to read 'R. Benson', with a long horizontal flourish extending to the right.

Ralph Benson  
*Executive Director*