Project Title:

A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change – PHASE II

Proposal by:

Matt Reiter, Quantitative Avian Ecologist
PRBO Conservation Science
Tomkat Field Station, P.O. Box 747
Pescadero, CA 94060

760-417-9997
mreiter@prbo.org

Scope & Budget:

Location: CA LCC-Wide
Duration in months: 24
Requested Funding: $90,000.00
Leveraged Funding: $213,584.00

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 lack of broad-scale coordinated monitoring for shorebirds in the CA LCC and the Pacific Flyway limits our ability to effectively manage their populations particularly in light of the predictions of climate change, which will likely alter habitat conditions (e.g. sea-level rise, reduced wetlands due to drought). PRBO Conservation Science is developing a broad-scale monitoring program to detect trends and quantify habitat relationships for Pacific Flyway shorebird populations. To accomplish our goals for this monitoring program within the CA LCC, we will complete three objectives in Phase II of this project: (1) Complete the shorebird monitoring plan for the CA LCC by developing a sampling design and monitoring protocol for wintering shorebirds in coastal southern California and northern Mexico. We will also integrate existing shorebird data collection efforts from the coastal southern California region and Mexico through new shorebird online data portal; also a product of LCC 2010. (2) Develop models to evaluate the influence of habitat factors from multiple spatial scales on shorebird use of San Francisco Bay and managed wetlands in the Sacramento Valley, as a model for the entire CA LCC. Our habitat association models serve as the basis to provide management recommendations to wetland habitat managers about how to allocate resources to maintain shorebird population objectives. (3) Develop an analytical framework to iteratively evaluate competing hypotheses about shorebird habitat associations and the impact of habitat changes as new monitoring data are available. Our project will provide baseline data and ongoing evaluation of wintering shorebird trends and habitat to inform management and conservation actions (i.e. water allocation in the Sacramento Valley; tidal flat and roosting site needs in coastal estuaries) in response to current and future land-use and climate-related changes.

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.

This is a continuation of a 2010 LCC project and has continued relevance in light of both 2011 LCC priorities. We have completed or are nearing completion of all deliverables from Phase I. In November 2010, we launched the new shorebird data entry portal through CADC. We collected data from >100 citizen scientists and biologists from throughout the CA LCC through this new tool. Interactive data summary tools, available by mid-April, will allow users to summarize

shorebird data within CADC at multiple spatial scales. We have completed the San Francisco Bay Shorebird Monitoring Plan and have submitted it to the CA LCC and external partners for review. We completed the water distribution maps for the Central Valley and are summarizing these data. By the end of May all deliverables as part of LCC 2010 funding will be complete and available online. Phase II is needed to complete the shorebird monitoring strategy for the entire CA LCC. The 2010 products provide a framework to facilitate the work in this proposed Phase II and we will build upon these earlier successes. We have initiated preliminary assessment of monitoring programs in southern CA LCC and have been in contact with partners who have shorebird monitoring data that we will use for simulations and sampling design assessments. Data for developing habitat models in San Francisco Bay and the Sacramento Valley are available for analysis and preliminary steps have been taken to prepare these data. Although a coordinated shorebird monitoring program for the CA LCC is clearly needed, using the data gathered is a critical component to maximizing the usefulness of the program. The habitat association models and iterative analytical framework that will be completed in Phase II of this program will allow surveillance monitoring data to be integrated into a formal adaptive management structure.

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

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. 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

PRBO (Contribution / In-Kind): $188,704 USFWS (In-Kind): $8,700 US Navy (In-Kind): $5,680 Sonoran Joint Venture (In-Kind): $3,500 CICESE (In-Kind): $7,000 _____ TOTAL: $213,584

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.

We have assembled a strong team of avian and quantitative ecologists to work on this ambitious and important project. Dr. Matthew Reiter (PRBO Conservation Science) is the project PI and will complete the majority of quantitative analyses. Dr. Reiter has over 10 years experience studying avian ecology and is an expert in sampling migratory bird populations and the application of analytical techniques to link birds with their habitats. Dr. Reiter is the PI on PRBO's Pacific Flyway Shorebird Survey project and on Phase I of this project funded by the 2010 CA LCC. Recent projects for Dr. Reiter include being PI on the Pacific Flyway Shorebird Survey (May 2009 – present; 45% time; $125k per year budget); PI on Phase I of this project funded through the 2010 CA LCC (Sept 2010 – present; 20% time; $50k); and quantitative ecologist on two compatible agriculture projects (May 2009 – present; 20% time; $250k). Mike Wolder (USFWS) is the lead biologist at the Sacramento National Wildlife Refuge Complex with >20 years of experience in wildlife management and research. Mr. Wolder initiated monitoring of shorebirds on the refuge complex in 1994 and has consulted many researchers at the refuge. Mr. Wolder's time commitments are linked directly to the tasks listed on his CV and his annual budget is dictated by the annual refuge budget. Brian Collins (USFWS) has worked as a wildlife biologist at the San Diego NWR Complex since 1994. As Wildlife Biologist for the coastal refuges in San Diego County, he oversees the Tijuana Slough National Wildlife Refuge, the south San Diego Bay NWR, and the Sweetwater Marsh NWR. Mr. Collins' time commitments are linked directly to the tasks listed on his CV (primarily overseeing a captive propagation program and biological monitoring) and his annual budget is dictated by the annual refuge budget. Carol

Beardmore (USFWS) is the Science Coordinator the Sonoran Joint Venture and has worked as an ornithologist for >20 years. She is also the editor of the "Sonoran Joint Venture Bird Conservation Plan" which includes southern regions of the CA LCC. Ms. Beardmore has no PI responsibilities. Her primary projects include coordination of a small grant program, monitoring coordination, liaison to partners, and leader of the SJV Technical Committee. She works with a budget to administer the Joint Venture provided by USFWS. Dr. Eduardo Palacios is an ecologist for CICESE at a research center in Baja, Mexico. Dr. Palacios has >20 years experience working with shorebirds and waterbirds in northern Mexico including coordinating surveys at key locations within the CA LCC. Recent projects for Dr. Palacios include: (1) an evaluation of the population status of the American and Black Oystercatchers in northwest Mexico (Apr 2009 - Oct 2010; Part-time; $25K), (2) conservation of priority wading birds breeding in México, specific to Reddish Egrets (Jan 2008 - Mar 2010; Part-time; $60K), and (3) conservation status of Snowy Plovers breeding in coastal Mexico (Jan - Decr 2007; Part-time; $80K). We will also be working closely with US Navy wildlife biologists Tiffany Shepherd (San Diego Bay) and Martin Ruane (Mugu Lagoon).

Project Title: A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change – **PHASE II**

Project Leader/ Contact Information: Matthew E. Reiter, PRBO Conservation Science, Tomkat Field Station, P.O. Box 747, Pescadero, CA 94060; (760) 417 - 9997; **mreiter@prbo.org**

Project Description: Shorebird populations in North America have experienced recent declines due to environmental changes including habitat loss and degradation. The impacts of climate change will add even more pressures. Understanding how shorebird populations are likely to respond to changes in land use and climate is essential for their conservation and management. This funding request is for the continuation of a 2010 California Landscape Conservation Cooperative (CA LCC) project to develop a large-scale, coordinated monitoring program for wintering shorebirds within the CA LCC region as a basis for informing shorebird conservation and habitat management in the face of climate change.

Hemispherically-significant proportions of Pacific Flyway shorebird populations concentrate within the boundaries of the CA LCC in winter, a critical season in their life history. However, there is little information on trends or habitat associations of these shorebird populations to guide conservation and management. We need a strategy to track shorebird population trends and evaluate their response to changing habitat and environmental conditions in order to set priorities for conservation and to evaluate management effectiveness within the CA LCC and in the Pacific Flyway. Phase I of this proposed project made advances towards fulfilling this need by developing two large-scale shorebird monitoring plans and the framework for data centralization and analysis (see "Continuing Project" section below).

The spatial distribution of wintering shorebirds is influenced by multiple factors that vary in their importance among spatial scales. Despite localized aggregation of shorebirds, likely a result of aggregated food resources, very specific foraging habitat needs, and protection from predators, their ability to rapidly change distribution in response to habitat factors makes the impact of local habitat management difficult to assess in the context of the overall population through local-scale monitoring alone. Typically, shorebird habitat management occurs within a wetland or wetland complex at a fairly localized spatial scale (<1 - 2 km). However, the effectiveness of these management strategies to attract shorebirds may vary due to annual variability in the availability of habitat in the surrounding landscape (e.g., the extent of flooded rice in the Sacramento Valley) or may change over time from habitat conversion and management (e.g., salt ponds to tidal marsh in the San Francisco Bay Estuary). For managers to make informed management decisions requires understanding how their localized actions contribute to the overall shorebird habitat in the broader landscape. Distinguishing local versus large-scale changes in shorebird population as the result of local management requires a measure of the conditions within each individual site, as well as a regular assessment of variation in the distribution and abundance of birds and habitat among sites over a larger spatial extent (e.g. Sacramento Valley, CA LCC).

PRBO Conservation Science (PRBO) is developing a broad-scale monitoring program to detect trends and quantify habitat relationships for Pacific Flyway shorebird populations, the Pacific Flyway Shorebird Survey (PFSS; http://data.prbo.org/partners/pfss/). The PFSS has the primary goals of: (1) developing an efficient, sustainable yet statistically robust sampling design and monitoring protocol for the Pacific Flyway; (2) establishing a framework to capture, manage, share, and analyze these monitoring data; and (3) understanding critical associations between habitat management, habitat change, and spatial scale on the abundance of shorebirds in order to inform conservation and management actions. This third goal is particularly needed in light of climate change and the call for climate change adaptation strategies. In Phase I of this project, we developed an online shorebird data portal, survey designs and protocols for coastal and interior habitats, and habitat data layers. The project proposed here builds upon this work completed in Phase I, addresses CA LCC priorities, and contributes to the development of the broader PFSS.

To accomplish our goals for the PFSS within the CA LCC, we will complete three objectives in Phase II of this project: (1) Complete the shorebird monitoring plan for the CA LCC by developing a sampling design and monitoring protocol for wintering shorebirds in the southern CA LCC. This will build upon the San Francisco Bay and Central Valley shorebird monitoring plans developed with support from CA LCC 2010 funding. We will

also integrate existing shorebird data collection from the southern CA LCC through the new online shorebird data portal; also a product of CA LCC 2010. (2) Develop models to evaluate the influence of habitat factors from multiple spatial scales on shorebird use of San Francisco Bay and managed wetlands in the Sacramento Valley, as a model for the entire CA LCC. Our habitat association models will serve as the basis to provide management recommendations to wetland habitat managers about how to allocate resources to maintain current shorebird population objectives. (3) Develop an analytical framework to iteratively evaluate competing hypotheses about shorebird habitat associations and the impact of habitat changes as new monitoring data are available through the California Avian Data Center (CADC) annually from the PFSS. Our project will provide baseline data and ongoing evaluation of wintering shorebird trends and habitat to update management recommendations and inform conservation actions (i.e. water allocation in the Sacramento Valley; tidal flat and roosting site needs in coastal estuaries) in response to current and future land-use and climate-related changes.

Deliverables will include: (1) compilation of existing shorebird monitoring programs across California and the CA LCC; (2) centralization and sharing of monitoring data from many existing partner programs through CADC; (3) a report recommending sampling design and monitoring protocol for wintering shorebirds in the southern CA LCC and San Diego Bay; (4) a manuscript for peer-review publication summarizing results of habitat association modeling; (5) an analytical framework to allow iterative updating of habitat association models as shorebird monitoring data are collected; and (6) a webpage identifying (a) a set of recommendations for wetland managers based on habitat association models and (b) the results of annual updates to the habitat association models.

CA LCC Priorities addressed: Our project provides the foundation for a long-term, sustainable monitoring program to establish baselines and track trends in Pacific Flyway shorebird populations in the CA LCC (priority addressed: *long term monitoring to establish ecological baselines*). We also provide a framework to evaluate the impacts of habitat changes on wintering shorebirds from climate change, management actions, and climate change adaptation strategies (*monitoring in the context of fully implemented adaptive monitoring frameworks)*. Our modeling approach is designed to reduce decision uncertainty and guide management actions both locally and across the entire CA LCC (*models at scales relevant to resource managers)*. The new shorebird monitoring plan, including standardized methodology and iterative data evaluation, will facilitate data and information sharing among a wide range of LCC partners and enable further collaborations to track and understand shorebird population trends, habitat associations, and, subsequently, impacts of the changing environmental landscape (*developing/standardizing metrics of change, open access information)*. The results generated as part of this work will facilitate future scenario planning at local, landscape, and eco-regional scales (*future scenario planning at landscape and ecoregional scales*). Furthermore by improving our understanding of factors influencing the distribution and abundance of shorebirds, we provide the necessary information for identifying ecosystem impacts of adaptive land-use change to minimize conflicts between human infrastructure changes and shorebird conservation (*identifying ecosystem impacts of adaptive land-use change*).

CA LCC Criteria addressed: Our proposed large-scale monitoring framework will provide regular data on the impacts of habitat management and climate change on the shorebird populations in the CA LCC. These analyses can determine plausible management strategies and quantify the impacts of those that have been put into place (criteria addressed: *applicability to conservation and adaptation decisions*). Currently our ability to forecast impacts of changing climate and habitat on shorebirds wintering in the CA LCC is limited by a lack of data and informative analyses. Our project will provide needed baseline data and ongoing assessment to understand the impacts of climate change on shorebird populations in California and reduce uncertainty of the effects of climate adaptation strategies (*ecological or ecosystem response to system/climate change*). Our analyses will use GIS layers, developed in Phase I, to assess the influence of the distribution of water in the Central Valley on shorebirds. We will model associations of five shorebird species and their habitat (climatic and habitat covariates) to better understand the scale at which environmental changes will influence the

effectiveness of localized shorebird management. These analyses will reduce uncertainty about the spatial scale to apply climate adaptation strategies and conservation actions (*breadth of understanding*). We will produce at least one peer-reviewed manuscript from this work, and results will be available through online interactive data tools and a webpage detailing our iterative model analyses (*accessibility*). The monitoring and analytical framework developed in this project is transferable to other wildlife monitoring programs within the CA LCC and in other LCCs. The online data entry portal allows many partners to contribute data easily and they can then take advantage of interactive data summary tools; both developed during Phase I of this project (*scope/transferability*). Thus far, we have partnered with six federal, state and local government agencies, and eight NGO's to coordinate shorebird surveys in the northern coastal and Central Valley portions of the CA LCC. We will build new collaborations with additional government agencies and NGOs as we expand this monitoring network, including partners in northern Mexico. We estimate >$210,000 in matching funds and in-kind support as part of this broad-scale, multi-partner project (*partnerships/leveraging*). This work is timely and needed as many shorebird populations in the CA LCC are thought to be declining. Linking shorebird monitoring data with habitat data in an adaptive management analytical framework will improve decision making to conserve necessary habitat and provide valuable information to improve the long-term success of the CA LCC (*timeliness and urgency*).

Approach and Scope of Work:

Develop a sampling design and monitoring protocol for wintering shorebirds in southern CA LCC and San Diego Bay using historic data and simulations. We will expand our wintering shorebird survey design into the southern region of the CA LCC. Generally, we are applying a 2-stage sampling design for shorebirds in the CA LCC. First, we will identify wetlands of importance for shorebirds using historic data collected by PRBO and other partners (Navy, USFWS etc.). Then we will identify existing monitoring programs in the southern CA LCC (e.g. Mugu Lagoon, Newport Bay) and determine if they meet the standards of the PFSS data collection protocol. We will develop a partnership with the existing program to coordinate efforts within the broader CA LCC-wide monitoring strategy. Lastly, we will develop online data-entry portals for partnering monitoring programs within CADC. For locations selected for surveys that do not have a monitoring program, we will work with local organizations and available site-specific data to develop an appropriate sampling design to efficiently collect data. Currently, San Diego Bay (a Western Hemisphere Shorebird Reserve Network site) is a site that requires annual long-term monitoring in order for this CA LCC program to be successful. We will use existing comprehensive survey data in a simulation exercise to determine the optimal sampling design for shorebirds in San Diego Bay. We conducted a similar simulation analysis using historic data for San Francisco Bay as part of our 2010 CA LCC project.

Develop multi-scale habitat models to evaluate the factors influencing shorebird use of San Francisco Bay and managed wetlands in the Sacramento Valley. We will use historic monitoring data to evaluate the factors influencing the distribution and abundance of roosting shorebirds in the San Francisco Bay estuary (SF Bay) over the last 20 years (1990 – 2010). We will also model factors influencing shorebird use of six National Wildlife Refuges that make up the Sacramento Valley National Wildlife Refuge Complex (SNWRC) between 2000 and 2010. We will consider five shorebird species in our initial model assessment in each landscape.

SF Bay - Comprehensive surveys were conducted for roosting shorebirds in SF Bay during November 1990 – 1992 and 2006 – 2008. Data were collected at >300 sampling units representing all shorebird habitat in the estuary. We will employ these data in conjunction with GIS habitat data to model factors influencing shorebird use and assess the scale at which habitat influences the abundance of roosting shorebirds in each sampling unit. We will characterize each sampling unit according to the dominant habitat type. We will calculate the proportion of tidal flat, salt pond, and tidal marsh habitat within 2-, 5-, and 10-km buffers around the sampling unit. We will also categorize each sampling unit as occurring in one of three regions of SF Bay; categories will be used as a factor in regression analyses to evaluate spatial shifts in the distribution of shorebirds. Lastly, we will include year as a covariate in our analysis to account for temporal changes overtime.

Sacramento Valley - We will employ long-term shorebird monitoring data from the SNWRC to evaluate factors influencing the abundance of shorebirds using the managed wetlands on SNWRC in early winter (November – December) between 2000 and 2010. SNWRC staff conducts surveys of all wetland units on six refuges for birds 2-times per month. During each survey, all shorebirds are counted by species and the proportion of each wetland unit that is flooded is estimated. Additional metadata recorded for each wetland unit include wetland type (e.g. semi-permanent, permanent, seasonal) and initial flood date. We will use the wetland unit as the sampling unit for our analysis. Variables considered in analysis will include percent flooded and days since first flood at the sampling unit scale, and the percent flooded rice and percent of flooded managed wetlands within 2-, 5-, and 10-km buffers in the landscape surrounding the sampling unit. We will also evaluate year-to-year, large-scale variation at the refuges using total amount of flooded area in the entire Sacramento Valley as a covariate. We will use classified Landsat images (2000 – 2010) developed as part of our 2010 CA LCC work to estimate the total amount of flooded rice and other wetlands surrounding wetland units at the refuge and for the entire Sacramento Valley.

Analysis - We will use mixed-effects hierarchical regression to model the influence of habitat and regional covariates on the expected count of shorebirds in a sampling unit, in either SF Bay or SNWRC, while accounting for correlations among observations. We will develop a set of models to evaluate *a priori* and employ a model selection approach to determine the relative support for each model in the model set. We will rank competing models using Bayesian Information Criterion (BIC). Accounting for temporal and spatial autocorrelation is necessary to accurately estimate sample variance. We will evaluate spatial and temporal autocorrelation using Moran's-I and temporal autocorrelation functions, respectively, both prior to model fitting and again with model residuals.

Develop a framework for iterative learning and adaptive management within CADC to provide decision support to habitat managers. In Phase I of this project, we developed online data entry portals in CADC to collect data from shorebird surveys and interactive online tools to summarize these data. In Phase II of this project, we will further exploit the data centralization. We will develop an analytical framework using data from CADC to iteratively evaluate the bird-habitat models as additional data become available, and update management recommendations as needed. First, we will establish a storage warehouse for spatially explicit habitat data for our sampling units and collaborate with partners to centralize these data. We will work with SNWRC staff to query bird survey and habitat data to facilitate data sharing between their existing database management system and CADC. We will work with members of PRBO's Informatics staff to format data for analyses and develop the analytical infrastructure to analyze models as new monitoring data (birds and habitat management) enter the system. We will apply Bayesian statistics which provide a quantitatively rigorous approach to update models overtime using annually collected shorebird monitoring data. Once this structure is developed it can be readily applied to other long-term monitoring programs to evaluate competing models and quantify uncertainty. The details of this analytical approach, the annual updated results, and management recommendations will be made available through a webpage.

Products/Data Sharing (timeline assumes funding date of 07/01/2011):

1. *Sampling design and monitoring protocol for wintering shorebirds in southern CA LCC and San Diego Bay using historic data and simulations.*
   a. Compilation of existing shorebird monitoring programs across CA LCC. The list of partnering programs will be available on the PFSS webpage and the full list will be made available to CA LCC. – *November 1, 2011*
   b. Report recommending sampling design and monitoring protocol for wintering shorebirds in southern CA LCC and San Diego Bay. Report will be made available to the CA LCC and posted to the PFSS webpage. – *January 31, 2012*
2. *Develop multi-scale habitat models to evaluate the factors influencing shorebird use of San Francisco Bay and managed wetlands in the Sacramento Valley*.

a. Manuscript for peer-review publication summarizing results of habitat modeling. We will provide a draft manuscript to the CA LCC as well project partners in March 2012, and the final manuscript will be posted on the PFSS webpage upon publication. – *March 31, 2012*

3. *Develop framework for iterative learning and adaptive management within CADC to provide decision support to habitat managers.*
   a. Analysis framework functional and linked to shorebird monitoring data. We will provide a report demonstrating this new capacity to the CA LCC and make it available on the webpage below. – *January 31, 2012*
   b. Webpage detailing analytical framework, updated model assessments, and management recommendations. The webpage will be open-source. – *March 31, 2012*

Measuring Results: Our project provides the needed framework to improve conservation and management for shorebirds in the CA LCC. Once the sampling design and monitoring plan is complete, we can measure the success of our work through the implementation of the program as follows. In November 2011, we anticipate pilot implementation of our sampling design and monitoring protocol at sites in southern CA LCC including San Diego Bay. Our habitat association models will provide information to help managers in SF Bay and SNWRC make decisions about how to allocate resources to provide habitat for wintering shorebirds. We will share this information with managers through in-person consultations and online resources developed on the project webpage. We will keep track of whether our recommendations are implemented and whether they had the intended effects. Lastly, with the iterative model analysis framework in place, we can pilot its functionality with 2011 survey data. This analytical framework is also an example for other monitoring programs as to how data collected can be used regularly and effectively to evaluate uncertainty. We envision other monitoring programs using the template we have developed. Thus a measure of success would be the number of programs that use this new framework. In addition, this analytical framework could be used in a fully adaptive management structure and to inform optimal decision making in the face of climate change. We will work with interested partners to apply this work throughout the CA LCC and beyond.

Continuing Project: This is a continuation of a 2010 LCC project and has continued relevance in light of both 2011 LCC priorities. We have completed or are nearing completion of all deliverables from Phase I. In November 2010, we launched the new shorebird data entry portal through CADC. We collected data from >100 citizen scientists and biologists from throughout the CA LCC through this new tool. Interactive data summary tools, available by mid-April, will allow users to summarize shorebird data within CADC at multiple spatial scales. We have completed the San Francisco Bay Shorebird Monitoring Plan and have submitted it to the CA LCC and external partners for review. We completed the water distribution maps for the Central Valley and are summarizing these data. By the end of May all deliverables as part of LCC 2010 funding will be complete and available online.

Phase II is needed to complete the shorebird monitoring strategy for the entire CA LCC. The 2010 products provide a framework to facilitate the work in this proposed Phase II and we will build upon these earlier successes. We have initiated preliminary assessment of monitoring programs in southern CA LCC and have been in contact with partners who have shorebird monitoring data that we will use for simulations and sampling design assessments. Data for developing habitat models in San Francisco Bay and the Sacramento Valley are available for analysis and preliminary steps have been taken to prepare these data. Although a coordinated shorebird monitoring program for the CA LCC is clearly needed, using the data gathered is a critical component to maximizing the usefulness of the program. The habitat association models and iterative analytical framework that will be completed in Phase II of this program will allow surveillance monitoring data to be integrated into a formal adaptive management structure.

California Landscape Conservation Cooperative 2011 Proposal Budgets

Reiter / PRBO Shorebird Monitoring in the CA LCC

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Product 1: Monitoring Plan				
Salaries:				
Project Coordinator / Quantitative Ecologist (PRBO)	$ 8,923	$ 28,588	$ -	$ 37,511
Informatics (PRBO)	$ 2,000	$ 10,000	$ -	$ 12,000
Shorebird Ecologist (PRBO)	$ 7,500	$ 20,000	$ -	$ 27,500
US Navy shorebird biologist (US Navy)	$ -	$ -	$ 5,680	$ 5,680
San Diego Bay shorebird biologist (USFWS)	$ -	$ -	$ 3,700	$ 3,700
Mexico shorebird biologist (CICESE)	$ 3,000	$ -	$ 5,000	$ 8,000
South coast shorebird biologist (Sonoran Joint Venture)	$ 3,500	$ -	$ 3,500	$ 7,000
Supplies:				
Computing resources (PRBO)	$ -	$ -	$ 35,000	$ 35,000
Existing data and protocols (PRBO)	$ -	$ -	$ 10,000	$ 10,000
Other (specify):				
Outside Services	$ 2,000	$ -	$ -	$ 2,000
Travel - Domestic	$ 3,000	$ 5,000	$ -	$ 8,000
Travel - Foreign (Mexico)	$ 4,000	$ 5,000	$ -	$ 9,000
Overhead (33.5%)	$ 10,024	$ -	$ -	$ 10,024
Subtotal Product 1	**$ 43,947**	**$ 68,588**	**$ 62,880**	**$ 175,415**
Product 2: Habitat Modeling				
Salaries:				
Quantitative Ecologist (PRBO)	$ 8,923	$ 19,058	$ -	$ 27,981
Informatics (PRBO)	$ 2,000	$ -	$ -	$ 2,000
Sacrmento Valley Refuge Biologist (USFWS)	$ -	$ -	$ 5,000	$ 5,000
Shorebird Ecologist (PRBO)	$ 6,500	$ -	$ -	$ 6,500
Supplies:	$ -	$ -	$ -	$ -
Computing resources (PRBO)			$ 10,000	
Other (specify):	$ -	$ -	$ -	$ -

Publication costs	$ 1,500	$ 2,000		
Conference fees and travel	$ 3,000	$ 2,500	$ 2,500	$ 8,000
Overhead	$ 7,344	$ -	$ -	$ 7,344
Subtotal Product 2	**$ 29,267**	**$ 23,558**	**$ 17,500**	**$ 56,826**
Product 3: Analytical Framework				
Salaries				
Quantitative ecologist (PRBO)	$ 8,915	$ 19,058	$ -	$ 27,973
Informatics (PRBO)	$ 6,471	$ 10,000	$ -	$ 16,471
Supplies:				
Equipment:				
Computer resources	$ -	$ -	$ 10,000	$ 10,000
Computer upgrades	$ 1,400		$ -	$ 1,400
Overhead:	$ 5,623	$ -	$ -	$ 5,623
Subtotal Product 3	**$ 16,786**	**$ 29,058**	**$ 10,000**	**$ 61,467**
Total	$ 90,000	$ 121,204	$ 90,380	$ 301,585

SAN FRANCISCO BAY JOINT VENTURE

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 second phase of the interdisciplinary research project entitled "A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change – PHASE II."

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.

Located on the Pacific Flyway, the San Francisco Bay Estuary is a vital stopover and wintering area for water birds and hosts higher proportions of total wintering and migrating shorebirds on the US Pacific Coast than any other wetland complex. Therefore, the San Francisco Bay estuary's importance to shorebird conservation is disproportional to other estuarine wetlands within the California LCC. Over 35,000 acres of coastal wetland restoration projects are currently planned or in progress within the San Francisco Bay Estuary that will benefit shorebirds and other water birds. Climate change and other environmental challenges provide major uncertainties likely affecting the success of these restorations and long-term habitat values for wetland birds. For example, the San Francisco Bay area stands to experience significant impacts from sea level rise because tens of thousands of acres of low elevations currently support vast areas of tidal flats and tidal marshes. This continuing CA LCC project will affect the implementation of a large-scale, coordinated monitoring program for wintering shorebirds within the CA LCC to inform their conservation and management in the face of climate change.

Understanding how the size and distribution of shorebird populations are likely to respond to changes in land use and climate is essential for their conservation and management all over the Pacific Flyway. Results of this program will help resource managers throughout the LCC assess how shorebird populations will fare in the face of sea level rise, altered freshwater flow, changed salinity regimes and sediment supply, and other projected habitat related challenges, and help them plan management actions accordingly. The proposed program will further supply vital information to many stakeholders and Joint Venture partners involved in long-term planning within the San Francisco Bay Estuary and beyond.

The Joint Venture Management Board believes that PRBO has several core strengths that make it uniquely suited to lead this project and develop important science and conservation tools that will help both the LCC and the Joint Venture in achieving their goals. Some of the core strengths that will help PRBO succeed in their proposed work are: vast experience with environmental monitoring, experience in conservation science, an ethic of partnership building, well-developed informatic infrastructure, and expertise in climate change effects on wildlife.

The Joint Venture Management Board recommends this project as it will build upon the San Francisco Bay and Central Valley shorebird monitoring plans developed by PRBO in 2010, and will integrate shorebird data collection throughout the CA LCC. It will develop needed models to evaluate habitat factors influencing shorebird use of San Francisco Bay and managed wetlands in the Sacramento Valley at multiple scales, as a model for the entire CA LCC. These habitat association models will inform the allocation of resources at the appropriate spatial scale to maintain shorebird population objectives. The project will further provide an analytical framework to iteratively evaluate the impact of habitat changes as new monitoring data become available through the California Avian Data Center (CADC).

This project represents an important step in achieving status baselines at local, regional and flyway scales, and an ongoing evaluation of wintering shorebird trends and associated habitat to inform management and conservation actions in the face of uncertainty related to continued environmental change. As such it will also directly integrate with recently outlined monitoring needs to assess effectiveness of Joint Venture conservation delivery. It also ties in with a number of ongoing or planned investigations on climate change impacts within the San Francisco Bay Joint Venture region, and will so directly contribute significant information to realizing Joint Venture goals.

This effort represents an important step in achieving standardized monitoring at local, regional and eco-regional scales, relevant indicators and datasets to address climate change impacts. As such it will directly contribute significant information to downscaled climate modeling, future wetland conservation planning, and the effective implementation of restoration and enhancement actions to benefit wetlands restoration and conservation within our region.

The SFBJV Management Board would like to recommend this proposal as a priority for achieving Joint Venture goals, and urges the California Landscape Conservation Cooperative to fund it in full.

Sincerely,

Bettina Ring
Vice Chair, SFBJV Management Board

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Room W-2606
Sacramento, California 95825-1846

In Response Reply To:
80230

April 8, 2011

Debra L. Schlafmann
Coordinator, California Landscape Conservation Cooperative
U.S. Fish and Wildlife Service
Modoc Hall, Suite 2007
Sacramento, CA 95819

Dear Ms. Schlafmann:

On behalf of the National Wildlife Refuges in the Pacific Southwest Region, I am writing in support of the proposal, "A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change – Phase II" being submitted by PRBO Conservation Science for funding through the California Landscape Conservation Cooperative (CA LCC) in 2011.

All indications are that shorebirds are vulnerable to climate change because of their life history and the habitats they use. The long-distance migration of many shorebird species may compound climate change effects. In the Pacific Southwest Region, our national wildlife refuges provide essential habitat for migrating and wintering shorebirds in the Pacific Flyway, particularly within the CA LCC. To successfully adapt management strategies at our refuges to mitigate for climate change effects, we need to understand how species will respond to a changing environment, the scale at which these responses occur, and shorebird response to our management actions. Although regular shorebird monitoring and management occurs at many of our refuges, the impact of this work is often only known within our individual refuge or refuge complex. The proposed project will provide the framework to assess our monitoring and management actions in the context of the broader Pacific Flyway and CA LCC populations and will inform adaptable management strategies of wetland habitats.

PRBO's efforts will contribute toward understanding how shorebird populations will respond to environmental change and how we, as managers, will need to adapt. PRBO has been a strong leader in the international, national, and regional shorebird science and conservation communities, with a highly respected scientific reputation. We are pleased to see the close collaboration with Refuge staff on this project and have confidence that their combined efforts will lead to the most effective strategies for shorebird conservation and management in the face of accelerating environmental change.

Sincerely,

Margaret T. Kolar
Regional Chief, National Wildlife Refuges

The U.S. Shorebird Conservation Plan

Building Partnerships for Shorebird Conservation

John Cecil, Chair
National Audubon Society
545 Almshouse Road
Ivyland, PA 18974 USA

Brad Andres, Coordinator
U. S. Fish and Wildlife Service
P.O.Box 25486, DFC-Parfet
Denver, CO 80225-0486 USA

Debra L. Schlafmann
Coordinator, California Landscape Conservation Cooperative
Pacific Southwest Region 8
U.S. Fish and Wildlife Service
Sacramento, CA

April 7, 2011

Dear Ms. Schlafmann,

On behalf of the U.S. Shorebird Conservation Plan Council, I am writing in support of the proposal, "A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change – Phase II" being submitted by PRBO Conservation Science for funding through the California Landscape Conservation Cooperative.

We understand that last year's effort (phase I) was highly successful in gathering the information needed to design an effective monitoring program and in building the partnerships needed to accomplish such a large-scale effort. Because there are few ongoing monitoring systems in place to track changes in shorebird populations in response to environmental change, we believe continuing PRBO's efforts will significantly contribute towards this understanding. Their program is being designed with the explicit intention to inform adaptable conservation strategies for shorebird populations in the face of climate change.

PRBO has been a strong leader in the international, national, and regional shorebird science and conservation communities, with a highly respected scientific reputation. We have confidence that their efforts are aligned with the greater scientific community's for a comprehensive understanding of changes in populations and landscapes, limiting factors to population growth, and the most effective strategies for shorebird conservation in the face of accelerating environmental change.

Thank you for your continued support of this ambitious, yet necessary, effort.

Sincerely,

John Cecil, Chair
U.S. Shorebird Conservation Plan Council

Project Title: A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change – **PHASE II**

Project Leader/ Contact Information: Matthew E. Reiter, PRBO Conservation Science, Tomkat Field Station, P.O. Box 747, Pescadero, CA 94060; (760) 417 - 9997; **mreiter@prbo.org**

PRBO Conservation Science
PO Box 747
Pescadero, CA 94060
760-417-9997
mreiter@prbo.org

EXPERIENCE

QUANTITATIVE AVIAN ECOLOGIST– Shorebird Monitoring & Adaptive Management
May 2009 – Present Wetland Ecology Division
PRBO Conservation Science

PH.D. RESEARCH ASSISTANT– Species Interactions & Nesting Geese
September 2006 – August 2009 Minnesota Cooperative Fish & Wildlife Research Unit
University of Minnesota

M.S. RESEARCH ASSISTANT – Predator, Prey, & Alternative Prey Dynamics
July 2003 – August 2006 Minnesota Cooperative Fish & Wildlife Research Unit
University of Minnesota

TEACHING ASSISTANT – Analysis of Populations
January – May 2006 Department of Fisheries, Wildlife, and Conservation Biology
University of Minnesota

BIOLOGICAL TECHNICIAN – Avian Disease Dynamics & Management
January 2001 – July 2003 U.S. Geological Survey
Hawaii Volcanoes National Park

RESEARCH ASSISTANT – Avian Disease Mosquito Vector Population Surveys
September 1998 – May 1999 U.S. Geological Survey
Hawaii Volcanoes National Park

EDUCATION

2006 –2009
Ph.D.: Wildlife Conservation
University of Minnesota

2003 – 2006
M.S. Wildlife Conservation
Minor: Statistics
University of Minnesota

SELECTED PUBLICATIONS

Reiter, M.E., and D.E. Andersen. 2011**.** Arctic foxes, lemmings, and Canada goose nest survival at Cape Churchill, Manitoba. Wilson Journal of Ornithology 123:266-276.

Reiter, **M.E.,** D.A. LaPointe, and C.T. Atkinson. 2009. Source habitat of avian malaria vector, *Culex quinquefaciatus*, in altered mid-elevation mesic-dry forests of Hawaii. Journal of Vector Ecology 34:208-216.

Reiter, M.E. and D.E. Andersen. 2008. Comparison of egg flotation and egg candling techniques for estimating incubation day of Canada goose nests. Journal of Field Ornithology 79:429 – 437.

Reiter, M.E., and D.E. Andersen. 2008. Historical trends in collared lemming abundance near Cape Churchill, Manitoba, Canada. Journal of Mammalogy 89: 138 – 144.

Reiter, M.E., C.W. Boal, and D.E. Andersen. 2008. Species composition, distribution, and habitat associations of anurans in a subarctic tundra landscape near Cape Churchill, Manitoba, Canada. Canadian-Field Naturalist 122:129-137.

Reiter, M.E., and D.A. LaPointe. 2007. Landscape factors influencing the spatial distribution and abundance of the mosquito (*Culex quinquefaciatus*) vector in a mixed residential/agricultural community in Hawaii. Journal of Medical Entomology 44: 861-868.

MEMBERSHIPS

The Wildlife Society
Chair, Program for Regional & International Shorebird Monitoring
Central Valley Joint Venture Shorebird and Waterbird Research & Monitoring Committee

AWARDS

2008 – 2009 Doctoral Dissertation Fellow – UMN
Wildlife Oral Presentation Award – Midwest F&W Conference
2001 Star Award – U.S. Geological Survey

Brian Collins
Wildlife Biologist
San Diego NWR Complex
USFWS
301 Caspian Way
Imperial Beach, CA 91932
office (619) 575-2704 x 318
cell (619) 778-2003

Brian Collins has worked in capacities for the San Diego NWR Complex since 1994. As Wildlife Biologist for the coastal refuges in San Diego County, he oversees the Tijuana Slough National Wildlife Refuge, the south San Diego Bay NWR, and the Sweetwater Marsh NWR.

Current Duties:

- Oversee a multi-agency and multinational captive-propagation protocol development program for the endangered bird, the light-footed clapper rail.
- Perform biological monitoring and wildlife community management for populations of endangered, threatened, migratory and endemic species.
- Provide liaison between the Service and other state, federal, local and international agencies and municipalities.
- Represent the San Diego Refuges in environmental consultations with various agencies and individuals relating to the Endangered Species Act, Clean Water Act, National Environmental Policy Act, Freedom of Information Act, National Wildlife Refuge Improvement Act, and other regulatory compliance related laws, policies and regulations.
- Conduct public informational outreach through media interviews, presentations at public meetings, lectures to university groups, written newsletter articles, and direct interaction with the public.
- Develop Comprehensive Conservation Plans and step-down management plans, Refuge Compatibility Determinations, and other planning related technical documents.
- Manage scientific research coordination, reporting, and permitting between the Service, USGS, other agencies, and academic institutions.
- Manage public use on the three coastal refuges.

Carol J. Beardmore
Wildlife Biologist – Ornithologist
U.S. Fish and Wildlife Service
2321 W. Royal Palm Rd., Suite 103
Phoenix, AZ USA 85021
602-242-0524 (ext. 248)
602-242-2513 fax

Education:
B.S. - Kansas State University 1974 in Wildlife Biology; M.S. - Texas A&M University 1994 in Avian Ecology, Wildlife Sciences.

Professional Societies and Organizations:
Western Field Ornithologists-Board Member (current); Cooper Ornithological Society-Asst. Secretary; Society of Conservation Biologists-founding member of Tejas Chapter and officer; Texas Partners in Flight-founding member and officer; Bat Conservation International-Texas Board Member; and others.

Recent Experience:
Science Coordinator for the Sonoran Joint Venture, 5/03 to present.
Western Regional Coordinator for Partners in Flight, 2/96 to 5/03.
Wildlife Biologist-Ornithologist -U.S. Fish and Wildlife Service, Austin/Corpus Christi, Texas, 4/91 to 2/96

Recent Publications:
Beardmore, C.J. 2007. Sonoran Joint Venture: Bird Conservation Plan – Waterfowl Management Supplement. Version 1.0.

Blancher, P. J., B. Jacobs, A. Couturier, C. J. Beardmore, R. Dettmers, E. H. Dunn, W. Easton, E. E. Iñigo-Elias, T. D. Rich, K. V. Rosenberg and J. M. Ruth. 2006. Making Connections for Bird Conservation: Linking States, Provinces & Territories to Important Wintering and Breeding Grounds. Partners in Flight Technical Series No. 4. Partners in Flight website: http://www.partnersinflight.org/pubs/ts/04-Connections

Sonoran Joint Venture Technical Committee. Beardmore, C.J., ed. 2006. Sonoran Joint Venture Bird Conservation Plan, Version 1.0. Tucson: Sonoran Joint Venture.

Panjabi, A., C. Beardmore, P. Blancher, G. Butcher, M. Carter, D. Demarest, E. Dunn, C. Hunter, D. Pashley, K. Rosenberg, T. Rich and T. Will. 2001. The Partners in Flight handbook on species assessment and prioritization. Version 1.1. Rocky Mountain Bird Observatory. Brighton, CO.

Other Skills:
- Co-taught numerous resource management courses including monitoring techniques
- Designed and led monitoring projects.

EDUARDO PALACIOS
Resume

Conservation Biology Dept. CICESE Unidad La Paz
Miraflores # 334, Col. Bella Vista
La Paz, Baja California Sur, México 23050
Correo-E: epalacio@cicese.mx

BIRTH: Los Cabos, B.C.S., México, 13 August 1964

EDUCATION

1981-85	Universidad Autónoma de Baja California Sur	**Marine Biologist**
1988-92	CICESE	**M. Sc. Marine Ecology**
1994-2000	University of California, Davis	**Ph.D. Ecology**

SELECTED PUBLICATIONS

Molina, K. C., R. M. Erwin, **E. Palacios**, E. Mellink, and N. W. H. Seto. 2010. Status review and conservation recommendations for the Gull-billed Tern (*Gelochelidon nilotica*) in North America. U.S. Department of Interior, Fish and Wildlife Service, Biological Technical Publication, FWS/BTP-R1013-2010, Washington, D.C.

Collins, C.T., and **E. Palacios**. 2008. The distribution and status of Royal Terns on the Pacific coast of southern California and Baja California, México. Studies in Avian Biology 37:46-51.

Palacios, E., y E. Mellink. 2007. The colonies of vanRossem's Gull-billed Tern (Gelochelidon nilotica vanrossemi) in México. Waterbirds 30:214-222.

Mellink, E., **Palacios, E**., y E. Amador. 2007. Colonies of four species of terns and the Black Skimmer in western Mexico. Waterbirds 30:358-366.

Zárate-Ovando, B., **E. Palacios**, H. Reyes-Bonilla, E. Amador, and G. Saad. 2006. Waterbirds of the lagoon complex Magdalena Bay – Almejas, Baja California Sur, México. Waterbirds.29(3): 350-364.

Wolf, S., B. Keitt,A. Aguirre-Muñoz, B. Tershy, **E. Palacios**, and D. Croll. 2006. Transboundary seabird conservation in an important North American marine ecoregion. Environmental Conservation 33(4): 294-305.

Palacios, E., Anderson, D.W., Mellink, E., y González, S. 2000. Distribution and abundance of Burrowing Owls on the peninsula and islands of Baja. Western Birds. 31:89-99.

Palacios, E., y Mellink, E. 2000. Nesting waterbirds on Islas San Martin and Todos Santos, Baja California. Western Birds. 31:184-189.

Page, G.W., **Palacios, E**., Alfaro, L., Gonzalez, S., Stenzel, L., y Jungers, M. 1997. Numbers of wintering shorebirds in coastal wetlands of Baja California, Mexico. J. Field Ornithol. 68:562-574.

Mellink, E., **Palacios, E**., y González, S. 1997. Non-breeding waterbirds of the Delta of the Río Colorado, México. J. Field Ornithol. 68:113-123.

Lopez-Uriarte, E., Escofet, A., **Palacios, E**., and González, S. 1997. Migrant shorebirds at sandy beaches located between two major wetlands on the Pacific coast of Baja California (México). Natural Areas Journal 17:212-218.

Palacios, E., y Mellink, E. 1996. Status of the Least Tern in the Gulf of California. J. of Field Ornithol. 67:48-58.

Palacios, E., Alfaro, L., y Page, G.W. 1994. Distribution and abundance of breeding Snowy Plover on the Pacific coast of Baja California. J. Field Ornithol. 65:490-497.

Michael Wolder
Sacramento National Wildlife Refuge Complex
752 County Road 99W
Willows, CA 95988
Work: (530) 934-2801
mike_wolder@fws.gov

EDUCATION

Humboldt State University, Arcata, CA - M. S. Degree in Wildlife Management (1993)
University of Nevada-Reno - B. S. Degree in Wildlife Management (1989)

EXPERIENCE

Sacramento National Wildlife Refuge Complex, Willows, CA
Supervisory Wildlife Biologist Dec. 2001-Present
Wildlife Biologist Oct. 1993-Dec. 2001
Student Trainee Nov. 1990-Oct. 1993
Biological Technician June 1989-Nov. 1990

Have worked primarily in the Sacramento Valley of California for the past 22 years, mostly managing wetlands and monitoring waterfowl and other wetland-dependent species at the Sacramento National Wildlife Refuge Complex (Complex) and other areas in the Central Valley. Assist and advise refuge managers in the overall planning, analysis, and operation of refuge programs; In current position, supervise three full-time wildlife biologists and direct the biological components of the Complex's habitat management system. Have completed work details to: survey breeding waterfowl in Western Dakotas/Eastern Montana, assist with an arctic goose nesting ecology study at the Yukon-Kuskokwim Delta, Alaska, work on controlling an avian botulism outbreak at the Salton Sea, California, and help with clean-up at the Gulf oil spill in Louisiana.

Humboldt State University Foundation (contracted to: Northern Prairie Wildlife Research Center)
Waterfowl Technician, May 1987-Aug. 1988

Served as the primary research assistant for a wetland ecology project, collecting and organizing biological data from agricultural drainwater evaporation basins and seasonal wetlands in the Tulare Basin.

U. S. Forest Service, Toiyabe National Forest, Bridgeport, CA
'84-volunteer, '85-Range Aid, '86-Biological Technician Summers of 1984-86

Assisted with riparian and in-stream habitat improvements for rare trout populations on several small streams in the Sierra Nevada Range.

PUBLICATIONS

Wolder, M. A. 1993 Disturbance to wintering northern pintails at Sacramento National Wildlife Refuge, California. M. S. Thesis, Humboldt State Univ., Arcata, CA. 62pp.

Wolder, M. A., and J. G. Mensik. 1993. Wintering waterfowl survival in California. Ducks Unlimited-California Magazine. 2pp.

Wolder, M. A. 1995. Diseases of waterfowl wintering in the Central Valley of California. Valley Habitats No. 12. Ducks Unlimited, Inc., Rancho Cordova, CA. 12pp.

Bias, M. A., M. A. Wolder, and P. E. Schmidt. 1997. Disturbance as a component of habitat quality. Valley Habitats No. 17. Ducks Unlimited, Inc., Rancho Cordova, CA. 12pp.

Gilmer, D. S., K. A. Gonzalez, M. A. Wolder, and N. R. Graves. 1998. Nongame and upland gamebird surveys on Sacramento National Wildlife Refuges, 1986-1993. Western Birds 29:83-102.

Wolder, M. A. 2001. Incorporating reptile needs into wetland restoration. Birdscapes-News from International Conservation Partnerships, Spring/Summer 2001 Issue.

Kwasny, D. C., Wolder, M. A., and C. R. Isola. 2004. Technical guide to best management practices for mosquito control in managed wetlands. Central Valley Joint Venture pub. 35 pp.

Lawler, S. P., Dritz, D. A., Johonson, C. S., and M. Wolder. 2008. Does synergized pyrethrin applied over wetlands for mosquito control affect *Daphnia magna* zooplankton or *Callibaetis californicus* mayflies? Pest Manage. Sci. 64: 843-847.

REFERENCES

Greg Mensik
U. S. Fish and Wildlife Service (Ret.)
221 N. Ventura Ave.
Willows, CA 95988
(530) 934-2360

Paul Hofmann
Ca Dept. of Fish and Game
502 S. Merrill Ave.
Willows, CA 95988
(530) 934-9309

Joe Fleskes
U. S. Geological Survey
6924 Tremont Rd.
Dixon, CA 95620
(707) 678-0682