PROJECT LEADER/AGENCY/CONTACT INFORMATION: Matthew E. Reiter, PRBO Conservation Science, 3820 Cypress Drive #11, Petaluma, CA 94954; (707) 781-2555 ext. 351; **mreiter@prbo.org**

TITLE: A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change.

PROJECT SUMMARY: PRBO Conservation Science (PRBO) will develop a sampling design and monitoring protocol for wintering shorebirds in the Central Valley and the San Francisco Bay Estuary as the basis for an efficient, sustainable yet statistically robust monitoring program for the LCC region and eventually all of California. This program will assess trends in abundance, spatial distribution, and habitat associations of wintering shorebirds, and evaluate the potential impact of land use changes and climate change on these populations.

PROJECT GOALS: PRBO is developing a broad-scale monitoring program for wintering shorebird populations in California. This project is part of the first phase of the program with the primary goals of developing an efficient, sustainable yet statistically robust sampling design and monitoring protocol for the Central Valley-Bay Delta LCC region and a framework to capture, manage, and analyze these monitoring data. To accomplish our goals, we will complete three objectives:

1. Develop a sampling design and monitoring protocol for wintering shorebirds in the Central Valley informed by the spatial and temporal distribution of water. In the largely agriculture-dominated Central Valley, an efficient large-scale monitoring program for shorebirds requires an understanding of the spatial and temporal distribution of suitable habitat. Although the distribution of natural and managed wetlands is largely known, wintering shorebirds also rely on agriculture fields that are flooded post-harvest (Elphick and Oring 1998). To define the sampling frame for shorebird monitoring and allocate sampling effort across the Central Valley, the spatio-temporal dynamics of flooded agriculture need to be understood. Also, quantifying current associations of shorebirds with flooded landscapes will form the basis for projecting the impact of changes in habitat as the result of land-use changes and climate change on these populations.

2. Develop a sampling design and monitoring protocol for wintering shorebirds in the San Francisco Bay Estuary using simulations. In the San Francisco Bay estuary (SF Bay), a long-term monitoring program for shorebirds requires a design that is intensive enough to effectively generate unbiased estimates of change in the shorebird abundance and spatial distribution while also being sustainable. PRBO is conducting simulations using comprehensive (i.e. count "all" shorebirds) November roost surveys of the SF Bay that were completed annually 1990-92 and 2006-08 to determine the minimal sampling effort necessary for detecting changes in response to future land use and habitat conditions. We assume that one survey will be conducted annually in order to maintain citizen scientist (the primary surveyors) engagement in the program. We will employ the results of these simulations to develop a survey design and monitoring protocol that accurately captures changes in the abundance of shorebirds using SF Bay without having to conduct comprehensive counts.

3. Develop an online shorebird monitoring portal at the California Avian Data Center. An effective broad-scale monitoring program requires participation from state and federal agency personnel as well as many citizen scientists. To succeed in these collaborations, we will centralize data from multiple sources using an integrated system for unified data entry, storage, and analyses. PRBO's California Avian Data Center (CADC; www.prbo.org/cadc), a secure, well-tested platform for managing, analyzing, and visualizing avian monitoring data, will provide a cost-effective solution for the data entry, management, and visualization needs of the large-scale shorebird monitoring program. The CADC system will enable up-to-date information on shorebird abundance and trends at multiple spatial scales, and provide the framework to support a large-scale monitoring program.

PARTNERS: 1. PRBO Conservation Science **-** Project lead, remote sensing, simulation analyses, statistical analyses, protocol descriptions**. 2.** Ducks Unlimited, Inc. **-** Remote sensing assistance**. 3.** U.S. Geological Survey, Western Ecological Research Center – Historical water data provision.

HOW PROJECT WILL ADVANCE LCC GOALS: Our proposed project will address at least 4 LCC emphasis areas, including "Land Cover", "Habitat Connectivity", "Water Resources", and "Species and Habitat Information". Understanding the spatial and temporal patterns of water distribution in the Central Valley will form the foundation for evaluating changing land cover, habitat connectivity for wetland dependent birds, the annual timing and variability of water regimes, and the relationship between shorebird abundance and different wetland habitats (e.g. managed wetlands, flooded agriculture). The establishment of a large scale monitoring program for wintering shorebirds will provide an ongoing assessment of shorebird populations at a scale that is compatible with the scale of the LCC. In addition, our project will leverage other grant funds to help incorporate results into a much larger California-wide shorebird monitoring program, covering parts of multiple LCCs, and within the next five years, will be coordinated with other programs throughout the United States and other countries along the Pacific Flyway. We will show immediate results, particularly as some of the proposed work is already underway, yet the work accomplished under this grant is essential to helping the LCC fulfill its long term goals. This project is supported by both Joint Ventures in the LCC region (San Francisco Bay and Central Valley) and explicitly addresses a top priority of the Central Valley Joint Venture as identified in its 2010 Monitoring and Evaluation Plan. Our analyses will help fulfill the LCC's desired accomplishments for 2010 by developing an "inventory and monitoring protocol to capture data on fish and wildlife populations and their habitats to detect changes resulting from climate change." The development of the shorebird monitoring portal at CADC will facilitate data and information sharing among a wide range of LCC partners and enable further collaborations to track and understand population trends, habitats, and the changing environmental landscape.

METHODS:

1. Develop a sampling design and monitoring protocol for wintering shorebirds in the Central Valley informed by the spatial and temporal distribution of water. We are concerned primarily with identifying specific regions of the Central Valley with regular water availability and quantifying among year variability in the spatial and temporal distribution of water. We will conduct an unsupervised classification of Landsat TM imagery (30m pixels) to delineate coarse patterns of spatial variability in water and non-water regions of the Central Valley during early (December) and late (February) winter (we have identified these months as the likely survey window) for a sample of at least 5 years over the period 2000 – 2010 using remote sensing techniques that have been applied previously in the Central Valley (Fleskes et al. 2005). We will use historic data on water presence at specific locations to validate our classified Geographic Information System (GIS) data layers (grids). Because there may be long-term temporal trends in water distribution, we will only use data from the last 10 years to assess variability in the distribution of shorebird habitat. We will utilize landscape ecology metrics to quantify spatio-temporal contagion and spatio-temporal complexity (Parrot et al. 2008) of the historic water distribution. We will also combine the classified water grids to calculate the proportion of classified images where each pixel was classified as water. Regions with high values will indicate areas with regular water availability whereas areas with low values will indicate little or no water presence. Based on these data, we will define the sampling strata for monitoring winter shorebirds in the Central Valley and develop a survey design and monitoring protocol that captures changes in the abundance of shorebirds.

2. Develop a sampling design and monitoring protocol for wintering shorebirds in the San Francisco Bay Estuary using simulations. PRBO is conducting simulations using comprehensive November shorebird

roost surveys of SF Bay that were completed annually 1990-92 and 2006-08. These simulations will help determine the minimal sampling effort (spatially) necessary to detect future changes in response to changing land use and habitat conditions while assuming that 1 survey will be conducted annually in order to maintain citizen scientist (the primary surveyors) engagement with the program. We consider these existing data from the 224 count locations to be a representation of the "true" number of birds present in SF Bay during each of the six years of monitoring. We have selected 8 species that are common in SF Bay and represent a variety of body sizes. For each species, we will calculate change as the sum of birds observed in the 2006-08 surveys divided by the sum of birds observed in the 1990-92 surveys. We will consider 3 levels of sampling effort in our simulations, measured in terms of the percentage of the total number of sampling locations surveyed annually, to evaluate how much we could reduce sampling effort within each year and still achieve the same result as observed using 100% effort (i.e. all 224 locations surveyed). We will consider 4 methods of selecting sampling locations to survey shorebirds: 1) independent random sample; 2) stratified random sample; 3) generalized-random tessellation sample; and 4) stratified generalized-random tessellation sample. We will also evaluate 2 approaches to stratification. First, we will sample each of 3 distinct areas of the bay as strata. Second, we will stratify by weighting the drawing of samples based on the natural-logarithm of the total number of shorebirds observed at each sample location in the years 1990–92. We will then compare among scenarios both within and among species and across all species together using measures of bias, variance, and overall accuracy. To quantify the overall performance of each scenario, we will average the bias, variance, and accuracy indices across the 8 species. Using the results of these simulations, we will develop a survey design and monitoring protocol that will capture changes in the abundance and spatial distribution of shorebirds using SF Bay in winter.

3. Develop an online shorebird monitoring portal at the California Avian Data Center

The CADC informatics infrastructure has been used successfully to consolidate point count and area survey data from multiple organizations throughout California and the Western US. It is designed to provide easy access to data while also ensuring data security and formalizing ownership and sharing policies. We will develop a new shorebird portal to provide access to counting protocols, monitoring location information and maps, data collection forms and protocols, and data entry and editing screens. We will also provide a safe repository for controlled access to all shorebird observation data for the LCC region including data from ≥10 National Wildlife Refuges, State Wildlife Areas, and other ongoing monitoring programs; data access level controls will be specified by data contributors (see Avian Knowledge Network; http://www.avianknowledge.net). The goal is to provide managers, analysts, and others as complete access to data as possible while limiting availability to people outside the project. We will perform all system hosting and administration tasks, but data owners will have the ability to download a complete copy of their project observation data at any time, in several standard formats. We will also make the Central Valley classified water distribution grids available for download via this portal.

PRODUCTS/TASKS AND TIMELINE /DATE OF COMPLETION:

1. *Develop a sampling design and monitoring protocol for wintering shorebirds in the Central Valley informed by the spatial and temporal distribution of water.*
   - *a.* GIS layers documenting the distribution of water and non-water areas during the winter in the Central Valley for a sample of ≥5 years between 2000 and 2010 and an aggregated GIS layer identifying the probability of water presence for each pixel in the Central Valley. (July–September 2010).
   - *b.* Quantification of the distribution, abundance, and variability of water during winter in the Central Valley using above layers and spatio-temporal complexity metrics. (September 2010)

   c. Report recommending sampling design and monitoring protocol for wintering shorebirds in the Central Valley. (September–December 2010)
2. *Develop a sampling design and monitoring protocol for wintering shorebirds in the San Francisco Bay Estuary using simulations.*
   a. Report recommending sampling design and monitoring protocol for wintering shorebirds in the San Francisco Bay estuary. (July–September 2010)
3. *Develop an online shorebird monitoring data portal at the California Avian Data Center.*
   a. Field data forms and protocols, web-based data entry/edit screens. (July–September 2010)
   b. Visualizations of trends at pre-*se*t or user-defined spatio-temporal scales. (September–December 2010)

IS THE PROJECT ON-GOING? This work is part of a larger project to develop a statewide shorebird monitoring program in California. We have initiated simulations of the San Francisco Bay data. There are some final components to these analyses that are needed to complete the monitoring protocol for SF Bay. This work has been funded by Resources Legacy Fund and The David and Lucile Packard Foundation. We have also initiated work on the data portal in the California Avian Data Center with funding from The David and Lucile Packard Foundation and an anonymous donor. Additional funding is needed initiate and complete the water distribution analysis and to complete the shorebird portal.

PERFORMANCE METRICS WITH TIMELINE FOR EACH:

1. Pilot implementation of sampling design and monitoring protocol monitoring program at ≥20 sites in the Central Valley and SF Bay. (November–December 2010)
2. Beta testing of shorebird monitoring portal by ≥20 citizen scientists. (November–December 2010)
3. Data from ≥10 National Wildlife Refuges, State Wildlife Areas, and other ongoing monitoring programs centralized through CADC (July–December 2010)

CONSERVATION OUTCOMES:

1. Data on the distribution of shorebird habitat in the Central Valley to guide conservation actions and management.
2. Data on the distribution of shorebirds in the Central Valley and SF Bay to guide conservation and management actions and quantify their impact on shorebird populations.
3. A centralized database framework to collect, manage, and analyze shorebird monitoring data at multiple scales.

TOTAL FUNDS REQUESTED FROM CA LCC: $50,000.

MATCHING FUNDS: $126,724 -- The David and Lucile Packard Foundation ($72,505); S.D. Bechtel Jr., Foundation ($44,219); Anonymous Donor ($10,000).

LETTERS OF SUPPORT: (1) Dean Kwasny, Natural Resources Conservation Service; (2) Susan Skagen, Program for Regional and International Shorebird Monitoring; (3) John Cecil, US Shorebird Conservation Plan Council.

LITERATURE CITED

Elphick, C.S. and L.E. Oring. 1998. Winter management of California rice fields for waterbirds. Journal of Applied Ecology 35:95-108.

Fleskes, J.P., W.M. Perry, K.L. Petrik, R. Spell, and F. Reid. 2005. Change in area of winter-flooded and dry rice in the northern Central Valley of California determined by satellite imagery. California Fish and game 91:207-215.

Parrott, L., R. Proulx, and X. Thibert-Plante. 2008. Three-dimensional metrics for the analysis of spatio-temporal data in ecology. Ecological Informatics 3:343-353.

BUDGET AND MATCHING FUNDS

OUTCOME #1: Shorebird sampling design and survey protocol for the Central Valley

EXPENSES	Amount
Salaries and Benefits	
Matthew Reiter (PI) [$4720/mo. x 2.5 mos.]	$16,839
Len Liu (Image Analyst) [$3180/mo. x 3 mos.]	$13,618
Catherine Hickey (Wetlands Director) [$5980/mo. X 0.75 mos.]	$6,403
Khara Strum (Wetlands Ecologist) [$3749/mo. X 2 months]	$10,700
Sub-total	$47,560
Outside Services (DU and USGS)	$9,000
Equipment (image software)	$2,200
Travel (mileage)	$800
Total Direct Costs	$59,560
Indirect Costs (33.5%)	$19,953
Total Outcome Expenses	$79,513
FUNDING	
Requested from CA LCC (pending)	$25,000
The David and Lucile Packard Foundation (in-hand)	$30,000
S.D. Bechtel Jr., Foundation (in-hand)	$24,513
Total Outcome Funding	$79,513

OUTCOME #2: Shorebird sampling design and survey protocol for San Francisco Bay

EXPENSES	Amount
Salaries and Benefits	
Matthew Reiter (PI) [$4720/mo. x 1.5 mo.]	$10,103
Julian Wood (SF Bay Project Director) [$4096/mo. x 1.5 mo.]	$8,767
Gary Page (Wetlands Director) [$6760/mo. X 0.75 mos.]	$7,235
Lynne Stenzel (Statistician) [$4891/mo. X .75 mos.]	$5,234
Sub-total	$31,339
Travel (mileage)	$500
Total Direct Costs	$31,839
Indirect Costs (33.5%)	$10,666
Total Outcome Expenses	$42,505
FUNDING	
Requested from CA LCC (pending)	$10,000
The David and Lucile Packard Foundation (in-hand)	$22,505
Anonymous (in-hand)	$10,000
Total Outcome Funding	$42,505

OUTCOME #3: Shorebird monitoring data portal at CADC

EXPENSES	Amount
Salaries and Benefits	
Matthew Reiter (PI) [$4720/mo. x 1.5 mo.]	$10,103
Michael Fitzgibbon (software engineer) [$5220/mo. x 2.5 mos.]	$18,622
Catherine Hickey (Wetlands Director) [$5980/mo. X 0.75 mos.]	$6,403
Khara Strum (Wetlands Ecologist) [$3749/mo. X 1 mo.]	$5,350
Sub-total	$40,478
Travel (mileage)	$500
Total Direct Costs	$40,978
Indirect Costs (33.5%)	$13,728
Total Outcome Expenses	$54,706
FUNDING	
Requested from CA LCC (pending)	$15,000
The David and Lucile Packard Foundation (in-hand)	$20,000
S.D. Bechtel Jr., Foundation (in-hand)	$19,706
Total Outcome Funding	$54,706

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
California State Office
430 G. St. #4164
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Fax: (530) 792-5790

May 28, 2010

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

Dear Ms. Schlafmann:

As Chair of the Central Valley Joint Venture's Shorebird and Waterbird Technical Committee, I am writing in support of a proposal submitted by PRBO Conservation Science entitled, "*A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change.*"

The Central Valley Joint Venture recently completed a Monitoring and Evaluation Plan for the purpose of examining the most critical assumptions underlying its Implementation Plan and determining the most prominent information needs that currently limit its biological planning and conservation. Development of a shorebird monitoring program, as proposed by PRBO, was determined to be one of the highest monitoring and evaluation priorities of the Shorebird and Waterbird Technical Committee. Additionally, centralization of population and habitat monitoring data was recognized as critical to understand how populations respond to a changing environment at broad-scales and to inform adaptive conservation strategies.

PRBO Conservation Science has been a long-standing member of the Central Valley Joint Venture and brings unique expertise on shorebird and waterbird monitoring approaches and conservation needs. I have confidence that their project will be designed from a strong quantitative foundation and, in the spirit of the Joint Venture, will engage a multitude of partners in its development and implementation to ensure its success and direct applicability to informing conservation solutions.

Thank you for considering support of this high priority project of the Central Valley Joint Venture Shorebird and Waterbird technical committee. Should you have any questions, I can be reached at (530)792-5648.

Sincerely,

Dean Kwasny
Chair, Shorebird & Waterbird Technical Committee

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Fort Collins Science Center
2150 Centre Avenue, Building C
Fort Collins, CO 80526-8118

May 27, 2010

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

Dear Ms. Schlafmann,

As co-Chair of the Program for Regional and International Shorebird Monitoring (PRISM), I am writing to extend my strongest support for a proposal by PRBO Conservation Science entitled "A Broad-Scale, Multi-Species Monitoring Protocol to Assess Wintering Shorebird Population Trends in Response to Future Land Use and Climate Change." In recent years, growing concerns of the potential impacts of climate change on wildlife populations has amplified the importance of developing scientifically sound and logistically feasible monitoring approaches.

PRBO Conservation Science has great long-standing expertise in regional and international shorebird monitoring and ecology, and Dr. Matthew Reiter contributes greatly to the sampling design expertise and quantitative rigor of the team. The approach outlined for developing monitoring programs for agricultural areas in the Central Valley and the San Francisco Bay estuary embodies sound design elements and 'state-of-the-science' techniques. The data management and analysis portal with the California Avian Data Center will ensure the successful use and dissemination of this important information.

The questions and scientific methods outlined in the proposal are the highest priorities of PRISM. They will form the basis for the development of shorebird monitoring programs throughout the Western Hemisphere. I have every confidence that the work will be highly successful, and I encourage you to support this worthy effort.

Sincerely,

Susan K. Skagen, PhD
Co-Chair, Program for Regional and International Shorebird Monitoring
Research Wildlife Biologist

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

June 01, 2010

Dear Ms. Schlafmann,

On behalf of the U.S. Shorebird Conservation 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" being submitted by PRBO Conservation Science for funding through the California Landscape Conservation Cooperative.

All indications are that shorebirds are extremely vulnerable to climate change because of their unique life history and the habitats they use throughout their annual cycle. The long-distance migration of many shorebird species compounds climate change effects. Central to the ability to adapt conservation strategies or mitigate for climate change effects is an understanding of how species might respond to a changing environment and to monitor and evaluate the actual response. There are few ongoing monitoring systems to track changes in shorebird populations in response to environmental change. PRBO's efforts are a significant contribution towards this understanding. Their program is being designed with the explicit intention to inform adaptable conservation strategies for shorebird populations into the future.

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 support of this ambitious, yet necessary effort.

Sincerely,

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