Central Valley Joint Venture Monitoring & Evaluation Plan

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Shorebirds and Waterbirds

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Introduction

The Central Valley of California supports one of the largest wintering shorebird populations of any inland site in North America (Shuford et al. 1998,Hickey et al. 2003), and also sustains widespread breeding populations of Black-necked stilts, American Avocets, and Killdeer (Shuford et al. 2007). In addition, large and varied populations of waterbirds (egrets, herons, ibis, bitterns, rails, grebes, pelicans and cormorants) also depend on the Central Valley during the wintering and breeding periods (Kushlan et al. 2002, Shuford 2010). While shorebird and waterbird conservation was not targeted in the original 1990 Central Valley Habitat Joint Venture Implementation Plan, these bird groups undoubtedly benefited from many of the habitat conservation achievements generated by the plan. Shorebird and waterbird conservation was formally addressed in the 2006 Central Valley Joint Venture (CVJV) Implementation Plan Central Valley Joint Venture 2006), which includes individual chapters on wintering shorebirds, breeding shorebirds and waterbirds. Generally, these chapters set population and habitat conservation objectives for shorebirds and waterbirds that CVJV partners can use in the development and implementation of conservation programs.

While the 2006 CVJV Implementation Plan made great strides in developing population and/or habitat objectives for wintering shorebirds, breeding shorebirds, and waterbird focal species, these objectives were largely based on limited population data and untested assumptions. Unlike other bird groups, there is no long-term population monitoring for shorebirds and waterbirds in the Central Valley, thus making it difficult to: (1) set precise population and habitat objectives, and (2) assess shorebird and waterbird response to conservation measures. In addition, there is little information on habitat use and foraging ecology of these groups, which makes it difficult to confidently make assumptions with regard to habitat and food availability. Finally, the lack of information on shorebird and waterbird populations, habitat use, and ecology may make it difficult to assess and address the effects climate change may have on these species. As a result, an effective Monitoring and Evaluation Plan (Plan) that addresses these basic information needs is critical to the long-term conservation of shorebirds and waterbirds in the Central Valley.

In developing the Plan three primary sources of information were used: (1) biological assumptions and needs addressed in the 2006 CVJV Implementation Plan, (2) a list of monitoring and research needs generated in 2008 during two CVJV Shorebird and Waterbird Working Group meetings, and (3) an updated and refined list of monitoring and evaluation needs developed in 2009 by the CVJV Shorebird and Waterbird Working Group. In this document, these informational needs have been synthesized into 14 Monitoring and Evaluation issues (Table 1) that address the following groups: (1) all shorebirds and waterbirds, (2) wintering shorebirds, (3) breeding shorebirds, and (4) waterbirds. Each Monitoring and Evaluation issue presented contains an explicit description of the issue, a background statement, a bulleted list of desired products that address the issue, and an explanation of how the expected outcomes relate to CVJV conservation activities.

The issues and products presented in the Plan are not intended to be a complete list of all research and monitoring questions related to shorebirds and waterbirds in the Central Valley, but rather a description of the highest priority needs for evaluation and monitoring as it relates to

CVJV conservation activities.   To further refine priority needs for monitoring and evaluation, the CVJV Shorebird and Waterbird Working Group ranked the 34 individual products (see Appendix 1 for ranking methodology). These products were ranked relative to: (1) their contribution toward improving assumptions of the 2006 CVJV Implementation Plan, (2) their contributions toward monitoring and tracking CVJV population and habitat objectives, (3) their sequencing (some products need to be completed before others begin) and (4) current project and funding availability. The overall rank for each desired product is listed in parentheses within the text as well as in Table 1.

Monitoring and Evaluation Issues
Shorebirds and Waterbirds

1. Tracking Net Landscape Change

Issues: Estimates of habitat gains and losses at landscape scales are essential to estimate true conservation progress and to set appropriate habitat objectives.

The CVJV currently lacks the capability to track both habitat gains and losses at the scale(s) necessary to evaluate the net impact of CVJV programs.

Background: Traditional wildlife habitat programs such as acquisition, restoration and enhancement of wetlands have been a cornerstone of the CVJV's conservation delivery since its inception. The CVJV 1990 and 2006 Implementation Plans contain habitat objectives for wetlands and wetland-associated uplands for a suite of migratory birds. To track accomplishments toward JV habitat protection, enhancement, and restoration goals, the CVJV maintains an online project database. Habitat acreage goals are tracked by habitat category (palustrine, riverine, upland, agriculture, etc.), habitat type (emergent shrub-scrub, forested, etc.), and water regime (perennial, seasonal, tidal/non-tidal, etc.). The system allows partners to input and track project information in a timely manner, which provides JV staff and partners up-to-date information on their progress toward JV habitat goals at any time, and provides a measure of habitat "gain." However, landscape changes related to urban development and changing agricultural land uses are largely beyond the control of the CVJV. The cumulative impacts of these changes may dwarf what can be accomplished by traditional wildlife programs. The JV's habitat tracking system was not designed to track habitat loss, but it is important for the JV to do so nonetheless.

In 2005, the North American Waterfowl Management Plan (NAWMP; Plan) Committee (PC) commissioned the first ever continental assessment of the NAWMP's goals and accomplishments. From this assessment the NAWMP Continental Assessment Final Report was released in February 2007 (http://www.fws.gov/birdhabitat/NAWMP/files/FinalAssessmentReport. .pdf). One of the primary conclusions of this report was that at the continental scale, most JVs could not critically evaluate progress toward attaining Plan population objectives, and could not with confidence describe landscape conditions needed to achieve those objectives. This is partially attributable to the limited ability to assess ongoing net landscape change. Therefore, the assessment report recommends that JVs do a better job of monitoring key habitat trends, such as the extent of wetlands (all JVs), nesting habitat (breeding JVs), or foraging habitat (wintering JVs).

The continental assessment requires that JVs report to the PC triennially on progress towards meeting the goals and objectives of their implementation plan. A component of this will be demonstrating the effect of JV activities on net landscape change. Although the JV's will be reporting triennially, the appropriate interval for change assessment will likely be 5 years,

because the cost of obtaining some data sets may be quite large, and the ability to detect changes at the landscape scale may vary by habitat type

Desired Products:

- Data listing habitat gains, losses, and net change at a minimum five year interval in each basin for the following habitat types: seasonal wetlands, permanent/semi-permanent wetlands, rice[1], corn[2], other wildlife-friendly crops[3], riparian habitat, and upland nesting cover.[4] **(Rank:1t)**

- Data listing gains, losses, and net change in each basin for incompatible habitats, particularly perennial crops (i.e. vineyards and orchards) and residential and commercial development. **(Rank:6t)**

- GIS data layers depicting spatially explicit gains and losses for each of the above habitat types. **(Rank:5t)**

- Monitor general agricultural trends (using California Resource Agency Information) on an annual basis to better track habitat changes and upcoming conservation challenges. **(Rank:11t)**

Expected Outcomes: Net habitat gain and loss data will allow the CVJV to guide wetland, riparian, and agricultural land protection, restoration and enhancement programs to better contribute to CVJV Plan objectives. This data will also enable the CVJV to compare landscape changes with any observed changes in shorebird and waterbird populations. Agricultural trend data for acreage and field status (flooded, plowed, etc.) of rice and corn will directly provide data inputs for the JV bio-energetic models to allow fine-tuning of programs to achieve plan objectives. Monitoring general agricultural trends on an annual basis will enable us to more precisely track habitat changes and predict upcoming conservation challenges. Finally, the tracking of wetland and agricultural habitats will allow us to assess the potential long-term impacts climate change may have on habitat availability.

[1]rice includes the following sub-categories (in acres): total rice grown and total winter-flooded rice for hunting and straw decomposition.

[2]corn includes the following sub-categories from the Delta Basin in acres): total corn grown, total winter-flooded corn, total unflooded corn, total corn plowed, average density of waste corn in harvested fields (lbs/acre).

[3]other wildlife-friendly crops include post-harvest flooded agricultural fields in the Tulare Basin, row crops and pasture important for wintering Sandhill Cranes, and alfalfa and irrigated pasture used by shorebirds and waterbirds.

[4]For all data, must ensure that categories by which agricultural statistics are compiled match the generic habitat types tracked by the CVJV.

2. Develop Centralized Database for Shorebirds and Waterbirds

Issue: To manage effectively for shorebirds and waterbirds in the Central Valley, it will be increasingly important to archive all population monitoring data and other relevant information in a centralized database that is easily accessible and provides value-added analyses and visualizations (i.e. spatial maps, graphs) that advance conservation practices.

Background and Need: Currently most data on population sizes, trends, habitat needs, and best management practices for shorebirds and waterbirds in the Central Valley are scattered and not easily accessible. Lack of timely access to available information could hamper efforts to manage effectively for these species and to refine or design research or monitoring plans in an efficient and informed manner.

In recent years, there has been a surge in the development of centralized databases for birds. These include broad-based ventures such as the Avian Knowledge Network (www.avianknowledge.net/content/; Cornell Lab of Ornithology) and the California Avian Data Center (www.prbo.org/cadc; PRBO Conservation Science), which includes data on all species of birds. Other such databases target specific groups of birds. For example, the Waterbird Monitoring Database (www.pwrc.usgs.gov/cwb/database/; hosted by USGS for Waterbirds for the Americas Initiative) mainly focuses on colonial waterbirds. The creation of such databases provides the opportunity to use or modify database structures to meet the needs of the CVJV to track information on shorebirds and waterbirds in the Central Valley.

Desired Products:
- A centralized database on shorebirds and waterbirds in the Central Valley as a repository to aid in the protection and management of these birds and their habitats. **(Rank:3)**
- Linkage of this database, as practical, with other comparable regional and national databases. **(Rank:11t)**
- New online tools, or refinement of those from other databases to meet Central Valley needs, to allow managers and conservation practitioners to visualize trends, indices, or other patterns that will enable them to more effectively conserve these species and their habitats. **(Rank:12)**

Expected Outcomes: The development and use of a centralized database will allow the timely access to information that will enable more effective conservation of shorebirds and waterbirds in the Central Valley.

3. Effects of Climate Change on Shorebird and Waterbird Populations

Issues: Potential impacts of climate change on shorebird/waterbird habitat and populations needs to be evaluated.

The CVJV Management Board has tasked the chairs of all standing committees to report how climate change is being addressed by their respective committee.

Background: The Intergovernmental Panel on Climate Change's Assessment Report (IPCC 2007) stated that global warming is "unequivocal" and can largely be attributed to human activities. While there is certainty that climate change is occurring, little is known about the potential effects on shorebirds and waterbirds (Crick 2004, Wormworth and Mallon 2006, Audubon 2009) and there remains many questions regarding how it will affect natural resources at the regional level. In the Central Valley, wetland and agricultural habitats may be particularly vulnerable to climate change. Potential changes in precipitation, snow melt, stream flow, evaporation, sea-level rise and other processes may affect the quantity, quality, and availability of water for managed wetlands and wildlife-friendly agriculture (e.g., rice and corn). These potential changes may be further exacerbated by socio-economic and political issues that put additional pressures on water supply and use. While it is unknown how these potential changes will affect shorebirds and waterbirds, a primary assumption is that changes in water and habitat availability could lead to changes in shorebird and waterbird abundance and distribution. To more accurately assess the effects climate change may have on shorebirds and waterbirds in the Central Valley, dependable models are needed that project the range of changes in water supplies and available habitat. In this realm it will be important to coordinate and work with existing and new partners who have expertise in climate change modeling. These joint efforts, along with other targeted monitoring projects, will improve our ability to predict and assess changes in habitat availability and shorebird/waterbird populations.

Desired Products:
- Models to project the impacts of climate change on the quantity, quality and availability of water for wetland and agricultural habitats in the Central Valley. **(Rank:5t)**
- A Vulnerability Assessment that qualitatively and quantitatively describes the potential impacts of climate change on shorebird/waterbird habitats and populations in the Central Valley. **(Rank:10t)**

Expected Outcomes: The results of dependable climate change models will allow the CVJV to more accurately determine the potential effects of climate change on water supply and shorebird/waterbird habitats. These results, in turn, will enable the CVJV to assess the impact climate change will have on individual shorebird and waterbird populations and assess their vulnerability to these changes. This information, along with targeted monitoring efforts, will improve the CVJV's ability to anticipate, assess, and plan for expected changes associated with climate change.

4. Assess Shorebird and Waterbird Response to Wetland Restoration, Enhancement, and Management

Issues: Information on shorebird and waterbird response to wetland restoration and enhancement activities is currently lacking.

Information on shorebird and waterbird response to wetland management practices is not readily available to wetland managers and planners.

Background:

Managed seasonal and semi-permanent wetlands are used by most wintering and breeding shorebirds and waterbirds in the Central Valley and as a result these habitat types are targeted for conservation by the CVJV. While a considerable amount of wetland restoration and enhancement has taken place in the Central Valley, very little monitoring has been conducted to see how shorebirds and waterbirds actually respond to these habitats (however, see DiGaudio et al. 2009). Furthermore, there is little existing information on wetland restoration or enhancement for shorebirds (Isola 1998) and waterbirds, and most information is based on anecdotal observations. Thus, it would be extremely helpful to monitor restored or enhanced wetlands and determine shorebird and waterbird response, over time, to a variety of restoration/enhancement features including: wetland type, wetland size, wetland topography, and wetland and riparian vegetation plantings.

While some information exists on shorebird and waterbird response to wetland management and habitat in the Central Valley (Safran et al. 1997, Isola et al. 2000,Taft et al. 2002), there is still relatively little data describing shorebird and waterbird response to common wetland management practices. Many CVJV objectives are contingent on shorebirds and waterbirds responding positively to water manipulations in managed wetlands, however little information is available to support these assumptions. In particular, more information is needed on shorebird and waterbird response to: 1) average wetland water depths, 2) late summer drawdown of semi-permanent wetlands, 3) initial fall flooding of seasonal wetlands, and 4) late winter/spring drawdown of seasonal wetlands. In addition, more information is needed regarding shorebird and waterbird response to common wetland vegetation manipulation practices such as disking, mowing and burning. These common practices directly effect the composition of wetland vegetation and wetland productivity, which in turn, likely effect shorebird and waterbird use.

Desired Products:
- Data describing shorebird and waterbird response to wetland restoration and enhancement features including: wetland size, wetland topography, and wetland and riparian vegetation. **(Rank:6t)**
- Data describing shorebird and waterbird response to water and vegetation manipulations in managed wetlands throughout the Central Valley. **(Rank:6t)**

Expected Outcomes: Information derived from the investigation of shorebird and waterbird response to wetland restoration/enhancement projects would be used directly by wetland managers and restoration ecologists to improve future wetland projects for shorebirds and

waterbirds. In addition, information derived from targeted research of shorebird and waterbird response to water and vegetation management would help provide insight to assess CVJV shorebird and waterbird habitat objectives and improve "on the ground" wetland management for shorebirds and waterbird in the Central Valley.   Research and monitoring would also evaluate trade-offs in habitat values for other wetland dependent species when managing for optimal shorebird and/or waterbird use.

Monitoring and Evaluation Issues
Wintering Shorebirds

1. Assess Proportion of Habitat Available to Wintering and Migrating Shorebirds

Issues: It is unknown whether seasonal wetlands, semi-permanent wetlands and flooded agricultural habitats are meeting the "required-depth-ratio" objectives set for wintering and migrating shorebirds in the CVJV Implementation Plan.

The amount of emergent wetland vegetation and trees may make seasonal and semi-permanent wetlands less available to wintering, migrating and breeding shorebirds.

Habitat acres inputs into the TRUEMET model for wintering shorebirds assume that all seasonal, semi-permanent and flooded agricultural habitats are equally available to shorebirds regardless of water depth and vegetative cover.

Background: While studies (Safran 1997, Isola et al. 2000) indicate foraging shorebirds require water depths less than 10 cm, CVJV estimates of existing wetland and flooded agricultural acres are not stratified by water depth. This made it necessary to set a "required depth ratio" when determining CVJV habitat objectives for wintering and migrating shorebirds. The "required depth ratio" is defined as the fraction of seasonal wetlands, semi-permanent wetlands and flooded agricultural habitat that must be less than 10 cm in depth to meet shorebird needs. Depending on the planning region, it was determined that 50-100% of existing seasonal wetlands would have to provide foraging depths of less than 10 cm sometime during the winter period to meet shorebird needs. Given current wetland management strategies and the physical attributes of many existing wetlands, these objectives are not likely being met. The importance of appropriate water depths to foraging shorebirds cannot be understated, and reliable estimates of depth ratios in seasonal wetlands, semi-permanent wetlands and flooded agricultural habitats are crucial in determining whether the CVJV shorebird habitat objectives are being met.

In addition to water depth, vegetative cover can affect shorebird use of wetlands. While not well documented, shorebirds prefer more open habitats and generally avoid wetlands dominated with trees and tall, emergent wetland vegetation. The specific vegetative characteristics of existing Central Valley wetlands are not currently available and we do not have precise data describing shorebird response to wetland vegetation. Accordingly, the CVJV did not account for wetland vegetative characteristics when developing habitat objectives for shorebirds. The reality is that many seasonal and semi-permanent wetlands in the Central Valley are heavily vegetated and may preclude shorebird use. As a result, we may be over estimating the amount of wetland habitat actually available to shorebirds. To determine whether this is a significant issue, we need data describing vegetative characteristics of existing Central Valley wetlands and shorebird response to wetland vegetation.

Desired Products:

- Sampling methodology to determine water depths, and subsequently observed depth-ratios, for seasonal wetlands, semi-permanent wetlands, and agricultural habitats throughout the Central Valley during the summer, fall, winter and spring flooding periods. **(Rank:4t)**
- Documentation of shorebird response/use of wetlands with varying amounts of emergent wetland vegetation and trees throughout the Central Valley. **(Rank:8t)**
- Description of the vegetative characteristics of existing wetlands to a level that would allow assessment of their value as shorebird habitat. **(Rank:9t)**

Expected Outcomes: Water depth and depth-ratio information would allow the CVJV to determine whether existing shorebird habitat objectives are sufficient to meet the true demands of wintering and migrating shorebirds. If not, this information could be used to help wetland managers refine water management practices to seasonally provide additional shallow water habitat in specific basins. Refinement of water management practices might also provide the dual benefit of conserving water resources.

In addition, data regarding shorebird response to wetland vegetation would allow the CVJV to determine if the vegetative characteristics of a wetland have a significant effect on shorebird use. If wetland vegetation is determined to have a significant effect on shorebird use, precise information on the vegetative characteristics of existing wetlands would allow the CVJV to adjust habitat objectives accordingly.

Finally, water depth ratios and vegetative characteristics could be used to refine "available habitat acre" inputs used in the TRUEMET model for wintering shorebirds. Integration of the TRUEMET model with Central Valley foraging values will help refine habitat objectives for wintering shorebirds.

2. Habitat Foraging Values for Wintering Shorebirds in Central Valley Agricultural Lands and Wetlands

Issues: Habitat-foraging-value inputs to the TRUEMET model for wintering shorebirds are based on estimates of invertebrate biomass from the Mississippi Alluvial Valley.

The CVJV 2006 Implementation Plan uses a single estimate of invertebrate biomass for all habitat types in the Central Valley.

The dynamic nature of invertebrate prey populations presents challenges for estimating food resources available to wintering shorebirds.

Background: The CVJV 2006 Implementation Plan assumes the quantity of invertebrate food resources is the primary factor that limits wintering shorebird populations in the Central Valley. An energetic model uses four inputs (population objectives, daily energy requirements, habitat acreages, and habitat-foraging-values) to estimate the amount of habitat wintering shorebirds will require when population are at goal levels. However, estimates of invertebrate biomass that inform the habitat-foraging-value inputs are based on estimates from the Mississippi Alluvial Valley. To improve the accuracy and precision of the model, regional and habitat specific estimates of food availability are needed. Specifically, estimates of invertebrate biomass are needed for the following habitats: 1) flooded rice fields in the Sacramento Valley and Delta, 2) post-harvest flooded corn in the Delta, 3) post-harvest flooded crop fields (wheat, tomato, cotton, etc.) in the Tulare Basin, and 4) seasonal and semi-permanent wetlands throughout the Central Valley. Finally, developing studies to estimate biomass must consider the dynamic nature of this food resource relative to environmental conditions, shorebird foraging pressure, and competition from non-shorebirds.

Desired Products:

- A thorough review to assess the usefulness of reported invertebrate data from the Central Valley in the published and grey literature. **(Rank:7)**

- Estimates of invertebrate biomass, across seasons, in four major habitat categories of the Central Valley, including: post-harvest flooded rice fields, post-harvest-flooded corn, post-harvest flooded agricultural fields in the Tulare Basin, and managed seasonal and semi-permanent wetlands. **(Rank:6t)**

Expected Outcomes: Reported and observed estimates of invertebrate biomass from the primary habitat types will allow for relevant Central Valley foraging value inputs into the TRUEMET model. Integration of Central Valley foraging values and "available habitat acre" inputs into the TRUEMET model will ultimately help refine habitat objectives for wintering shorebirds.

3. Develop Methods to Monitor Migrant and Wintering Shorebird Populations

Issues: There is currently no monitoring program to track the abundance and distribution of shorebirds in the Central Valley.

Valley-wide surveys are time and labor intensive, so a cost-effective sampling methodology is needed to collect up-to-date information on shorebird populations to guide and evaluate conservation efforts.

Background: Some shorebird populations in North America have experienced recent declines and they face continuing pressures from habitat loss and degradation (Brown et al. 2001) and climate change (Wormworth and Mallon 2006, Audubon 2009). Unfortunately, there is little information on shorebird population trends in the Central Valley or elsewhere in the Pacific Flyway to guide conservation efforts. Although baseline surveys of shorebird populations were conducted in the Central Valley in the early 1990s (Shuford et al. 1998), there currently is no program in place to track shorebird abundance in this region. Previous valley-wide censuses relied heavily on expensive, labor intensive aerial surveys that are not financially or logistically repeatable. As an alternative, a cost-effective sampling methodology is needed to annually collect data on Central Valley shorebird populations. This continuous population data is important to detect how environmental changes affect shorebird populations and to evaluate the effectiveness of CVJV conservation programs.

PRBO Conservation Science (PRBO) has recently collaborated with other research and management agencies to create the Program for Regional and International Shorebird Monitoring (PRISM), which is designed to help understand the status, distribution, abundance, and habitat relationships of North America's breeding shorebird populations. PRBO is currently seeking funding to establish a PRISM component in California to measure the responses of both coastal and inland shorebird populations to changing habitat conditions. This program would mobilize a network of citizen scientists, NGO personnel and agency personnel to collect shorebird population data and aid the CVJV in refining habitat and population objectives for shorebirds. The Central Valley will initially be the main focus of monitoring in the interior of the state.

Desired Products:

- A well-designed and cost-effective program that will monitor shorebirds across all regions and key habitats in the Central Valley during the migratory and wintering periods. **(Rank:1t)**

Expected Outcomes: Once designed and implemented, such a monitoring program would enable the CVJV to: 1) track wintering and migrating shorebird abundance and distribution, 2) refine population and habitat objectives for shorebirds, and 3) facilitate the evaluation of CVJV efforts in enhancing shorebird populations. This information would also be important in assessing the potential impacts climate change may have on the abundance and distribution of wintering and migrating shorebirds.

Data on wintering and migrating shorebirds would be integrated into a centralized data management system for shorebirds and waterbirds and be available to inform management decisions. In addition, the program would be integrated with broader regional and national efforts to monitor wintering and migrating shorebird populations.

Monitoring and Evaluation Issues
Breeding Shorebirds

1. Develop Methods to Monitor Breeding Shorebirds

Issue: No program currently gathers information on inter-annual variability or tracks long-term trends in breeding shorebird populations in the Central Valley. Such information is needed to guide conservation actions for breeding shorebirds.

Background: Before European settlement and the loss of 90% of its wetlands, California's Central Valley contained extensive shallow-water habitat, which varied dramatically both seasonally and annually depending on the amount of flooding from winter rains or spring runoff from snowmelt. These ephemeral wetlands were highly productive, and when they persisted into spring and summer provided important habitat for breeding shorebirds. Wetland loss has disproportionately affected breeding shorebirds, as subsequent wetland restoration and enhancement has focused on wintering habitat rather than breeding habitat. A valley-wide survey in 2003 provided baseline data on the size of breeding populations of Black-necked Stilts and American Avocets and documented these species' great dependence on evaporation and waste-water ponds created for agricultural, municipal, or industrial purposes (Shuford et al. 2007). Reliance on these environments is generally risky, as future changes in management practices may serve humans but reduce benefits to wildlife. To set biologically sound habitat and population objectives, it is important to build on the one-year baseline survey to assess annual variability and track long-term trends in breeding shorebird populations.

Desired Products:

- A well-designed and cost-effective program that will monitor breeding shorebirds across all regions and key habitats in the Central Valley. **(Rank:8t)**

Expected Outcomes: Once designed and implemented, such a monitoring program would enable the CVJV to: 1) track the abundance and distribution of breeding shorebirds, 2) refine population and habitat objectives for breeding shorebirds, and 3) evaluate the success of its efforts in enhancing populations of breeding shorebirds. This information would also be important in assessing the potential impacts climate change may have on the abundance and distribution of breeding shorebirds.

Data on breeding shorebirds would be integrated into a centralized data management system for shorebirds and waterbirds and would be available to inform management decisions. In addition, the program would be integrated with broader regional and national efforts to monitor breeding shorebirds.

2. Conduct Research on the Reproductive Success of Shorebirds in Key Habitats in the Central Valley

Issue: Although data exist on the approximate size of populations of some breeding shorebirds in the Central Valley, very little is known about their reproductive success in this region and how it varies among key habitats. Such information is needed to guide effective management of these habitats for shorebirds.

Background: A valley-wide survey in 2003 provided baseline data on the size of breeding populations of Black-necked Stilts and American Avocets and documented these species' dependence on rice fields, managed wetlands and evaporation and waste-water ponds created for agricultural, municipal, or industrial purposes (Shuford et al. 2007). It is unknown, however, whether stilts and avocets are successfully reproducing in these habitats or whether their populations are maintained by recruitment of young produced outside the Central Valley. Without such information it will not be possible to make informed decisions on how to enhance or maintain the viability of particular habitats for breeding shorebirds.

Studies that measure reproductive success by marking all nests, banding all chicks, and following the fate of each brood in a given area are often difficult to implement because they are time consuming and costly. Given the reality of time and budget constraints, it may prove more effective to evaluate relative reproductive success in key habitats by simply making periodic counts of adults and the number of young in various age classes.

Desired Products:
- Documentation of the reproductive rates of Black-necked Stilts and American Avocets in key Central Valley habitats, including rice fields, sewage ponds, agricultural evaporation ponds, and managed wetlands. **(Rank:10t)**
- Data on specific habitat parameters that either enhance or reduce the reproductive success of Black-necked Stilts and American Avocets (e.g., water depths, number and type of nesting islands, vegetative cover, predation, etc.). **(Rank:10t)**
- Identification of broader landscape features associated with higher reproductive success of shorebirds. Features likely to influence reproductive success may include proximity to other wetlands or shallow-water habitats, proximity to urban or suburban development, dominant crop types in the vicinity of breeding areas, etc. **(Rank:13)**

Expected Outcomes: These studies would provide information on which habitats are most important to the reproductive success of shorebirds and which habitat/landscape features enhance or detract from the reproductive success of shorebirds. This information would enable mangers to direct resources effectively to restore or enhance habitats important to breeding shorebirds within landscape matrixes conducive to high reproductive success.

Monitoring and Evaluation Issues
Waterbirds

1. Collecting Baseline Data on Colonial-Nesting Waterbirds

Issue: Baseline data on the current abundance and distribution of nesting colonial waterbirds in the Central Valley is essential for setting habitat and population objectives.

Background and Need: Before European settlement and the loss of 90% of its wetlands and riparian habitat, California's Central Valley contained extensive amounts of seasonal wetlands, semi-permanent wetlands and riparian forest habitat. These wetlands and associated riparian habitats were highly productive, and provided important habitat for many species of breeding waterbirds. Wetland loss has disproportionately affected breeding waterbirds, as subsequent wetland restoration and enhancement has focused primarily on wintering rather than breeding habitat. As is the case for breeding shorebirds (Shuford et al. 2007), the current paucity of shallow-water wetlands in summer appears to leave breeding waterbirds in the Central Valley very dependent on habitats created for agricultural, municipal, or industrial purposes. Reliance on these artificial environments is generally risky, as future changes in land management practices may serve humans but reduce benefits to wildlife. To set defensible habitat and population objectives for breeding waterbirds, it is crucial to document the current population sizes, colony locations, and patterns of habitat use of key waterbird species in the Central Valley. Ideally, data would be gathered over a period of years to capture the range of variation in these parameters with respect to the normal range of habitat and climatic conditions.

From 2009–2011, U.S. Fish and Wildlife Service is coordinating a survey of breeding colonial waterbirds throughout 11 western states, including California. Key species groups that will be surveyed in the Central Valley include grebes, cormorants, herons and egrets, ibis, and terns. This survey could be instrumental in establishing baseline data which CVJV could use to help develop specific population and revised habitat objectives for colonial waterbirds.

Desired Products:
- Document size/location of colonies and estimate regional population for each species of grebe, cormorant, heron, egret, ibis and tern breeding in the Central Valley. **(Rank:2)**
- Develop GIS-based atlas which depicts current and historic waterbird colonies. **(Rank:9t)**

Expected Outcomes: Successful completion of this survey would enable the CVJV to develop scientifically sound baseline population and habitat objectives for colonial nesting waterbirds in the Central Valley. Surveys could also help establish protocol and baseline populations for future monitoring activities. Future monitoring activities could prove important in assessing the potential long-term impacts of climate change on the abundance and distribution of colonial nesting waterbirds. Development of a GIS-based atlas will allow biologists to spatially track waterbird colonies over time and compare to historic species occurrences. Data on colonial-nesting waterbirds would be integrated into a centralized database and integrated with broader regional and national efforts.

2. Multi-species Monitoring of Migrant and Wintering Waterbirds in the Central Valley

Issue: A lack of reliable data on population trends of migrant and wintering waterbirds in the Central Valley hampers the ability to identify species at risk and to evaluate whether wetland protection, restoration and enhancement efforts are successfully benefiting all species of waterbirds.

Background and Need: The ability to accurately track trends in wildlife populations is a valuable tool for evaluating the success of conservation efforts. Currently, there is not a program designed to specifically monitor trends of waterbird populations in the Central Valley. The Christmas Bird Count gathers some data on wintering waterbirds in the Central Valley but it is not well-suited for this task. At the local scale, some long-term monitoring is conducted on particular refuges or wildlife areas and some short-term monitoring is conducted on private lands. None of these, however, is adequate to track long-term trends of waterbirds valley-wide. Hence, to enable informed conservation and management decisions, a monitoring system is needed to accurately track trends in numbers of migrant and wintering waterbirds across the entire Central Valley.

Currently there is enthusiasm to develop monitoring programs for waterbirds at the national scale, under the North American Waterbird Conservation Plan, or regionally, through such efforts as the Intermountain West Coordinated Bird Monitoring Program. There also are efforts underway to gather baseline data or to monitor colonial waterbirds and secretive breeding marshbirds. It would be valuable to build on the momentum and expertise of these broader programs to develop a monitoring program for migrant, and particularly, wintering waterbirds in the Central Valley.

Desired Products:
- A well-designed and cost-effective program that will monitor wintering and migrant waterbirds across all regions and key habitats in the Central Valley. **(Rank:5t)**

Expected Outcomes: Once designed and implemented, such a monitoring program would provide baseline data on waterbird populations that the CVJV could incorporate into its own waterbird population and habitat objectives. The monitoring program would also enable the CVJV to continually evaluate the success of its efforts in maintaining and enhancing waterbird populations. Finally, this information would also be important in assessing the potential impacts of climate change on the abundance and distribution of wintering and migrating waterbirds.

Data on wintering and migrant waterbird populations would be integrated into a centralized data management system for shorebirds and waterbirds and be available to inform management decisions. In addition, the program could be integrated with broader regional and national efforts to monitor waterbirds.

3. Monitoring Breeding Secretive Marshbirds

Issues: A lack of reliable data on population trends of secretive marshbirds in the Central Valley hampers the ability to identify species at risk and to evaluate the impacts of wetland protection, restoration and enhancement efforts on these species.

Secretive breeding marshbirds are among the most difficult species of waterbirds to monitor and, as a result, need specific survey protocols.

Background and Need: The ability to accurately track trends in wildlife populations is a valuable tool for evaluating the success of conservation efforts, yet little information is available on patterns of change in populations of many waterbirds. This is particularly the case for various inconspicuous breeding marshbirds. Many of these nest in dense marsh vegetation and are cryptically colored, secretive, and heard more often than seen. Species of secretive marshbirds in the Central Valley include the Pied-billed Grebe, Least Bittern, American Bittern, Sora, Virginia Rail, Black Rail, American Coot, and Common Moorhen. A monitoring system to accurately track trends in numbers of these species across the entire Central Valley is needed to enable informed conservation and management decisions.

Under the banner of the Waterbird Conservation for the Americas initiative, efforts are underway to develop a continental-scale monitoring program to estimate temporal and spatial changes in abundance of selected breeding marshbird species at various scales. Population data will be tied to ancillary data on habitat to inform population and habitat management strategies (www.fws.gov/birds/waterbirds/monitoring/marshmonitoring.html). Progress has been made in developing a standard protocol (Conway and Timmermans 2005, Conway and Nadeau 2006), but consensus has yet to be reached on a sampling design that would be practical for the diverse regions of the continent while producing useful continental-scale information. Efforts to develop a monitoring program for secretive marshbirds in the Central Valley will benefit from the momentum and expertise of these broader programs and should link to them if possible.

Desired Products:
- A well-designed and cost-effective program to monitor secretive breeding marshbirds across all regions and key habitats in the Central Valley. **(Rank:9t)**

Expected Outcomes: Once designed and implemented, such a monitoring program would enable the CVJV to evaluate the success of its efforts in enhancing populations of secretive marshbirds and to continually refine population and habitat objectives for these birds. This information would also be important in assessing the potential impacts of climate change on the abundance and distribution of secretive marshbirds.

Data on secretive breeding marshbirds would be integrated into a centralized data management system for shorebirds and waterbirds and be available to inform management decisions. In addition, the program could be integrated with broader regional and national efforts to monitor secretive marshbirds.

4. Ecology and Monitoring of At-risk Waterbirds

Issue: It is crucial to monitor the populations and study the ecology of at-risk waterbirds to inform best management practices for these vulnerable species.

Background and Need: Species or subspecies of at-risk waterbirds that are designated of particular conservation concern at the state level, federal level, or under national/regional conservation plans, warrant monitoring to track populations and understand factors limiting population growth. Of such species, the Sandhill Crane and the California Black Rail have been the focus of recent research efforts in the Central Valley and are focal species in the CVJV 2006 Implementation Plan. With this in mind, Sandhill Cranes and Black Rails will be the initial focus of monitoring and evaluating at-risk waterbirds.

Sandhill Crane: Various subspecies of Sandhill Cranes winter in the Central Valley. The Greater Sandhill Crane is listed as state threatened, the Lesser Sandhill Crane is designated as a state Bird Species of Special Concern, and the Canadian Sandhill Crane has the smallest population of the three. At present, the only valley-wide coordinated program that counts cranes is the midwinter waterfowl survey, but some cranes are missed and numbers counted show great variation. Also, aerial surveys are not suitable for distinguishing the subspecies. Hence, it would be valuable to design and implement a monitoring program that accurately tracks population trends of all three subspecies of cranes. Data on wintering and migrating Sandhill Crane populations will be integrated into a centralized database for waterbirds and shorebirds to provide timely information on waterbird trends to inform management decisions. It also would be valuable to document the distribution of key foraging and roosting areas and the local landscape features that best explain the patterns of use in these areas.

To leverage research that graduate students are currently conducting on Sandhill Cranes in the Sacramento Valley (Laura Shaskey) and in the Delta and San Joaquin Valley (Gary Ivey), it would be valuable to support those efforts to obtain information that would assist the CVJV in maintaining and enhancing crane habitat throughout the Central Valley.

California Black Rail: The California Black Rail is listed as state threatened and warrants further study to determine its population status in the Central Valley. A breeding population was first discovered in the low foothills of the Sierra Nevada in 1994 (Richmond et al. 2008). Currently, breeders are known to occupy scattered locations in the foothills of Butte, Yuba, Nevada, and Placer counties and a few locations on the Central Valley floor in Butte and Yuba counties. These small populations inhabit freshwater sedge and/or cattail marshes within oak-savannah and open-range annual grasslands. An isolated population also occurs in a freshwater marsh at White Slough Wildlife Area in the Delta of San Joaquin County. Additional undocumented reports of this species in rice fields also need to be followed up with formal surveys. The foothill populations have been studied for the past 5–6 years, but the valley-floor populations have not yet been systematically surveyed. It would be valuable to: document the locations and size of the rail population on the valley floor, understand the rails' seasonal movements within the Valley, understand local population extirpation and colonization patterns, and to determine if valley-floor populations are linked to the nearby foothill populations.

It would be important to work with the existing research program on the foothill metapopulation, headed by Dr. Steve Beissinger and Jerry Tecklin

(http://nature.berkeley.edu/~beis/rail/project.html), and to expand the scope of research to include relevant regions of the Central Valley floor.

Desired Products:

Sandhill Crane
- A coordinated aerial survey of cranes to estimate total population of cranes in Central Valley and each key wintering region. Ground counts of cranes to obtain ratios of the subspecies to use in estimating the size of the population of each. **(Rank:9t)**
- Determine location of all nighttime crane roosts and their proximity to key foraging areas. Frequent winter counts of cranes using roost sites, either on an annual basis or at intervals that are suitable to assess changes in crane use. Counts of cranes at key foraging areas. Develop a valley-wide GIS layer with roost site and key foraging locations and associated data (ownership status, land use, survey numbers, etc.) for use in conservation planning. **(Rank:4t)**
- Identification of the key characteristics of roost sites, such as size, water depth, isolation from human disturbance, vegetation structure, and surrounding land use. **(Rank:8t)**
- Comparison of foraging habitat use with habitat availability, food availability, and management practices to identify factors associated with crane abundance and distribution. **(Rank:8t)**

California Black Rail
- Systematically survey Central Valley wetlands and rice lands to determine location and size of Black Rail population. Develop a valley-wide GIS layer with key breeding locations and associated data (ownership status, land use, survey numbers, etc.) for use in conservation planning and in identifying landscape features important to rails. **(Rank:8t)**
- Identification of patterns of metapopulation dynamics, including rates, patterns, and distances of dispersal, and habitat characteristics that lead to local extirpation, stable populations, or colonization. Determination of recruitment rates and adult survivorship. **(Rank:14t)**
- Identification of the key characteristics of the rails' breeding and winter sites, such as size, water depth, isolation from human disturbance, vegetation structure, and surrounding land use (including different grazing regimes). **(Rank:11)**

Expected Outcomes:

Sandhill Crane and California Black Rail: Information obtained will help guide land management decisions to support crane and rail populations and to prioritize habitat protection, restoration, and enhancement projects.

Data on Sandhill Cranes and Black Rails would be integrated into a centralized data management system for shorebirds and waterbirds and be available to inform management decisions. If relevant, the program could also be integrated with broader regional and national efforts to monitor these species.

6. Landscape Features Important to Waterbirds

Issue: To maximize the benefits of wetland restoration or agricultural enhancement for waterbirds, more information is needed on the broader landscape features that influence the value of local sites to breeding and wintering waterbirds.

Background and Need: Selection of sites for habitat protection, wetland restoration or winter flooding of agricultural lands is often made opportunistically. Ideally such decisions should be made on the basis of criteria that will ensure relatively high benefits to waterbirds at a reasonable cost. Although research increasingly indicates that features of the broader landscape influence the suitability of colony sites, wetlands, or flooded fields as waterbird habitat, the use of this information in the selection of habitat protection, restoration and enhancement sites is not widespread. In Sacramento Valley ricelands, the densities of geese, wading birds, and shorebirds are positively correlated with the amount of wildlife refuge or semi-natural wetland in the vicinity of a flooded field (Elphick 2008). In the north San Francisco Bay region, estuarine emergent wetland and open water within 1 km were of primary importance in explaining occupancy of heron and egret colonies, and other landscape features helped explain variation in reproductive success of herons and egrets (Kelly et al. 2008). Additional research is needed in other regions of the Central Valley to gather and refine data on what landscape features are important to various groups and species of waterbirds to inform optimal site selection for habitat protection, restoration and enhancement projects. Given increasing fiscal and socio-political constraints on wetland protection, wetland restoration and agricultural enhancement, it is important to obtain information that will optimize benefits for waterbirds.

Desired Products:
- Identification of landscape features that are important to groups and individual species of waterbirds. **(Rank:10t)**
- Identification of how landscape features important to waterbirds vary among regions of the Central Valley depending on the particular matrix of wetlands, agriculture crops, and urban development in the area. **(Rank:14t)**

Expected Outcomes: Such information will allow the CVJV and its partners to maximize the benefit to waterbirds from habitat protection, restoration and enhancement projects by further refining and incorporating the criteria of landscape features into the site selection process.

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Table 1. CVJV Shorebird and Waterbird Monitoring and Evaluation Plan issues and products.

Issue	Product	Rank[1]	Average Score[2]
Tracking Net Landscape Change	Beneficial habitat gains and losses.	1t	4.64
	Incompatible habitat gains and losses.	6t	3.73
	Spatial depiction of habitat gains and losses.	5t	3.91
	Monitor agricultural trends on annual basis.	11t	2.64
Develop Centralized Database	Centralized database for Central Valley.	3	4.27
	Link database with regional/national databases.	11t	2.64
	Develop online tools for managers/biologists.	12	2.27
Effects of Climate Change on Shorebirds and Waterbirds	Develop models to assess impact on water resources.	5t	3.91
	Conduct vulnerability assessment for species and habitats.	10t	2.82
Assess Shorebird and Waterbird Response to Habitat	Shorebird/waterbird response to restoration/enhancement	6t	3.73
	Shorebird/waterbird response to water and vegetation management.	6t	3.73
Assess Habitat Available to Wintering/Migrating Shorebirds	Determine water depths and observed depth-ratios.	4t	4.09
	Document shorebird use of vegetated wetlands.	8t	3.18
	Describe vegetative character of existing wetlands.	9t	3.00
Habitat Foraging Values for Wintering Shorebirds	Assess invertebrate data from literature.	7	3.36
	Estimate invertebrate biomass in different habitat types.	6t	3.73
Monitor Wintering/Migrating Shorebird Populations	Develop wintering/migrating shorebird population monitoring program.	1t	4.64
Monitor Breeding Shorebirds	Develop breeding shorebird population monitoring program.	8t	3.18
Research Reproductive Success of Shorebirds	Document reproductive rates of BNST's and AMAV's.	10t	2.82
	Habitat parameters that effect reproductive success.	10t	2.82
	Landscape features associated with reproductive success.	13	1.91
Collect Baseline Data on Colonial Nesting Waterbirds	Document size/location of waterbird colonies and estimate regional populations.	2	4.45
	Develop GIS based atlas depicting current/historic colonies.	9t	3.00
Monitoring Migrant and Wintering Waterbirds	Develop wintering/migrating waterbird population monitoring program.	5t	3.91
Monitoring Secretive Breeding Marshbirds	Develop monitoring program for secretive marshbirds.	9t	3.00
Monitoring At-Risk Waterbirds	Conduct aerial survey to monitor Sandhill Crane population.	9t	3.00
	Determine Sandhill Crane roost sites/foraging locations and develop GIS map of locations.	4t	4.09
	Identify habitat characteristics of crane roost sites.	8t	3.18
	Identify habitat factors associated with crane abundance.	8t	3.18
	Survey wetlands/rice lands to determine size/location of Black Rail population and develop GIS map of locations.	8t	3.18
	Black rail metapopulation dynamics.	14t	1.73
	Identify characteristics of black rail habitat.	11	2.64
Landscape Features Important to Waterbirds	Identification of landscape features important to waterbirds.	10t	2.82
	Identify how landscape features vary among regions.	14t	1.73

[1] The letter t indicates a tie with one or more other products.

Appendix 1. Product ranking methodology.

The draft Monitoring and Evaluation Plan and a ranking spread sheet (Excel) listing all 34 products were provided to each member of the Shorebird and Waterbird Working Group. Each member was asked to score the individual products listed on the ranking spread sheet as a high priority (5), moderate priority (3) or a low priority (1). They were asked to score these products based on: (1) their contribution toward improving assumptions of the 2006 CVJV Implementation Plan, (2) their contributions toward monitoring and tracking CVJV population and habitat objectives, (3) their sequencing (some products need to be completed before others begin) and (4) current project and funding availability.

Eleven working group members scored the 34 individual products provided on the ranking spread sheet. The individual product scores (n=11) were compiled and an average score was determined for each product. The product rank was determined based on the average product score, with product ranks descending from the highest average product score to the lowest average product score.