Summary Information

The Nature Conservancy

Measuring the Performance of Riparian Restoration Projects on the Sacramento River

Amount sought: $1,103,944

Duration: 36 months

Lead investigator: Dr. Gregory Golet, The Nature Conservancy

Short Description

This project will determine the success of horticultural restoration projects towards (ERP goal 4), and (ERP goal 1) on a wider geographic basis. This project will use remote censusing and field−based monitoring techniques to better characterize existing habitats and species abundance, distributions, fecundity, and survival (at both restoration sites and in remnant riparian areas) at the landscape scale. The iterative process of mapping and characterizing riparian vegetation, ground−truthing mapped areas, and refining mapping methodologies will enable us to evaluate the recovery of riparian habitats, songbirds and the VELB at the scale of the entire Project area. In addition, it will allow us to better determine the relative utility that various types of GIS−derived landscape−scale data (e.g., relative elevation, landform age, channel position, channel features, etc.) have in predicting occurrences and abundances of key species and communities. A SECONDARY OBJECTIVE is to integrate new monitoring information into an ecological scorecard framework that tabulates and synthesizes information to characterize the status and trends of focal biodiversity in the Sacramento River Project area.

Executive Summary

Over the past 18 years, The Nature Conservancy (TNC) and its partners including the U.S. Fish and Wildlife Service, the CA Department of Water Resources, the CA Department of Fish and Game, and the CA Department of Parks and Recreation) have worked to implement many of the conservation initiatives outlined in the Sacramento River Conservation Area Forum handbook. TNC has planted a suite of native woody species (trees and shrubs), and more recently, forbs and grasses on 3,600 acres of Sacramento River floodplain habitat. CALFED and CVPIA have provided direct support to this effort by funding projects focused on planning, acquisition, restoration, research and monitoring. Virtually all of these grants have advanced implementation of TNC’s horticultural restoration program on the Sacramento

River, although each did so in different ways, and/or at different locations. Through grants to TNC and other organizations, CALFED has funded 5,683 acres of habitat protection between Red Bluff and Colusa in the SRCAF Inner River Zone, with 15,000 total acres of protected habitat called for under ERP Milestone 60.

Although localized monitoring confirms the success of the horticultural approach for restoring habitats for wildlife, there is a need for a more comprehensive assessment of previously implemented projects. In particular, we need to determine how successful horticultural restoration projects have been at achieving CALFED's recovery goals for habitat (ERP goal 4), and native at−risk species including songbirds and the VELB (ERP goal 1) on a wider geographic basis. Answering these questions is important for determining the effectiveness of existing CALFED−funded projects, informing adaptive management of current riparian restoration efforts in the Project area, and developing future restoration strategies (especially as additional restoration is required to meet ERP goals.

To comprehensively address these information gaps we need to use remote censusing and field−based monitoring techniques to better characterize existing habitats and species abundance, distributions, fecundity, and survival (at both restoration sites and in remnant riparian areas) at the landscape scale. Only by examining the system as a whole can we define the relative contribution that horticultural restoration projects are making to ecosystem recovery.

Our GOAL is to quantify how Sacramento River riparian restoration projects are contributing towards meeting ERP recovery goals for habitat and native at−risk species. Past field studies have generated a multitude of valuable information that can now be used as part of a landscape−scale analysis to assess recovery of species and habitats over the entire Sacramento River Project area (Red Bluff to Colusa). PRBO Conservation Science has conducted songbird research and monitoring on the Sacramento River and other watersheds in the Central Valley for 12 years, and University of California researchers have studied the VELB on five north state rivers for over four years.

A PRIMARY OBJECTIVE of our project is to use remote censusing and field data to evaluate the degree to which past restoration activities are promoting the recovery of riparian vegetation, songbirds and the Valley elderberry longhorn beetle (VELB) in the Project area. The iterative process of mapping and characterizing riparian vegetation, ground−truthing mapped areas, and refining mapping methodologies will enable us to evaluate the recovery of riparian habitats, songbirds and the VELB at the scale of the entire Project area. In addition, it will allow us to better determine the relative utility that various types of GIS−derived landscape−scale data (e.g., relative elevation, landform age, channel position, channel features, etc.) have in predicting occurrences and abundances of key species and communities.

A SECONDARY OBJECTIVE is to integrate new monitoring information into an ecological scorecard framework that tabulates and synthesizes information to characterize the status and trends of focal biodiversity in the Sacramento River Project area. The scorecard uses quantitative data assembled by TNC staff, teams of partner institutions and experts to track important ecological characteristics and synthesize their status into a set of simple categorical ratings of biodiversity status in an area. Through repeated measurement, managers can use the framework to determine whether the status of biodiversity is responding to conservation investments and strategies over time. The framework has the added advantages of providing a rigorous basis for setting conservation objectives, assessing threats to biodiversity, identifying monitoring and research needs, and communicating management information to non−specialists.

The proposed project will produce IMPORTANT OUTCOMES including: comprehensive estimates of the amount and type of habitat that has been created on the river (through natural processes and through horticultural means); estimates of VELB and songbird population size; and characterizations of the relative success of different restoration projects in promoting the recovery of riparian habitats and associated species. It will also further the development and implementation of a rigorous framework for assessing the status of biodiversity and the success of conservation projects in the Sacramento River Project area.

Our project will provide information that is useful at a variety of scales. It builds off of past productive collaborations and has the desirable characteristics of being both interdisciplinary and multi−institutional. It is structured to meet the information needs of, and be highly coordinated with, both agencies and stakeholders. By evaluating past restoration actions, it will support adaptive management of a primary CALFED ERP Stage 1 Action (Action 1: Protect, enhance and restore the meander belt between Red Bluff and Chico Landing). In so doing, it will inform and direct the decision−making process of resource managers in CALFED ERP Ecological Management Units 3.2 &3.3. The project presents a durable partnership, in that it has a mechanism in place for continuation of funding beyond the project’s 3−year term.

Measuring the Performance of Riparian Restoration Projects on the Sacramento River

A. Project Description: Project Goals and Scope of Work.

1. Problem, Goals and Objectives –

Background. The Sacramento River is a fundamental state water source that drains 24,000 square miles of the northern Central Valley and supplies 80% of freshwater flowing into the Bay-Delta (CA State Lands Commission 1993). Historically, the river was lined by approximately 800,000 acres of riparian forest (Katibah 1984). However, over 95% of this habitat has been lost to logging, agriculture, urban development, and flood control and power generation projects. Two-thirds of the linear extent of the river's banks have been modified and confined by levees and riprap. Channelization, bank protection and the construction of the Shasta Dam degraded many habitats by restricting the dynamic forces that promote natural habitat succession and regeneration along the river. Cumulatively, these changes have greatly stressed the Sacramento River ecosystem. The loss and degradation of riparian habitat has diminished the river's ability to support viable wildlife populations and encouraged the invasion and proliferation of non-native invasive species (NIS).

The loss of riparian habitat along the Sacramento River has caused local extirpations and threatens the persistence of important native species. At-risk species include resident and Neotropical migratory songbirds and the Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), taxa which are the focus of this proposal. The Valley elderberry longhorn beetle, hereafter VELB, is a Federally threatened species that is absent from large areas within its historical range (CALFED 2000a). Special-status songbirds that have declined and/or have experienced range retractions include the state Endangered western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), and the California Species of Special Concern yellow-breasted chat (*Icteria virens*), yellow warbler (*Dendroica petechia*), and Modesto song sparrow (*Melospiza melodia mailliardi*). Bird species that no longer reproduce along the river include least Bell's vireo [*Vireo bellii pusillus*] and willow flycatcher [*Empidonax trailii*]) (Gaines 1977, CDFG & PRBO 2001).

Although severely degraded, the Sacramento River is still one of the most diverse and extensive river ecosystems in California, composed of a rich mosaic of aquatic habitats, oxbow lakes, sloughs, seasonal wetlands, riparian forests, valley oak woodlands, and grasslands. A striking feature of the Sacramento River is the potential for restoration that it presents. Recognizing this potential, and in an effort to restore habitat as well as viable populations of resident and Neotropical migratory birds, the VELB and other species, government and non-government organizations have begun to implement a series of restoration programs along the river. The CA State Legislature, in 1986, passed Senate Bill 1086, which mandated the development of a management plan to protect, restore and enhance riparian habitat along the Sacramento River and its tributaries. The Sacramento River Conservation Area Forum (SRCAF), a non-profit organization, formed, and set as its primary goal the preservation of remaining riparian habitat and the reestablishment of a continuous riparian corridor from Red Bluff to Colusa. CALFED has specified collaboration with the SRCAF as a priority for the Sacramento River region.

Over the past 18 years, The Nature Conservancy (TNC) and its partners (including the U.S. Fish and Wildlife Service, the CA Department of Water Resources, the CA Department of Fish and Game, and the CA Department of Parks and Recreation) have worked to implement many of the conservation initiatives outlined in the SRCAF handbook (CA Resources Agency 2000). TNC has planted a suite of native woody species (trees and shrubs, Alpert et al. 1999), and more recently, forbs and grasses on 3,600 acres of Sacramento River floodplain habitat **(Figs. 1a & 1b).** CALFED and CVPIA have provided direct support to this effort by funding projects focused on planning, acquisition, restoration, research and monitoring. See **Table 5** for a listing of previously funded grants from CALFED to TNC's Sacramento River Project (the "Project"),

including information on project type, accomplishments, and current status. Virtually all of these grants have advanced implementation of TNC's horticultural restoration program on the Sacramento River, although each did so in different ways, and/or at different locations. **Figures 1a & 1b** map locations where CALFED funds have supported these activities, and **Figure 2** displays the conceptual linkages between planning, acquisition, restoration, research and monitoring that support TNC's riparian restoration program on the Sacramento River. Through grants to TNC and other organizations, CALFED has funded 5,683 acres of habitat protection between Red Bluff and Colusa in the SRCAF Inner River Zone (D. Burmester *pers. comm.*), with 15,000 total acres of protected habitat called for under ERP Milestone 60 (USFWS et al. 2004).

Although localized monitoring confirms the success of the horticultural approach for restoring habitats for wildlife (Alpert et al. 1999, Brown & Wood 2002, Griggs & Golet 2002, Golet et al. 2003, Hunt 2003, Stillwater Sciences 2003, Wood 2003, Gardali et al. 2004), there is a need for a more comprehensive assessment of previously implemented projects. In particular, we need to determine how successful horticultural restoration projects have been at achieving CALFED's recovery goals for habitat (ERP goal 4, CALFED 2000b), and native at-risk species including songbirds and the VELB (ERP goal 1, CALFED 2000b) on a wider geographic basis. Answering these questions is important for determining the effectiveness of existing CALFED-funded projects, informing adaptive management of current riparian restoration efforts in the Project area, and developing future restoration strategies—especially as additional restoration is required to meet ERP goals.

To comprehensively address these information gaps we need to use remote sensing and field-based monitoring techniques to better characterize existing habitats and species abundance, distributions, fecundity, and survival (at both restoration sites and in remnant riparian areas) at the landscape scale. Only by examining the system as a whole can we define the relative contribution that horticultural restoration projects are making to ecosystem recovery.

Our goal is to quantify how Sacramento River riparian restoration projects are contributing towards meeting ERP recovery goals for habitat and native at-risk species.

Past field studies have generated a multitude of valuable information that can now be used as part of a landscape-scale analysis to assess recovery of species and habitats over the entire Sacramento River Project area (Red Bluff to Colusa). PRBO Conservation Science has conducted songbird research and monitoring on the Sacramento River and other watersheds in the Central Valley for 12 years, and University of California researchers have studied the VELB on five north state rivers for over four years.

A primary objective of our project is to use remote sensing and field data to evaluate the degree to which past restoration activities are promoting the recovery of riparian vegetation, songbirds and the VELB in the Sacramento River Project area. The iterative process of mapping and characterizing riparian vegetation, ground-truthing mapped areas, and refining mapping methodologies will enable us to evaluate the recovery of riparian habitats, songbirds and the VELB at the scale of the entire Project area. In addition, it will allow us to better determine the relative utility that various types of GIS-derived landscape-scale data (e.g., relative elevation, landform age, channel position, channel features, etc.) have in predicting occurrences and abundances of key species and communities.

A secondary objective is to integrate new monitoring information into an ecological scorecard framework that tabulates and synthesizes information to characterize the status and trends of focal biodiversity in the Sacramento River Project area. The scorecard uses quantitative data assembled by TNC staff, teams of partner institutions and experts to track important ecological characteristics and synthesize their status into a set of simple categorical ratings of biodiversity status in an area. Through repeated measurement, managers can use the framework to determine whether the status of biodiversity is responding to conservation investments and strategies over time. The framework has the added advantages of providing a

rigorous basis for setting conservation objectives, assessing threats to biodiversity, identifying monitoring and research needs, and communicating management information to non-specialists.

The proposed project will produce important outcomes including: comprehensive estimates of the amount and type of habitat that has been created on the river (through natural processes and through horticultural means); estimates of VELB and songbird population size; and characterizations of the relative success of different restoration projects in promoting the recovery of riparian habitats and associated species. It will also further the development and implementation of a rigorous framework for assessing the status of biodiversity and the success of conservation projects in the Sacramento River Project area.

Our project will provide information that is useful at a variety of scales. It builds off of past productive collaborations and has the desirable characteristics of being both interdisciplinary and multi-institutional. It is structured to meet the information needs of, and be highly coordinated with, agencies and stakeholders. By evaluating past restoration actions, it will support adaptive management of a primary CALFED ERP Stage 1 Action (Action 1: Protect, enhance and restore the meander belt between Red Bluff and Chico Landing, CALFED 2000b). In so doing, it will inform and direct the decision-making process of resource managers in CALFED ERP Ecological Management Units 3.2 & 3.3. The project presents a durable partnership, in that it has a mechanism in place for continuation of funding beyond the project's 3-year term (see also **Long-term Funding Strategy** section, p. 18).

2. Justification (including conceptual model and hypotheses) –

Our project is designed to test the hypothesis that horticultural restoration promotes the recovery of native floodplain riparian habitats and associated indicator species, specifically songbirds and the VELB.

To test this hypothesis we crafted a conceptual model (**Fig. 3**) that portrays our understanding of key ecosystem parameters that affect two specific ecosystem response variables (songbirds and the VELB) that our restoration action (horticultural restoration) is designed to influence. The model displays physical processes that shape habitat characteristics that are important for these taxa. It also portrays linkages between the restoration action we are evaluating, and the ecosystem response indicators that our project will gather quantitative data on.

In conducting an evaluation of the effectiveness of horticultural restoration, it is important to monitor not only the local habitat attributes (the "habitat indicators" in **Fig. 3**) that this restoration action is designed to affect change in, but also those physical parameters (the "physical process indicators" in **Fig. 3**) that influence habitat dynamics across the larger landscape. Specifically, it is important to monitor patterns of channel meander and avulsion as these processes lead to the creation and loss of habitat through sediment deposition and erosion (NRC 2002). As such, they set the template upon which vegetation dynamics are played out in the natural landscape. By quantifying habitat changes at the landscape scale, we can determine the relative importance of habitat changes resulting from horticultural restoration programs, and thus accurately assess the relative contribution of this restoration action to species recovery.

For riparian songbirds, our conceptual model (**Fig. 3**) emphasizes that birds respond to vegetation characteristics which in turn are influenced by physical processes. Studies to date (e.g., Nur et al. 2004) demonstrate that structural characteristics (number of sub-layers, height of vegetation, etc.) as well as plant species composition are important to birds. Furthermore, the conceptual model includes the effect of the landscape matrix surrounding riparian habitat on bird response (**Fig. 3**). The above listed factors influence habitat selection by birds (e.g., the decision by birds as to which patch to forage in and which patch to attempt to breed in), and thus influence the spatial distribution of birds, and, ultimately, the abundance patterns of birds. Yet variation in abundance of birds does not necessarily translate to concomitant variation in habitat quality (Bock & Jones 2004). Instead, the habitat of the highest quality will be habitat that supports growing populations of songbirds, i.e., habitat supporting "source" not "sink" populations. Population growth rate in turn reflects the combination of survival and reproductive

success achieved by that population (**Fig. 3**). Our conceptual model emphasizes variation in reproductive success, which itself reflects aspects of vegetation (the vegetation provides food for insects which birds prey upon and provides nest substrate and concealment for nesting birds) and the surrounding habitat/landscape matrix (reproductive success reflects the risk of predation, which is mediated by patch configuration and characteristics of surrounding land as well as vegetation characteristics). Reproductive rates are a potent indicator by which to evaluate restoration success and can easily be studied in birds, compared to other taxa.

For elderberry and VELB, the conceptual model (**Fig. 3)** shows the main causal links that are expected. Both relative elevation and floodplain age are known to influence vegetation type along the middle Sacramento River (Vaghti 2003). In turn, these factors influence elderberry occurrence (Vaghti et al. *In prep*.). Additionally, vegetation height is expected to influence the suitability of habitat for elderberry by influencing canopy cover, but this remains to be demonstrated quantitatively. The precise relationships between associated vegetation, elderberry occurrence and elderberry condition (including size) remain to be determined. It is hypothesized that VELB colonization is influenced by elderberry size and that other variables shown in **Fig. 3** have a more minor effect (if any), yet these assumptions need to be tested. The proposed project will address these uncertainties and others, including the effect of site isolation on VELB colonization patterns and subsequent population size. Further details on the focus of the VELB studied are provided in **Task 3** below.

3. Previously Funded Monitoring –

Previous monitoring studies suggest that horticultural restoration activities can effectively increase the abundance of songbirds (**Fig. 4**, Gardali et al. 2004) and VELB (River Partners 2004) on the Sacramento River. However, no comprehensive large-scale assessment and characterization of habitat created through horticultural restoration programs has been completed to date. Additionally, there has been little work examining the functionality of existing restored floodplain habitats.

Bird monitoring, at various levels of intensity, has been ongoing in restored and remnant riparian forests within the Project area since 1993 (see also **Task 2** below). Monitoring efforts have most consistently focused on estimating bird abundance and community composition and relating these parameters to site-specific habitat characteristics and evaluating changes over time (Gardali et al. 2004, Nur et al. 2004). Additionally, monitoring has been conducted to estimate reproductive success and adult survival at a subset of sites. Monitoring has also focused on use of the Project area for birds during migration (Humple & Geupel 2002). Results to date indicate that the restoration activities along the Sacramento River are successfully providing habitat for a diverse community of songbirds. For example, the abundance of several species with diverse life-history requirements dramatically increased as the age of revegetation increased (Gardali et al. 2004, **Fig. 4**).

PRBO is beginning the second year of a CALFED-funded project investigating songbird population responses to riparian condition across the entire Central Valley. The current proposal will build on the foundation established by this previously-funded project. Work to date has identified a set of vegetation and habitat variables that appear to be important in influencing abundance and/or occurrence of riparian songbird species over the scale of the entire Central Valley. For example, several species were shown to be positively associated with tree height and/or canopy cover (Nur et al. 2004), attributes that may be studied through remote sensing image analysis. At the same time, analyses to date have identified species whose abundance is influenced by understory characteristics (e.g., extent of mugwort), which may ultimately be influenced by the physical processes (e.g., flooding) to be studied in the proposed project.

The next phase of the currently-funded PRBO project (to be completed in Years 2 and 3 of the project) will investigate the influence of landscape factors with respect to variation in songbird abundance. Additional work will examine the influence of patch configuration and adjacent land-use on reproductive success. As a result, the currently funded work will serve to characterize the important variables (with respect to habitat and landscape) that will then be modeled in the

proposed project. We will thus not need to begin by analyzing data to identify the important variables for songbirds in the Central Valley; this will already have been accomplished.

The proposed work will build on previous studies of songbirds by specifically focusing on the value of restoration projects to birds, and in particular, those projects implemented along the reach of the Sacramento River from Colusa to Red Bluff, and by including detailed information on physical parameters that are not being studied in the current project. The proposed work will also extend the time series of bird population response to change in habitat through restoration by four years. Thus, a number of restoration sites will be studied that will be approximately 15 years since horticultural restoration by 2007, an important period of time for evaluating bird population response (Gardali et al. 2004).

A study by PRBO comparing survival, physical condition, fidelity, and over winter site persistence between remnant and restored riparian areas was initiated during winter 2004/2005. No funds have been identified for work in 2005 or beyond.

On the Sacramento River there has been a small amount of previous monitoring of elderberry and the VELB. The main previous activity was to examine about 7000 planted elderberry to determine if VELB were present or absent in 2003 (River Partners 2004, **Table 4**). These data have not been analyzed other than to tabulate the frequency of VELB by refuge unit and field. Additionally Theresa Talley and Marcel Holyoak (unpublished data) evaluated the presence of VELB and elderberry size in 5 fields in a total of 3 restored units in 2001. These data position us well to be able to see how widespread VELB populations are now and how much they have grown since the initial surveys.

See also **Table 4** for a list of research and monitoring projects focusing on similar topics that Principal Investigators (PIs) from this proposal are involved with, **Table 5** for a list of CALFED-funded projects that TNC has implemented in the Sacramento River Project area, and **Table 6** for a list of research and monitoring projects focusing on terrestrial habitats within the Sacramento River Project area that applicants from this proposal are not involved with as PIs.

4. Approach and Scope of Work –

TASK 1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS USING REMOTE SENSING DATA

To model patterns of vegetation change and songbird and VELB response to restoration actions we need to characterize important aspects of riparian habitats at both restoration sites and at remnant habitats across the Project area (Gardali et al. 2004, Loiselle et al. 2003, Osborne 2001). Aspects to be characterized include both current floodplain landform features and dynamic riverine processes. Characterizing these parameters is important for generating data to support subsequent analyses proposed in this project, and, more generally, for assessing the overall health of the Sacramento River ecosystem.

We will characterize landform features and riverine processes in the current project by employing remote sensing and field calibration techniques. Below we list the remote sensing techniques that will be employed, the associated analyses, and the parameters that these analyses will define. These parameters may be thought of as “indicators” (*sensu* CALFED 2001b, Murphy 2002) as they describe environmental change, and are important for assessing vegetation, songbird (**Tasks 2**) and VELB (**Tasks 3**) response to current and prior restoration actions. The data generated through the characterization of these parameters are useful as well, in that they support further development of the ecological scorecard of the Sacramento River Project area (**Task 4**). A comprehensive list of the specific indicators that each task of our project will define is presented in **Table 7.**

Subtask 1.1: Analyze new aerial photos to define channel, land cover, and floodplain features important for vegetation, songbirds and the VELB.

To characterize riparian habitats important for vegetation, songbirds and the VELB, we will digitize land cover, channel, and floodplain features (*described below*) on orthorectified true

color aerial photos (obtained from an imagery vendor) of the reach of the Sacramento River between Red Bluff and Colusa (**Fig. 1**). Stereo-pair aerial photographs will be taken in late spring at a representative fraction scale of 1:12,000, scanned at 1000 dpi and georectified. These will provide data on water feature classes, channel position, and vegetation composition.

Classification

The land cover, channel features, and floodplain water bodies depicted on these photos will be vector digitized into a GIS layer using ArcGIS software (ESRI 2004). Each land cover and water feature map polygon will be attributed with its respective class. The land cover mapping process will be guided by the classification system implemented in a 1997 land cover study by UC Davis (Greco et al. 2003a) and a channel mapping study of low-flow channel features (Greco & Alford 2003). The land cover and water feature attribute classes were derived from the California Wildlife Habitat Relationship System (CWHR) (Mayer & Laudenslayer 1986) and the wetland classification system developed by the USFWS (Cowardin et al. 1979). Examples of the CWHR habitat types include valley riparian, valley oak woodland, annual grassland, orchards and croplands. Channel mapping categories include riverine (main channel and side channel), lacustrine, freshwater emergent wetland, tributary channel, and island.

The classification system allows definition of a main channel for use in delineating a centerline for the river reach. Channel centerline data will be used to calculate various riverine physical process indicators (e.g., sinuosity, rate of land reworked) that will be used to model habitat and species response dynamics (**Tasks 2 and 3**), and that will be incorporated into an ecosystem scorecard (**Task 4**). Physical process indicators will be computed using GIS-derived data and various analytical tools (e.g., MATLAB).

Channel Position

The dataset of channel positions will be used to quantify channel migration patterns, which are a principle driver of habitat dynamics in alluvial riparian systems. Channel position data exists for a subset of recent years—1976, 1987, 1997, 1999 (Greco & Alford 2003), but to our knowledge has not been determined post-1999. On the landscape scale, channel migration patterns may be characterized by defining area of land reworked (eroded and redeposited), and the related indicator, floodplain age (the time elapsed since a given landform was deposited). Both are useful riverine monitoring indicators in that they strongly influence vegetation dynamics and wildlife use patterns.

We will quantify these parameters by cataloging erosion and deposition patterns from the channel centerline and water body maps (using existing scripts in which we spatially combine annual channel centerline data and calculate area eroded per bend per time interval [Fremier 2003, Greco et al. *In prep.* a]). This will include estimating rates of bank migration at both the bend and entire reach scale, documenting the spatial patterns of deposition, and indexing the fluvial process that created the floodplain (avulsions vs. migration). Floodplain age will be related to vegetation characteristics on restoration sites and at remnant areas within the Project area.

Vegetation Composition

Both remotely sensed and field data will be analyzed to quantify current ecological condition of riparian vegetation stands, including plant species composition, height class, and aerial extent. This information will help inform bird-habitat relationships, as well as identify important potential VELB habitat. Riparian vegetation stand height will be mapped for a subset of the Project area using 2005 LIDAR data (see Subtask 1.2). We will subtract the bald earth topographic surface from the raw data to derive continuous values of vegetation height. The stands will then be classified into six height classes (<1, 1-5, 6-10, 11-15, 16-20, >20 m) using zonal statistics in ArcGIS. For river reaches outside the LIDAR data collection area we will use a photogrammetric approach to estimating three stand heights classes (<6, 6-20, >20 m) using the methods described in Greco et al. (2002), Greco & Plant (2003) and Greco et al. (2003).

Areas of new woody vegetation recruitment on recently formed channel features (e.g., pointbars, off-channel aquatic habitats) will be mapped and characterized to assess the degree to which natural vegetation recruitment is taking place in the system. This effort builds off of a previous study in which recent recruitment (circa 1983 to present) was field mapped in a subset of the Project area (Roberts et al. 2003). Understanding the amount of natural recruitment taking place, as well as the amount that is being lost through erosion and clearing is important for setting the context to evaluate the contribution that restoration sites are making toward the recovery of native habitats and biota (including songbirds and the VELB).

Previous classifications will be analyzed along with new data generated from this project to quantify changes in mapped categories (from 1997 to 2005) according to methodology described in Greco & Plant (2003).

Subtask 1.2: Analyze LIDAR data to define channel and floodplain features important for vegetation, songbirds and the VELB to obtain topographic/elevation data.

Topography is an important physical variable structuring the floodplain environment. The dynamic fluvial geomorphic processes of bank erosion, floodplain deposition, and scour act to change floodplain elevations over time and produce highly complex land surface relationships to groundwater. Depth to groundwater is an important factor that explains the spatial distribution of several key riparian tree species such as willows (*Salix* spp.) and cottonwood (*Populus fremontii*) in lower floodplains and Valley oak (*Quercus lobata*) and walnut (e.g., *Juglans californica*) in upper floodplains (Peterson et al. 2003, Greco et al. *In prep* b). A map depicting depth to groundwater is a valuable planning and analysis tool for restoration managers and scientists. In the context of the present project it will be used in Subtasks 1.4, 2.2, and 3.1.

Detailed, precise topographic data may be obtained using the light detection and ranging (LIDAR) remote sensing methodology. With funding made available from another project, topographic land surface data will be updated in 2005 in the Princeton to Colusa reach of the Project area using LIDAR. The reach will be flown at one foot resolution and a bald earth land surface model will be extracted from the raw LIDAR data by a vendor.

With the LIDAR data we will be able to calculate "relative elevation"—the vertical distance above the nearest flowing channel water surface. The raw input needed to compute floodplain relative elevation is: (1) a topographic land and bathymetric surface, and (2) a base-flow (or mean summer low-flow) water surface. We developed the spatial analysis algorithms (GIS methodology) required to compute this indicator in a previous project. Relative elevation will be modeled using either the water surface elevations from a previous HEC-RAS modeling effort, or water surface elevations extracted from the LIDAR data. The merits of each approach will be evaluated after the LIDAR data have been collected and analyzed.

LIDAR data will also be used to measure vegetation structure of restoration sites and remnant riparian forests in the Princeton to Colusa reach. Recent studies have shown this technique to be useful in mapping landcover into broad classes, as well as for estimating parameters such as aboveground biomass and leaf area index (Lefsky et al. 1992, 2002). Parameters such as these may prove useful in characterizing species distributions in the present study, as birds are often associated with three-dimensional features in forests (Carey et al. 1991, Nur et a. 2004).

Subtask 1.3: Analyze IKONOS data channel and floodplain features to characterize native and non-native plant species important for vegetation, songbirds and the VELB.

We will acquire and analyze multi-spectral satellite remote imagery (IKONOS) to further classify vegetation composition into dominant and subdominant native and non-native plant species assemblages. This will be accomplished with an automated vegetation community mapping procedure that was developed from unique species reflectance signatures obtained from over 100 previously sampled georeferenced vegetation field plots (from unpublished data in Greco 1999, Fremier 2003, and Vaghti 2003). IKONOS data will be used to measure attributes of riparian vegetation across the landscape, with particular attention being given to characterizing conditions at areas of new recruitment and at restoration sites. IKONOS have been

shown to be useful in tracking invasive plant species (Joshi et al. 2004) and in predicting patterns of species richness for songbirds and insects in other systems (Seto et al. 2004).

Subtask 1.4: Analyze the relative importance of different parameters for predicting the distribution and condition of vegetation communities.

We will ground-truth remotely sensed data to calibrate classifications of remotely sensed images. Ground truthing will be done by quantifying relative percent canopy cover of key native and exotic plant species and by measuring stand heights. Data will be combined into a phyto-sociological classification system (see Vaghti 2003) and characterized according to the California Native Plant Society's Manual of California Vegetation (Sawyer Keeler-Wolf 1995).

The spatial distribution of the vegetation communities mapped in Subtask 1.1 will be analyzed for their responses to floodplain age, relative elevation, and other key landscape and local site characteristics. Each mapped category of plant species, association, or alliance will have a response curve generated over each continuous variable (i.e. floodplain age and relative elevation). This information will be used to identify thresholds in environmental variables that influence the distribution of vegetation communities. In combination with soils mapping, this information will provide restoration ecologists with a model to guide planting designs for future restoration sites in the Project area.

We will also use multivariate statistical methods to assess the response of vegetation communities and individual species to variables such as floodplain age, distance to channel, and relative elevation (Fremier 2003, Greco et al. *In prep.* a, b). Initial investigations along these lines have assisted researchers in understanding the distribution patterns of blue elderberry (*Sambucus mexicanus*), the host plant to the VELB (Vaghti et al. *In prep*.).

TASK 2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS

The objectives of **Task 2** are to:

(1) characterize variation in bird population indicators at three spatial scales: a) the entire Project area; b) at a subset of sites with extensive information on birds and the habitat attributes that influence bird populations; and c) within sites.

(2) characterize variation in bird population indicators across time.

(3) compare riparian restoration sites with each other and with reference riparian sites in order to: a) evaluate the contribution of restoration activities to bird recovery; and b) characterize the value of different horticultural restoration approaches.

(4) determine the contribution of restoration to the current population viability of songbirds by establishing the linkage between avian abundance and underlying demographic processes (i.e., reproductive success and survival).

We will accomplish these objectives by developing bird-habitat-landscape models, collecting data to calibrate and validate these models, and then applying the models.

For birds, habitat features alone do not determine bird population responses; landscape context is also important (Howell et al. 2000). Species interactions and responses may vary for species within patches that adjoin different patch types; for species in habitat patches of similar composition, but of differing patch sizes or distributions; and for species in habitat patches of similar composition but located within different landscape matrices (Howell et al. 2000). Thus landscape context may shape foraging and breeding decisions by birds, as well as the long-term viability of populations (e.g., adjacent land use influences nest predation).

At the same time, it is well established that the occurrence of bird species in habitat patches is not sufficient to ensure that populations are self-sustaining, let alone increasing. **Task 2** will address the relationship between bird occurrence and underlying demographic processes.

Subtask 2.1: Initial development of bird-habitat-landscape models, applicable to Project area

We will integrate information on birds previously collected by PRBO (1993 to 2004, with further data collection planned for 2005) at sites on the Sacramento River, together with results of ongoing analyses of abundance patterns and trends (Gardali et al. 2004) and habitat associations of riparian songbirds (Nur et al. 2004). Subtask 2.1 will concentrate on the structure (spatial and temporal) of the bird-relevant models, while identifying the most salient parameters for birds, and at the same time integrating the bird studies with the geomorphological and vegetation studies. The modeling will parallel that for VELB as much as possible.

Subtask 2.2: Collection of bird population data to provide input for models

We will collect data on bird populations using two integrated levels of study, to be conducted at two spatial scales. At the broader spatial scale, through extensive surveys, we will obtain current data (in 2006 and 2007) on bird species occurrence, community composition, and abundance, using the point count survey method. The point count method is widely used by ornithologists (Ralph et al. 1993, 1995) and has been used in the Sacramento Valley since 1993 by PRBO scientists to estimate abundance patterns of songbirds (Gardali et al. 2004), assess species diversity, and to develop predictive models of songbird habitat associations (Nur et al. 2004). We will survey approximately 25 sites (both restoration and remnant) totaling roughly 300 individual survey stations using point count protocols and survey designs developed and successfully implemented by PRBO throughout the region (Ralph et al. 1993, Gardali et al. 2004). Additionally, a vegetation survey (relevé) will be conducted within 50 m of each point count location; these data to be used in analysis as in Nur et al. (2004). For all analyses, some data will be used for model development; other data will be reserved for model validation. Importantly, data collected by PRBO since 1993 will provide the ecological backdrop from which to understand current patterns.

To date, bird abundance data show that restoration efforts appear to be successfully providing habitat for a diverse community of songbirds (Gardali et al. 2004). However, these same data indicate that there are notable differences between restored and remnant habitat as well as among both types of sites. Further, Gardali et al. (2004) showed that several birds species were increasing on remnant as well as restored plots (e.g., Fig 4.) indicating that there may be some ecological interactions among plots that are a function of landscape attributes such as proximity and/or connectivity. We will analyze the affects of various site-specific and landscape scale factors to explain variation in songbird abundance patterns both among and within sites.

The second level of study is more intensive, focusing on primary demographic parameters of select species at a small number of restoration and remnant sites. The contribution of these restoration sites to the overall population viability and future population growth of songbird species at a large spatial scale has yet to be established. Filling this information gap is a goal of the analyses and modeling comprising **Task 2**. This effort, too, builds on previous work carried out by PRBO between 1993 and the present, at six nest-monitoring sites (two or three studied per year) and several mist-netting sites (two or three studied per year) within the Project Area. A key objective of the present study is to determine the reproductive success of birds breeding in restored riparian habitat and at remnant sites, and to identify causal factors. Factors to be explored in this context are both the physical process and habitat indicators identified in **Figure 3**. This analysis should help us determine whether habitat values at restored sites can be enhanced through adjustments of particular habitat features (e.g., vegetation composition), thus providing a basis for both evaluating current restoration projects, and guiding future activities.

Two highly standardized methods (Ralph et al. 1993) for collecting demographic data will be used. To obtain the necessary information on reproductive success and its components (e.g., clutch size, hatching success, number of breeding attempts), we will locate and monitor nests for all species present (Martin and Geupel 1993) and color-band adults of select species on 6 sites. We will focus on four species, two Neotropical migrant species (Black-headed Grosbeak [*Pheucticus melanocephalus*] and Western Wood-pewee [*Contopus sordidulus*) and two year-

round resident (non-migratory) species (Spotted Towhee [*Pipilo maculates*] and Common Yellowthroat [*Geothlypis trichas*]), but will also locate and monitor nests for all species present at nest-monitoring sites. To obtain statistically reliable estimates of adult survival, at select sites we will conduct constant-effort mist-netting and analyze data using capture-recapture methods (Cooch et al. 1996, DeSante et al. 2001). An example of such analysis for previously collected data is provided in Gardali and Nur (2004).

A strong point of the data collection and analyses described is that PRBO currently has funding to conduct parallel studies along Clear Creek (Shasta County), Mokulmne River (San Joaquin County), the southern San Joaquin River (Fresno County), the Merced River (Merced County) and, pending future funding, an additional site on the Sacramento River (Beehive Bend with River Partners), the San Joaquin National Wildlife Refuge (Stanislaus County) and the Cosumnes River Preserve (Sacramento County). Thus results can be compared and combined over a large portion of the CALFED watershed.

Subtask 2.3: Development and calibration of robust models to evaluate the contribution of restoration for bird populations across the Project area.

In this subtask we will compare bird abundance and community composition among restoration sites, among remnant forest sites, and between restoration sites and remnant forests. We will identify factors quantified in **Task 1** (e.g., channel position, channel features, relative elevation and topography, vegetation composition) that are responsible for these differences. This will enable us to partition variation in bird population indicators (with respect to occurrence, abundance, and species composition) into within-site and between-site differences, and to further partition the between-site differences into those attributable to treatment (remnant forest vs. riparian restoration) and those attributable to other factors (e.g., proximity to agriculture). This component will draw on data gathered as part of **Task 1**, as well as relevé vegetation surveys, which provide within site variation on vegetation and habitat characteristics at a fine scale.

We will analyze nest-monitoring data on reproductive success and its components to determine long-term variation in absolute and relative success among sites, among years, and within sites. We will analyze these data to determine factors responsible for this variation, emphasizing indicators developed from **Task 1**, but also identifying other relevant factors not captured by the **Task 1** analysis.

We will develop deterministic population growth rate models to characterize target species, combining information on reproductive success with that on adult survival (determined through capture-recapture analyses of mist-netting data, see Subtask 2.2 above), as well as other demographic information for each species.

We will calibrate vegetation and habitat indicators with that of avian abundance and species composition for the entire avian community. This calibration will enable us to validate these models in Subtask 2.4. We will also calibrate avian abundance data with that of reproductive success and population growth rate. A final step is to calibrate habitat and vegetation indicators with reproductive success and population growth data for the 4 target species.

As part of this subtask, we will determine which habitat types and landscape configurations support the highest species diversity of birds, greatest abundance of key species, highest reproductive success, and greatest population growth rates.

Subtask 2.4: Map bird habitats and validate bird-habitat-landscape models.

Vegetation, habitat and landscape features determined under **Task 1** to influence bird metrics and models under **Task 2** will be mapped across the entire Project area (100 river miles of the Sacramento Watershed). Vegetation will be ground-truthed using relevé vegetation surveys, and other intensive survey methods. Information on vegetation, habitat, and landscape will then be used to statistically predict species diversity, abundance of select species, reproductive success, and population growth rates across the entire Project area (*sensu* Howell et al. 2000, Loiselle et al. 2003). These model predictions will be validated using a subset of data not used in model development (e.g., a subset of point count stations will be used only for model validation). Areas

of divergence will be identified and the basis for divergence will be examined. The validation process will allow the robustness of the models to be evaluated and allow bird-habitat-landscape to be modified accordingly. Conditions promoting source populations will be determined through the modeling process, and locations of probable source populations will be identified for conservation action.

TASK 3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB

Subtask 3.1: Estimate the amount of VELB habitat that has been created. We will calculate, compare and contrast the amount of elderberry that habitats mapped with remote sensing are supporting. Blue elderberry (*Sambucus mexicana*) is the sole host plant of the threatened VELB. The VELB was listed in 1980 (Federal Register 1980), and a recovery plan was published in 1984 (USFWS 1984). However, this recovery plan is based on little species-specific information. Currently we have only a general understanding of the factors that control VELB abundance: VELB are associated with areas of higher elderberry numbers ("clumps" rather than "isolated" shrubs; Collinge et al. 2001); they have a preference for elderberry stems over 2.5 cm in diameter (Collinge et al. 2001); and there are weak correlations with distance from rivers, the amount of canopy cover (T.S. Talley & M. Holyoak unpublished data), paved surfaces (Talley et al. *In review*), and the absence of invasive Argentine ants (Huxel 2000). However, there have been few attempts to systematically survey VELB habitat (ongoing work by T.S. Talley & M. Holyoak is an exception), and no studies have tried to assess the relative value of restored (including mitigated) and natural VELB habitat. Such attempts are invaluable for guiding future restoration and mitigation efforts, and for assessing the recovery potential of the VELB.

The activities for this subtask will be divided into four components:

Estimate the amount, size and condition of elderberry in restored areas. For each of 20 sites we will measure 10 groups of 30 (300 total or as close to this as is available) elderberry shrub basal diameters and assess condition using several variables previously shown to reflect shrub stress level (e.g., percent dead stems, insect herbivory, bark damage). Sites will consist of fields stratified by age and planting type from eight Sacramento River National Wildlife Refuge Units including Flynn, Rio Vista, Phelan Island, Pine Creek, Ord Bend, Packer, Ryan, and Sul Norte Units. Using the same indicator variables of elderberry condition will ensure comparability with earlier measurements made at the same sites and in 5 other watersheds (T.S. Talley & M. Holyoak unpublished). Plant chemical analyses will not be conducted because extensive analyses along the American River Parkway failed to find any correlates of VELB occupancy or density of shrubs (T.S. Talley and M. Holyoak unpublished). Five replicate 50×50 m quadrats will be surveyed for the number of elderberry stems of >2.5 cm present. For a subsample of 50 randomly selected shrubs we will measure the diameter of all branches or stems of at least 2.5 cm in diameter at the point of branching or origin from the ground. Locations of all shrubs (or density quadrats) will be recorded using Trimble GeoExplorer 3 GPS units. This will provide a direct quantification of the amount of usable habitat for VELB within each shrub. We will also record a standard set of environmental parameters, such as associated ground cover, shrubs and canopy cover species. Based on known times of planting and average size at planting we will calculate growth per year on a logarithmic scale to linearize growth. We will use ANOVA to calculate the effects on growth (cm/year or number of branches of >2.5cm produced per year) of vegetation type from the classification schemes derived from Vaghti et al. (*In prep.*) and **Task 1**. Estimates of growth will also be valuable for calculating appropriate mitigation ratios that can be used by USFWS (no estimates are currently available). Similar analyses will investigate how elderberry condition (a multinomially-distributed response variable) and elderberry density vary with vegetation type (ANOVA), and with site age (using simple correlations). Overall, these analyses will assess the effectiveness of different planting treatments for facilitating establishment and growth of elderberry.

Predict the expected elderberry size, condition and density for restoration areas that cannot be extensively sampled. We will make these predictions based upon the analyses described above. These estimates will be compared with 100 shrubs per site and three 50×50 m quadrats per site to

assess accuracy for each of 20 sites. We will use these estimates, correlation statistics and calculations of % error to calculate the accuracy of predicted values relative to observed values. Such analyses will also be used to calculate confidence limits for estimates of the total amount of VELB habitat created for use in Subtask 3.2 below.

Determine how the amount of planted VELB habitat compares with the amounts of natural habitat in the Project area. Estimates of the amount of elderberry planted are only meaningful relative to the amount of natural habitat within the Project area (100 river miles of the Sacramento River). We will use the vegetation classification and mapping data from Subtask 1.4, together with existing estimates of the density of elderberry in each vegetation type (Vaghti et al. *In prep*.) to estimate the total amount of elderberry in natural habitats and its distribution. These data will be used in modeling exercises in Subtask 3.2 below. The data will be ground truthed by selecting 40 natural sites as close as possible to the 40 planted sites described above. An additional 20 sites will be randomly located. In each site we will conduct elderberry measurements for 100 plants and 3 quadrats, as detailed above. These field-collected data will be used to calculate confidence limits for the total amount of elderberry and will provide elderberry size and condition estimates for use in Subtask 3.2 below.

Determine physical factors that control the amount of elderberry. The elderberry measures above will be tested for correlations with the physical data collected in Subtasks 1.1-1.3. We will measure how vegetation communities and individual species respond to variables such as floodplain age, distance to channel, relative elevation and depth to groundwater. These correlations, and related analyses similar to Vaghti et al. (*In prep*.) will establish the physical characteristics that are responsible for success of habitat restoration. Separate analyses will be conducted for natural and restored sites. If correlations with physical factors were stronger for natural sites this might indicate that in the long term elderberry will survive and grow better under natural conditions. Restoration practitioners have questioned whether, like other riparian tree species (see **Task 1**) the depth to ground water is a controlling factor for the survival of elderberry. The data collected in Subtask 1.4 would allow the first extensive test of this hypothesis.

Subtask 3.2: Determine the occupancy of VELB in natural and planted habitats.

VELB are rarely observed in the wild and instead surveys rely on the presence of distinctive exit holes to record VELB presence and abundance (e.g., Collinge et al. 2001, see http://www.des.ucdavis.edu/students/ttalley/ for an illustrated guide). Furthermore holes can be aged as new, 1-year-old, or older, which allows us to obtain estimates of cumulative population size through time, a year of interannual variation in numbers, and population size for the current year. All elderberry shrubs measured in the activities in Subtask 3.1 above will be examined for VELB exit holes and the number of exit holes in each tree will be recorded (and GPS locations taken as mentioned above). T.S. Talley and M. Holyoak have a well-developed mapping protocol for VELB (and elderberry characteristics) that is now in use by a number of agencies, companies and individuals. This facilitates comparison of survey data from different areas. We have existing survey data from 8 restoration sites in the study area (3 sites surveyed by Holyoak and Talley and 5 from River Partners 2004) and will compare these data with annual data collected during each of the 3 years of the grant, visiting the same shrubs annually. If the habitat nearest to the 40 adjacent planted sites is unoccupied by VELB we will conduct additional surveys to attempt to determine the location of the nearest occupied VELB habitat. We will use the VELB data to conduct the following analyses:

Determine the effects of site age and isolation on VELB colonization of planted sites. For the 40 planted sites logistic regression will be used to determine the effect on proportion of shrubs occupied by VELB of site age and distance from the nearest known VELB population (degree of "isolation"). Similar analyses will use linear regression to investigate VELB abundance in relation to site age and isolation. Randomization tests will be used if spatial autocorrelation is determined to be present, which could bias the proposed analyses. Identifying the age of restoration sites for colonization will help to determine the time need to monitor VELB mitigation sites to determine if they are successful. Similarly, we will be able to answer

questions about whether the placement of elderberry influences colonization by VELB, which can guide placement of restoration and mitigation sites.

Determine how habitat type influences the presence and abundance of VELB in natural sites. The 60 natural sites surveyed should provide an adequate sample to determine the influence of habitat type (from **Task 1**) on VELB presence or abundance. The statistical analyses will consist of contingency table analyses and will be conducted using general linear models (ANOVA cannot be used because vegetation types are not assigned, as they are in planted sites). If different vegetation types differ in VELB abundance or presence/absence we will conduct a variety of analyses of the effect on VELB abundance and presence/absence of elderberry measurements. These analyses will allow us to determine what are potential causes of any identified habitat type differences in VELB abundance. The analyses use simple statistical tests and are not described in detail for brevity. Hence we could answer questions about whether it is habitat type *per se* that influences VELB or whether it is differences in elderberry size or density in the different habitat types. This information could aid future restoration efforts.

Predict VELB population sizes and occupancy based on functions of habitat types, other habitat characteristics. We will use habitat mapping from Subtask 1.4 and estimates of VELB abundance from methods described above to predict VELB population sizes and occupancy based on functions of habitat types, other habitat characteristics (distance from rivers, elderberry density, etc.), and neighborhood VELB densities (reflecting colonization potential). Such "incidence function" models have proven effective for predicting regional "metapopulation" persistence through analyses of "metapopulation viability" (e.g., Hanski 1998). They make minimal assumptions, use available information efficiently, and can quantitatively predict the effects of management practices on persistence probability. The model will quantify the effect on persistence of creating new habitat (mitigation and restoration) and destroying or (take) altering habitat quality (by management). Project member Marcel Holyoak has extensive experience with such models (e.g., Holyoak 2000, Amarasekare et al. 2004). The statistics used in parameterization provide a means of judging our success at describing effects on VELB populations using the proportion of variation in VELB occupancy of habitat patches that is explained. The model makes predictions about habitat patch occupancy that will be tested using the field surveys of VELB populations. This makes the modeling approach testable and robust. We will engage in iterative rounds of model improvement until we obtain something that has reasonable predictive ability. Ultimately such a model could aid in setting recovery criteria for the VELB, which are lacking from the current recovery plan (USFWS 1984).

TASK 4: INTEGRATE NEW INFORMATION INTO ECOLOGICAL SCORECARD FRAMEWORK.

The CALFED ERP has not yet fully developed ecosystem indicators and performance measures for its lowland floodplain systems. This project will advance progress along these lines by developing a comprehensive assessment of ecological health and conservation project effectiveness for the Sacramento River Project area. This will be achieved by incorporating current information (from this and other projects) into an ecological scorecard that characterizes biodiversity health through the synthesis of diverse scientific information (Poiani et al. 2000, TNC 2000a, Salafsky et al. 2002, Parrish et al. 2003, TNC 2003b). Our scorecard framework is similar to one that has been effectively employed by the River Health Programme in South Africa (e.g., Angliss et al. 2001), and resembles the framework advocated by Harwell, Young, and others (Harwell et al. 1999, Young & Sanzone 2002).

The ecological scorecard has four core components: (1) selecting a limited suite of focal biodiversity targets, the conservation of which is intended to serve as a coarse-filter/fine-filter framework for protecting the whole; (2) identifying a limited suite of key ecological attributes for each target, along with specific indicators for each, that provide the information for measuring target status; (3) identifying an acceptable range of variation for each key ecological attribute of the focal conservation targets; and (4) assessing the current status of each target, based on the status of its key ecological attributes with respect to their acceptable ranges of

variation, and integrating the assessments of target status into a measure of the status of biodiversity overall.

Significant progress has already been made on TNC's ecological scorecard for the Sacramento River Project area, which CALFED's Science Program has identified as an important component in characterizing the status of "Sacramento River Processes"—one of 6 Performance Measures identified for the ERP (http://science.calwater.ca.gov/library.shtml).

The framework is currently being implemented by TNC and its partners in hundreds of large-scale conservation areas across the Americas, Asia, the Pacific Islands, and Africa (TNC 2003a). It uses quantitative data assembled by TNC staff, teams of partner institutions and experts to track important ecological characteristics and synthesize their status into a set of simple categorical ratings of biodiversity status in an area. These ratings are scientifically credible and readily interpreted by protected area managers. Through repeated measurement, managers can use the framework to determine whether the status of biodiversity is responding to conservation investments and strategies over time. The framework has the added advantages of providing a rigorous basis for setting conservation objectives, assessing threats to biodiversity, identifying monitoring and research needs, and communicating management information to non-specialists.

The activities proposed in **Tasks 1-3** of this project were selected based upon needs identified during our initial implementation of the scorecard framework for the Sacramento River Project. **Table 7** presents a partial list of specific indicators that will be incorporated into the existing Sacramento River scorecard in this project.

TASK 5: PROJECT MANAGEMENT

To ensure that the project moves forward as planned the project manager will perform a number of important functions including: 1) coordinating project participants to further define roles and responsibilities; 2) organizing and leading meetings with subcontractors to coordinate details of sampling efforts for different tasks; 3) working with support staff to prepare and manage subcontracts; 4) ensuring that all scopes of services are reasonable, accurately stated, and can be performed within the times specified; 5) holding semi-annual meetings to share results and interpretations and set up timeline for coordinating mapping, ground truthing and data sharing for modeling and synthesis efforts (smaller groups of principal investigators will meet more often to integrate results); 6) working with Grants Specialist on agreement administration; 7) ensuring that only allowable costs are billed; 8) preparing and submitting reports; 9) giving presentations; and 10) ensuring that deliverables are completed.

TASK 6: PROJECT CLOSURE

A Project Closure Summary Report will be completed.

Performance Measures

The central focus of this project is to develop, refine and evaluate performance measures (defined in the Approach and Scope of Work section, pp 5-144.) for assessing progress toward specified CALFED ERP goals and milestones (listed in the ERP and CVPIA Priorities section, pp. 15-16). See also **Table 7** for a list of specific indicators that this project will gather quantitative data on. As such, this project will lead to significant progress in characterizing the effectiveness of CALFED-implemented conservation actions (acquisition, restoration, and planning) in the Sacramento River Project area (Red Bluff to Colusa). Our project will both develop performance measures and apply them, such that meaningful quantitative assessments of progress can be made (see **Task 4**). Information gained will permit a more thorough evaluation of the cumulative effects of restoration actions on ecosystem structure, processes and associated stressors, thereby enabling managers to more accurately assess progress and refine actions to advance restoration goals. Many of the lessons learned in this project will be directly transferable to other river restoration projects in the CALFED region, and we will work diligently to share results and management implications with appropriate audiences (see further details on outreach in sections 6, 7 and 8).

5. Feasibility –

The assembled team has extensive experience working on multi-disciplinary collaborative research projects. The principal investigators are experts in their fields. All have conducted important research in this study system, and have past experience applying the described methodologies. The work we propose can be completed in the time allotted, as many analyses will draw on existing data and most proposed methodologies have been tested in this system. As in the past, we will apply to the USFWS and CDFG for special-use permits before conducting research on agency lands. This project has the support of personnel at both of these agencies.

6. Expected Outcomes and Products –

See **Table 2** for a list of expected outcomes and products with associated delivery dates.

7. Data Handling, Storage and Dissemination –

PRBO and project staff have extensive experience with data base management, in particular with the types of data described in the proposal. Data are entered and proofed daily and are stored in a format compatible with ArcView and ArcInfo Geographic Information Systems (GIS) and SQL-based database systems. Results, reports and appropriate data will be made available through the PRBO website http://www.prbo.org/cms/index.php. PRBO maintains daily, weekly, and seasonal backup copies of all data collected as standard procedure. Original data sheets are scanned into pdf files at the end of each field season and stored off site. Bird monitoring data and metadata is stored in the California Partners in Flight database, which is part of the California Information Node of the National Biological Information Infrastructure. This is a public access resource and is maintained at the Information Center for the Environment by UC Davis staff (http://cain.nbii.gov/).

Data produced in this project will be archived and disseminated as appropriate in accordance with procedures developed through coordination with the Bay Delta and Tributaries Project (BDAT). BDAT contains environmental data concerning the San Francisco Bay-Delta and provides public access to that data. Over fifty organizations contribute data voluntarily to this project. The database includes biological, water quality, and meteorological data. These can be used to gauge the health of the estuary and to manage water and environmental resources. BDAT is a part of the California Environmental Data Exchange Network (CEDEN), which includes projects and organizations from all parts of the state.

8. Public Involvement and Outreach –

We presented this proposal to the SRCAF Technical Advisory Committee (TAC) in Willows on November 2, 2004. All feedback from the TAC was positive. Because our project was developed with input from agency (USFWS, CDFG, CDPR, CDWR) personnel with management and monitoring responsibilities for conservation lands along the Sacramento River, it meets core information needs for those groups that are the long-term stewards of the conservation lands.

TNC will coordinate all phases of this project with state and federal land management agencies along the river. All study plans will be provided to relevant agency personnel for review, and appropriate persons will be invited to participate in coordination meetings. We will inform local agencies and stakeholders of the progress and results of the project by reporting regularly to the SRCAF TAC and other local meetings as appropriate. TNC recognizes that there are concerns with habitat restoration that require open and cooperative interaction with all stakeholders (Golet et al. *In press*). We are aware of the sensitivities of stakeholders and will work to provide information by attending landowner meetings and offering tours as needed. We will also share information from this project in formal presentations at conferences and in published manuscripts (see **Table 2**). All final reports will be posted on the Sacramento River Portal website (http://www.sacramentoriverportal.org).

9. Work Schedule –

See **Table 3.** Due to the synthetic nature of the proposed work, none of the proposed tasks can be separated out without compromising the overall project outcome. However, the project could go forth and generate meaningful results if any of **Tasks 2, 3, or 4** are not funded.

B. Applicability to CALFED Bay-Delta Program ERP Goals, the ERP Draft Stage 1 Implementation Plan, and CVPIA Priorities.

1. ERP and CVPIA Priorities –

By developing and implementing an ecosystem monitoring and assessment program to evaluate the performance of ongoing riparian habitat restoration projects between Red Bluff to Colusa we will gather information that can be used by resource managers to assess progress toward ERP Goal 1, which calls for the recovery of endangered and other at-risk species, and native biotic communities. **Specifically, our project will evaluate the status of recovery of the Valley elderberry longhorn beetle (a MSCS R-designated species) as well as progress toward recovery of western yellow-billed cuckoo and California yellow warbler (a MSCS r-designated spp), and other neotropical migratory birds (Objectives 1, 2 and 3, CALFED 2000a).** Our project will also measure progress toward the enhancement and conservation of other biotic communities including riparian plant and seasonal wetland habitats. Our project will measure progress in reducing impacts of non-native invasive species (NIS) (MR-1) and further the recovery of at-risk species by developing a conceptual understanding and models of processes that cross multiple regions (SR-7).

Our project will meet specific information needs identified in the USFWS et al. (2004). Under Milestone 60, which calls for the protection of 15,000 acres of riparian habitat (5,800 acres protected to date) the report states that **"Assessment and evaluation of the types and quantities of habitats created by these [protection and restoration] efforts needs to continue and determination of progress and performance must occur"** (p. 3-49, USFWS et al. 2004). This statement offers direct support for our project's focus as we seek to characterize and quantify riparian habitats while simultaneously tracking the status of specific ecosystem indicators (songbirds and VELB) that are dependent upon these habitats.

Moreover, by assessing riparian habitats and indicator species distributions and abundances, our project will significantly advance progress toward ERP Milestone 112 **"Develop and implement a comprehensive monitoring, assessment and research program (CMARP) for terrestrial and aquatic habitats and species populations acceptable to the fish and wildlife agencies. Conduct range-wide surveys for all "R" and "r" covered plants and animals in the MSCS Focus Area"** (p. 3-83, USFWS et al. 2004). As recognized by USFWS et al. (2004), monitoring projects such as the one that we propose, as integral components of a CMARP, are essential for making CALFED's Action Specific Implementation Plan (ASIP) process work as intended.

Individual tasks address the following: **Task 1** focuses on assessing the recovery of native vegetation communities in restored and natural sites (MR-1, SR-4, ERP Goal 4). Information collected under **Task 2** will improve our understanding of how at-risk species respond to restoration efforts (ERP Goals 1 and 4). **Task 3** assesses status of recovery of Federally threatened VELB, information that will help to achieve recovery of a critical at-risk species (ERP Goal 1) by fulfilling the study needs specified in the ERP Implementation Plan (pg. 144, CALFED 2001a). **Task 4** directly addresses restoration priority SR-7 by analyzing historic data and developing and evaluating conceptual models and restoration performance measures.

2. Relationship to Other Ecosystem Restoration Actions, Monitoring Programs, or System-wide Ecosystem Benefits –

TNC's Sacramento River Project is part of a public-private partnership whose goal is to re-establish an approximately 30,000-acre riparian corridor with limited meander within the Sacramento River Conservation Area (SRCA). This partnership is formalized under a Memorandum of Agreement with project activities coordinated through the SRCAF non-profit organization. Public and private partners include the local governments, stakeholders, U. S. Fish

and Wildlife Service, California Department of Fish and Game, California Department of Parks and Recreation, California Department of Water Resources, U.S. Army Corps of Engineers, Riparian Habitat Joint Venture, Sacramento River Preservation Trust, River Partners, Northern California Water Association, and the Farm Bureau, among others.

Our proposed project complements a suite of proposed and ongoing research and monitoring projects in the CALFED area. **Table 4** details a subset of those projects in which participants in this proposal are Principle Investigators. If funded we will work actively with the Interagency Ecological Program to develop a riparian work team and to otherwise ensure that the there is adequate outreach of lessons learned such that our development and application of performance measures for riparian restoration on the Sacramento River can be readily transferred to other riparian systems in the CALFED region.

C. Qualifications.

Dr. Golet will serve as overall coordinator of this project. TNC will be the fiscal agent responsible for administering subcontracts with Principal Investigators at PRBO and UCD. Principal Investigators responsible for particular tasks are listed in **Table 1.** TNC staff assisting in the implementation of this project include Dawit Zeleke, Project Director, Mike Roberts, Hydrologist, Ryan Luster, Restoration Programs Manager, Wendie Duron, Grants Specialist, Cori Ong, Director of Operations, Jan Karolyi, Office Services Administrator, and Cathy Morris, Attorney. Project management activities are described in **Table 3.**

Biographical Sketches:

Tom Gardali grew up in California's Great Central Valley. He earned an undergraduate degree in Environmental Studies from the University of California at Santa Cruz in 1992 and has been a field biologist and ecologist for PRBO since 1993. His research interests are conservation oriented and range from natural history to restoration to the effects of habitat succession and climate patterns on birds. He has authored over 15 peer-reviewed publications and oversees field crews for 8 different projects in the Central California Region for the Terrestrial Ecology Division.

Geoffrey R. Geupel has a degree from Lewis and Clark College (BS Biology 1978) and has been employed as a biologist at PRBO for 24 years. He is currently Director of the PRBO's Terrestrial Ecology Division Program with a $1.7 million annual budget and 40 field biologists Mr. Geupel with over 25 years experience in ornithological monitoring and research, has authored over 30 refereed publications including *Field Methods for Monitoring Landbirds* published in 1993 by the USFS and has helped define bird-monitoring protocols now used throughout North America. Current areas of interest include population biology, bird response to habitat restoration, and conservation planning. He is currently: Co-Chair of California Partners in Flight, Chair of the Riparian Habitat Joint Venture's Science Committee, Board member of the Central Valley Joint Venture and Sonoran Joint Venture, and member of both the National Cowbird Advisory Council and Important Bird Area (IBA) National Technical Committee.

Gregory H. Golet has degrees from Bates College (B.S. Biology 1987), and the University of California, Santa Cruz (M.S. Marine Sciences 1994, Ph.D. Biology 1999). His doctoral research focused on the behavioral and physiological adjustments that birds make during breeding, and the effects these adjustments have on subsequent survival and future fecundity. Dr. Golet was a wildlife biologist for the U.S. Fish and Wildlife Service before joining TNC's Sacramento River Project as senior ecologist. His current work is focused on defining ecosystem responses to restoration management actions, and using science to inform watershed planning. He has 14 refereed publications, and has extensive experience coordinating and conducting research in California and Alaska.

Steven E. Greco has degrees from the University of California, Davis (B.S. Landscape Architecture 1987, M.S. Ecology 1993, and Ph.D. Ecology 1999). Currently he is an assistant professor in the Landscape Architecture Program in the Department of Environmental Design at the University of California, Davis. He teaches several courses on ecology, site planning, and

geographic information systems (GIS). His research interests include ecological restoration, patch dynamics, historical landscapes, and spatial modeling of terrestrial and hydrological processes using GIS computer technology. Dr. Greco has worked on a variety of projects that integrate landscape architecture, planning and design with ecological principles. He has extensive experience with the Sacramento River ecosystem and its landscape dynamics.

Marcel Holyoak has a B.Sc. in biology (1989) and a Ph.D. in ecology from the University of London (Imperial College, 1992). He was a postdoctoral fellow at the Centre for Population Biology (Silwood Park, U.K., 1992-1993), the University of Kentucky (1993-1994), and a research ecologist at the University of California, Davis (1994-2000). For the last four years he has been an Assistant/Associate Professor in Environmental Science and Policy at the University of California at Davis. He is a subject editor for two leading ecological journals, *Ecology* and *Ecology Letters*. Holyoak's research addresses the influence of spatial habitat factors on population and community ecology. His research program uses statistical and empirical modeling, together with field experiments and long-term observational studies, to assess how habitat factors influence population dynamics and community structure. Major current projects address the insect population viability and the effects of habitat fragmentation on community structure. He has worked closely with a variety of public agencies, companies and USFWS to investigate conservation problems for the VELB.

Christine A. Howell has degrees from the University of California Berkeley (B.A. Biology 1991) and the University of Missouri Columbia (PhD Ecology 1999). Her doctoral research focused on avian demography and life history evolution in a coastal California population of Song Sparrows. In 2000 she received an National Science Foundation Post-doctoral Fellowship in Biological Informatics to pursue research in collaboration with Missouri Botanical Garden and the International Center for Tropical Ecology at the University of Missouri Saint Louis. Her NSF research focused on the development and use of spatially explicit models and statistics (applying Geographic Information System technology) as practical tools in coarse-grain conservation studies. She uses these approaches to test hypotheses about the distributions of rare species, conservation reserve design, and the implications of global climate change. In 2004 she joined the staff of PRBO as a Conservation Scientist.

Eric Larsen has degrees from Harvard University in Applied Physics (1969), the University of California, Berkeley (M.S. Civil Engineering (Water Resources Division) 1986, and Ph.D. Civil Engineering (Water Resources Division) 1995). Currently he is an assistant research scientist in the Landscape Architecture Program in the Department of Environmental Design at the University of California, Davis. His research interests include quantitative principles of fluvial geomorphology for land management and restoration. Dr. Larsen serves as a science advisor for many public agencies and private groups, many directly related to the Sacramento River. Dr. Larsen has worked on a range of projects that relate the physical processes of river geomorphology with ecological principles. He has extensive experience with the Sacramento River meander migration dynamics and its relation to the ecosystem.

Nadav Nur has degrees from Duke University (Ph.D. in Zoology 1981) and an MS in Biostatistics from the University of Washington in 1991. He was Alexander von Humboldt Research Fellow, at the University of Tübingen from 1986-1987. From 1989 to the present, Dr. Nur has served as the senior quantitative and population ecologist for the PRBO Conservation Science Dr. Nur's research interests focus on population modeling, quantitative ecology and statistical analysis of landbirds, seabirds, shorebirds and marine mammals. He has been a PI on over 20 grants from federal, state and private funding sources (including NSF, EPA, USGS NBS, USFWS, CDFG, and CALFED). He has served as PI or co-PI on several projects studying avian populations using riparian habitat, beginning with studies on the Upper Sacramento River in 1992, and more recently on the Cosumnes River and throughout the CALFED region. Dr. Nur is author or co-author of over 50 scientific publications, including *A Statistical Guide to Data Analysis of Avian Monitoring Programs*, published in 1999 by the USFWS. He has served on two working groups of the CMARP arm of CALFED. He leads the Bird Team for the Integrated Regional Wetland Monitoring project in the San Francisco Estuary.

D. Cost.

1. Budget –

See appropriate forms.

2. Cost Sharing –

None.

3. Long-term Funding Strategy –

To assure that the proposed monitoring activities endure beyond the term of the grant, TNC plans to commit funding to continue monitoring at selected USFWS restoration sites along the Sacramento River for an additional 5 years, provided it is possible to do so.

E. Compliance with Standard Terms and Conditions.

See **Table 8.**

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G. Nonprofit Verification.

See Attachment 1.

Table 1. Tasks and associated lead(s).

Tasks	Lead(s)
TASK 1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS	Greco and Larsen
TASK 2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS	Geupel, Nur, Howell, and Gardali
TASK 3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB	Holyoak
TASK 4: INTEGRATE NEW INFORMATION INTO ECOLOGICAL SCORECARD FRAMEWORK	Golet
TASK 5: PROJECT MANAGEMENT	TNC
TASK 6: PROJECT CLOSURE	TNC

Table 2. Expected Products/Outcomes by task. The majority of the listed products will be presented as articles in peer-reviewed scientific publications and at conferences. We will pick a variety of journals to target managers (e.g., *Environmental Management* and *Restoration Ecology*), conservation practitioners (e.g., *Biological Conservation*) and ecologists (e.g., *Ecology*, *Ecological Applications*). Uncertainty in the time taken to publish articles means that scientific papers may not be accepted at the end of the project, however, drafts of all manuscripts will be delivered as final reports by the projects end.

TASK 1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS
- A report compiling spatial data (GIS), including documentation of methodology and data structure.
- A floodplain age map quantifying erosion, deposition, and fluvial processes. The product will be a continuous surface of floodplain age (GIS raster dataset) and a table of erosion and deposition per time interval at each bend.
- A MSE topographic surface for the Princeton to Colusa reach in 2005 in a triangulated irregular network (TIN) model (as derived from LIDAR), a relative elevation topographic surface model of the study reach delivered in TIN and raster format.
- A report summarizing the plant community mapping, including a ground-truthed land cover map of vegetation communities and canopy height with associated metadata.
- A report summarizing the changes in vegetation characteristics over time on both restored and remnant sites.
- manuscripts describing the management implications of the above analyses will be submitted to journals.
TASK 2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS
- A dataset integrating bird data collected in the region by PRBO from 1993 through the end of the study period that includes abundance patterns, abundance trends, habitat associations, survival, and reproductive success of riparian songbirds.
- A computer model that relates the dependent variables of riparian songbird presence and abundance with the independent variables of hydrology, landcover, vegetation, and geomorphology.
- A computer model that relates riparian songbird reproductive success with the independent variables of hydrology, landcover, vegetation, and geomorphology.
- Deterministic population growth rate models for focal bird species in relation to spatial habitat structure.
- A manuscript describing the computer model relating riparian songbird presence, abundance, and reproductive success with hydrology, landcover, vegetation, and geomorphology (*e.g.* for *Landscape Ecology* or *Ecological Applications*).
- A manuscript on the success of previously implemented Sacramento River riparian habitat restoration projects for promoting the recovery of songbirds (e.g., for *Restoration Ecology*).
- A manuscript that identifies conditions promoting source populations of riparian birds and identifies probable locations drawing on the combined GIS and field analyses (e.g., for *Ecology*).
TASK 3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB
- A manuscript on the success of previously implemented Sacramento River riparian habitat restoration projects for promoting the recovery of the threatened VELB (e.g., for *Restoration Ecology*)
- A manuscript on the success of different kinds of riparian habitat restoration approaches for creating habitat for the threatened VELB (e.g., for *Ecological Applications* or *Restoration Ecology*).
- A manuscript that estimates the regional population size for the VELB from the combined GIS and field analyses (e.g., for *Biological Conservation* or *Landscape Ecology*).
- A manuscript on the combined analysis of effects of all variables on VELB persistence that will be published in an ecological or conservation journal.
- We will also aid USFWS in revising the VELB recovery plan. This will be facilitated by providing USFWS with reports detailing recommendations for revising the Recovery Plan. The documents will aim to make restoration more effective and to give improved and quantitative estimates of what is required for species' recovery.
TASK 4: INTEGRATE NEW INFORMATION INTO ECOLOGICAL SCORECARD FRAMEWORK
- A completed ecological scorecard for the Sacramento Project area that tabulates and synthesizes information derived from project studies to characterize the status and trends of focal biodiversity in the area. Includes archival of supporting materials.
- A manuscript that communicates indicator selection, associated rating values, and health status of conservation targets in the Project area. The manuscript will describe how the assessment framework measures biodiversity health and the performance of restoration projects, and will include a recommended monitoring schedule for key indicators. Manuscript to be submitted for publication to *San Francisco Estuary and Watershed Science.*

Table 3. Work schedule (assumes a September 2005 start date).

Year	Schedule
TASK 1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS	
yr 1	Acquire, process, and begin analysis of geospatial data, June 2006 stereo-pair air photos to map channel features and land cover, 2003 IKONOS data to map plant communities, 2005 lidar data to map topography and vegetation height. Begin land cover interpretation, vegetation height mapping. Plan and initiate field studies for plant communities and map ground-truthing May 2006.
yr 2	Complete land cover mapping based on GIC methods June 2007; complete mapping vegetation height with lidar and photogrammetric techniques August 2007; complete channel mapping August 2007; begin modeling of floodplain age and land reworked August 2007; continue field ground-truth and vegetation community studies. Complete channel metrics November 2007.
yr 3	Complete floodplain age model and relative elevation model January 2008; complete ground-truth field studies July 2008; complete site factor analysis of mapped plant species and communities distributions over modeled environmental variables (e.g. floodplain age, relative elevation, radius of curvature) July 2008; Complete vegetation change analysis July 2008. Final report August 2008.
TASK 2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS	
yr 1	Data collection and ground truthing at restored and reference sites March to July 2006; Bird and related vegetation data entered into CalPIF database in Oct hosted at UC Davis ICE.
yr 2	Data collection and ground truthing at restored and reference sites March to July 2007; Bird and related vegetation data entered into CalPIF database in Oct ;Analysis of Bird habitat relationships and landscape factors. August 2007
yr 3	Demographic analyses; modeling of population growth rate and source populations August 2008. Final report/manuscripts for publication, August 2008.
TASK 3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB	
yr 1	Measure elderberry and VELB variables in natural and restored sites. Publish empirical findings between years 1 and 2.
yr 2	Remeasure VELB in restored and natural sites. All three years during April-July.
yr 3	Model construction and analysis Aug 2007-August 2008. Test model during Spring 2008. Prepare final publications September 2007-August 2008.
TASK 4: INTEGRATE NEW INFORMATION INTO ECOLOGICAL SCORECARD FRAMEWORK	
yr 2	Coordinate project staff and external experts in defining ratings values for all project indicators, August 2007.
yr 3	Finalize scorecard workbook, communicate results to external audiences, prepare final manuscript. August 2008.
TASK 5: PROJECT MANAGEMENT	
yr 1	Organize and lead meetings with subcontractors to coordinate details of sampling efforts for different tasks and further define roles and responsibilities, prepare and manage subcontracts, ensuring that all scopes of services are reasonable, accurately stated, and can be performed within the times specified.
yr 2-3	Hold semi-annual meetings to share results and interpretations and set up timeline for coordinating mapping, ground truthing and data sharing for modeling and synthesis efforts (smaller groups of PIs will meet more often to integrate results).
yr 1-3	Work with Grants Specialist on agreement administration, ensure that only allowable costs are billed, prepare and submit reports, give presentations, ensure that deliverables are completed.
TASK 6: PROJECT CLOSURE	
yr 3	Prepare Project Closure Summary Report and supporting information.

Table 4. Related research and monitoring projects that principal investigators on this proposal are involved with.

Project	PIs (bold are on this proposal)	Project description
Linking large-scale hydrological and biological processes in restoring riparian forest ecosystems	Elizabeth Crone Karen Holl Matt Kondolf **Nadav Nur**	National Science Foundation. Biocomplexity Incubation Grant. (Term: Jan. 1, 2001-Dec. 31, 2001) This grant is aimed at beginning development of models linking hydrology, vegetation, and bird communities along the Sacramento River, but provided no funding for data collection. The preliminary models developed as part of the Biocomplexity project will serve as starting point for the modeling efforts outlined in this proposal.
The influence of flood regimes, vegetative and geomorphic structures on the links between aquatic and terrestrial systems: Applications to CALFED restoration and watershed monitoring strategies	James Quinn Graham Fogg Mary Power Mark Schwartz Edwin Grosholz **Nadav Nur** Kyaw Tha Paw William Rainey	CALFED 01-A205. (Term: 1/1/2002 to 12/31/2005). This multidisciplinary project investigates the Cosumnes floodplain to link groundwater dynamics, growth and restoration of riparian vegetation, effects of flooding and terrestrial primary productivity on arthropod productivity, and populations of birds and bats as consumers and as indicators of restoration success. The project also examines contributors to species invasions. This proposal will share data systems with comparable efforts in the Cosumnes.
Evaluating Alternative Biodiversity Conservation Hypotheses	**Christine Howell**	National Science Foundation. Post Doctoral Research Fellowship in Biological Informatics. (Term: 8/1/2000-7/31/2003, Award #0074482). GIS and computer modeling were used to develop coarse-filter computer models for international conservation reserve network planning of birds and plants. The grant has produced methodology guidelines for predictive modeling, 2 peer reviewed articles, 2 articles in preparation, and led to invitations to join 2 working groups at the National Center for Ecological Analysis and Synthesis in Santa Barbara.
Riparian Landscape Modeling and Impact Assessment on the Sacramento River	**Steven Greco**	California Department of Water Resources, Off-stream Storage Investigation (Term: 7/1/00-6/30/02, Contract No. 4600000736) The goal of the riparian landscape modeling on the Sacramento River is to develop a set of tools to quantify and assess potential ecologically significant changes to the riparian ecosystem resulting from changed flows caused by the operation of an off-stream storage facility.
Sacramento River Vegetation and Channel Dynamics Investigation	**Steven Greco**	California Department of Water Resources, Northern District, Sacramento River Fisheries and Riparian Habitat Management Program. (Term: 7/1/01-6/30/02, Contract No. 4600001950) The objectives of this study were to compile a collection of historical aerial photography of the Sacramento River, map historical channel patterns and measure riparian vegetation characteristics.
Assessing the Effects of Alternative Setback Levee Scenarios Employing a River Meander Migration Model	**Eric Larsen**	CALFED ERP 99-N18 (Oct. 1, 2002-June 11, 2004). This investigation assessed the relationship between levee setback distance and habitat formation through the measure of land reworked. Our study showed three "thresholds" of setback distances for determining and limiting physical processes of meander migration and channel cutoff.
North-of-the-Delta Offstream Storage Investigation – Meander Migration in relation to altered flows, and ecological implications.	**Eric Larsen**	California DWR Contract No. 4600000664 North-of-the-Delta Offstream Storage Investigation. In support the Ecosystem Impacts Analysis component of the North-of–the–Delta Offstream Storage Investigation, the result of this research was to quantify and assess geomorphic and ecologically significant changes to the Sacramento River riverine-riparian ecosystem resulting from changed flows.

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Table 4 (cont.).		
Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.	**Geoffrey Geupel** **Nadav Nur** **Christine Howell** Diana Stralberg	CALFED ERP-02-P17 (Term 9/1/2003 - 9/1/2006). This investigation compiles previously collected information on riparian bird populations and the factors that influence their population trajectories from eight project areas within the CALFED region This project is: developing an online, queriable database of project information; developing models to explain temporal and spatial variation in bird community and population parameters, especially as they pertain to restoration activities; and developing statistical, predictive models that relate bird community and population parameters to habitat, landscape features, hydrology, and, ultimately, to management and restoration activities.
Ecosystem and Natural Process Restoration on the Sacramento River: Active Restoration of Riparian Forest	TNC Subcontract to: David Brown David Wood **PRBO**	CALFED 97-NO3 (Term: 12/1/98-6/30/02). This project focused on assessing ecosystem response to horticultural restoration by investigating wildlife response (birds and terrestrial arthropods) groundwater quality, nutrient cycling and soil development. Comparisons were drawn between restoration sites of varying ages and natural remnant habitats.
Genetic Identification of Watershed-Dependent Species of Special Concern in the Central Valley	Sonya Clegg **Geoffrey Geupel** **Nadav Nur** Brad Schaffer Tom Smith	CALFED 01-N43 (Jan. 1, 2002 - Dec. 31, 2005). Project utilizes molecular genetic techniques to determine taxonomic relationships of populations of concern, for birds and herptiles. Information will be used to identify and prioritize populations and watersheds for conservation and management actions.
Development of a management plan for the threatened Valley Elderberry Longhorn Beetle in the American River Parkway	**Marcel Holyoak**	NFWF (2001-2005), Sacramento Area Flood Control Agency and Sacramento County Parks (with support from 10 public agencies/companies). Three annual grants/contracts. The project conducted large scale surveys of VELB and elderberry along the American River Parkway, assessed mitigation and management practices, and modeled VELB metapopulations. The grant has produced 1 peer reviewed article, 2 submitted articles, and several more in preparation.
Assessment of colonization of Sacramento River sites by VELB	Theresa Talley **Marcel Holyoak**	Sacramento Flood Control Agency 2001. Pine Creek, Phelan Island and River Vista sites were assessed for elderberry size (basal diamter) and VELB presence. The data were used in one peer-reviewed publication.
Multi-species metapopulation dynamics: experiments in a model system.	**Marcel Holyoak** Susan Harrison	NSF (Oct. 1996-Sept. 1999). This grant used models and experiments to investigate predator and prey metapopulation dynamics. The grant led to 10 publications in peer-reviewed scientific journals.
Using phase dynamics and a model experimental system to understand the effects of extrinsic variability on predator and prey metapopulations.	**Marcel Holyoak** Alan Hastings	NSF (July 2002-June 2005). This grant investigates the spatial dynamics of predators and prey in relation to environmental variation. To date the grant has produced 4 peer-reviewed publications.

Table 5. Specific accomplishments and progress made on previous CALFED grants to TNC's Sacramento River Project.

Project Title	CALFED Program/ CVPIA Project	Term	Project Type	Progress and Accomplishments	Status
Ecosystem and Natural Process Restoration on the Sacramento River: Floodplain Acquisition and Management	CALFED 97-NO2 ERP	1/1/98-12/31/01	Acquisition, Planning and Monitoring	Five properties along the Sacramento River totaling approximately 1,866 acres were purchased (Kaiser, Dead Man's Reach, Gunnhill, RX Ranch, Ward). Hydraulic and geomorphic modeling, a public use and access study, a cultural resource overview, monitoring plans, and a final management and monitoring recommendations report were completed.	Completed.
Ecosystem and Natural Process Restoration on the Sacramento River: Active Restoration of Riparian Forest	CALFED 97-NO3 ERP	12/1/98-6/30/02	Restoration and Monitoring	Site preparation and planting of two sites (River Vista and Flynn) to riparian habitat totaling 264 acres was completed, and maintenance was complete by fall 2001. Monitoring of the site was conducted and reports filed.	Completed.
Ecosystem and Natural Process Restoration on the Sacramento River: A Meander Belt Implementation Project	CALFED 97-NO4 ERP	2/25/98-12/1/01	Acquisition, Restoration and Monitoring	The 94+ acre Flynn property and adjacent levee were purchased in December 1998. The levee was subsequently removed; as a result this site now supports one of the largest bank swallow colonies recorded on the Sacramento River. Restoration was implemented under CALFED 97-NO3 and 97-NO4. Maintenance was completed in fall 2001 and monitoring was conducted and reports filed.	Completed.
Floodplain Acquisition, Management and Monitoring on the Sacramento River	CALFED 98-F18, FWS Agreement #11420-9-J074 ERP	7/20/99-6/30/02	Acquisition	Funding was awarded for the acquisition portion of this grant. The 104+ acre Jensen property located in Colusa County was purchased in July 2000. This property is located within the setback levees of the Sacramento River Flood Control Project. Two additional properties, totaling 183+ acres were wholly or partially purchased including: the 129-acre Boeger property and the 54-acre Hays property purchased in May 2001.	Completed.

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Table 5. (continued)

Project Title	CALFED Program/ CVPIA Project	Term	Project Type	Progress and Accomplishments	Status
Floodplain Acquisition and Sub-Reach/Site Specific Management Planning: Sacramento River (Red Bluff to Colusa)	CALFED 2000-F03, FWS Agreement #11420-1-J001 ERP	6/1/01-5/31/03	Planning and Monitoring	Funding was awarded to implement the Sub-reach/Site Specific Planning portion of this proposal. Comprehensive conservation and management strategies for multiple benefits and uses of the river floodplain were developed. A hydraulic analysis for RM 167-172 and a socioeconomic assessment for the riparian corridor of the SRCA between Red Bluff and Colusa were completed. Stakeholder meetings were conducted, with updates regularly provided to the SRCA. A final report was developed outlining future conservation and management actions for the Beehive Bend sub-reach based on information developed within other tasks.	Completed.
Restoration of the Confluence Area of the Sacramento River, Big Chico and Mud Creeks	ERP-02-P16-D	1/1/04-12/31/06	Acquisition, Planning and Monitoring	Funding was awarded to complete Phase II of a four-phase project to protect and restore 311 acres of flood-prone, ecologically significant land located within the Sacramento River Conservation Area at the confluence of the Sacramento River, Big Chico and Mud Creeks. This includes the purchase of 2 properties and baseline assessments, restoration design, preparation of management plans and outreach for these and one other property. The appraisal for the 146-acre Nicolaus property has been approved by DGS. An appraisal for the 125-acre Nock property is currently under review.	The Nicolaus property should be under option in November. Planning for baseline assessment work is underway and will take place summer 2005.

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Table 5. (continued)

Project Title	CALFED Program/ CVPIA Project	Term	Project Type	Progress and Accomplishments	Status
Subreach Planning for the Sacramento River: River Mile 144-164	ERP-02-P27	4/15/04-4/14/07	Planning and Monitoring	Funding was awarded to collaboratively conduct planning with the Sacramento River Conservation Area Forum (SRCAF) for the subreach of the Sacramento River between Princeton and Colusa. This comprehensive approach to restoration planning includes a high level of stakeholder involvement will develop the tools and information needed to make informed land use decisions regarding the effects of restoration actions that are uniquely designed to correspond to local conditions. A Steering Committee has been formed, an MOA signed with SRCAF, and an Advisory Committee formed. Subcontracts have been let for a facilitator, for baseline assessment work, and to conduct a local landowner survey.	Initial meeting of Advisory Workgroup was held November 3, 2004. Priority landowner questions will be identified. The landowner survey, initial newsletter and other outreach programs will be initiated. Baseline assessment work will continue, and the subreach background report currently being prepared will be finalized the next quarter.
Collaborative Approach to Quantifying Ecosystem Flow Regime Needs for the Sacramento River	ERP-02D-P61	9/10/04-9/9/07	Monitoring	Partial funding was awarded to quantify ecosystem flow regime needs for the Sacramento River between Red Bluff and Colusa utilizing a collaborative workshop process, targeted field investigations, quantitative computer modeling, and a decision analysis tool to formulate linkages between the flow regime and ecosystem components. This agreement was only recently signed and work has just been initiated.	The project partners are finalizing study plans for field studies, which will begin this winter. Essa is initiating development of the decision analysis tool and a draft design document for the tool. Stillwater Sciences is initiating drafting of the State of the System report.

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Table 5. (continued)

Project Title	CALFED Program/ CVPIA Project	Term	Project Type	Progress and Accomplishments	Status
Sacramento River Restoration: Chico Landing Sub-Reach (RM 178-206)	ERP-02D-P65	TBD	Planning, Restoration*, Research and Monitoring	Partial funding was awarded to conduct restoration planning and research on three sites within the Chico Landing Sub-reach in preparation for future restoration, and on a set of reference sites that were previously restored by Contractor 5-13 years ago. The agreement for this work is currently being finalized. *Additional funding may be awarded for restoration implementation (at the USFWS-owned Pine Creek Unit [25 acres], Capay [550 acres], and Deadman's Reach [238 acres] properties), contingent upon the outcome of CEQA.	The Recipient Agreement should be signed in early November. CBDA is the lead agency for CEQA compliance under the agreement and an Initial Study has already been initiated.
Acquisition of Southam Orchard Properties for Preservation of Riparian Habitat	CVPIA grant, BuRec Agreement #00FG200173 b(1)"other"	9/12/00-9/30/02	Acquisition	A portion of the grant was applied to the purchase of the 76+-acre Southam property, purchased in July 2000. The remainder of the funding was applied to the purchase of the 238-acre Ward property purchased in April 2001.	The grant is complete. Additional funding was used to purchase each of these properties. CVPIA (AFRP) and private funding was used to complete the purchase of Southam. CALFED 97-NO2 and private funding was used to complete the Ward purchase.
Hartley Island Acquisition	CVPIA grant, FWS Agreement #1448-11332-7-G017 AFRP	8/14/97-9/30/01	Acquisition	Funding was used toward the purchase of two parcels on Hartley Island, including the 321-acre Sandgren parcel. The remaining funds available were applied to the purchase of the 76+-acre Southam parcel.	Completed.
Singh Walnut Orchard	CVPIA grant, FWS Agreement #11332-0-G014 AFRP	9/18/00-12/31/01	Planning	Pre-acquisition and planning were completed including pre-acquisition due diligence, signed option for Singh property, baseline assessment, and local stakeholder meetings to discuss restoration plans. A final report was completed that outlined baseline and ecological considerations with restoration alternatives.	Completed.

Table 6. Previously funded monitoring projects focusing on terrestrial habitats within the Sacramento River Project area that did not have applicants from this proposal as Principle Investigators.

Project Information	Significant Findings
Title: Measuring Key Connections between the River and Floodplain Funding Source: TNC from CALFED funding (ERP 97-NO3) To: CSU Chico PI: Dr. David L. Brown. Co-PI: Dr. David M. Wood. Status: Project completed. Report to TNC Published online at: http://www.sacramentoriverportal.org/eco_indicators/wood_brown_rv7_final_report.pdf	We measured nitrogen mineralization, soil carbon and soil bulk density over one year in two different-aged restoration sites (1993 and 1999 plantings) at the River Vista Unit of the Sacramento River National Wildlife Refuge (River Mile 216) and compared the results to an adjacent 40 year-old remnant riparian forest owned by the Wildlife Conservation Board. Results showed that there were no differences among the three sites in rate of monthly nitrogen mineralization. However, the remnant riparian forest had significantly lower soil bulk density than did the two restoration sites, and soil carbon generally increased with increasing forest age although not all depths showed a clear trend. We conclude that measurements of ecosystem function are feasible and valuable in evaluating restoration success but that more research is needed to refine the particular variables to be measured.
Title: Pattern of woody species recruitment on point bars on the middle Sacramento River Funding Source: TNC from CALFED (2000-F03, FWS Agreement #11420-1-J001ERP) To: CSU Chico PI: Dr. David Wood. Status: Project completed. Full report to TNC published online at: http://www.sacramentoriverportal.org/reports/beehive/apdx6.pdf	This study documents the occurrence and some of the physical conditions under which woody riparian species colonize point bars along the middle Sacramento River. An elevational zone of establishment was calculated for *P. fremontii*, *S. gooddingii* and *S. exigua*. In downstream point bar locations, where most colonization occurred, the recruitment zone was calculated to be 1.2 to 1.6m above low water. Information from published studies on other river systems on the ecological and hydrological requirements of riparian colonists appears generally applicable to the Sacramento River. Factors that affect probability of success include a low slope angle on the point bar, which places more area into the recruitment zone than would a high slope angle; and sand or silt as a substrate type. However, for small-statured individuals growing in exposed sites on an active floodplain, the future is uncertain and end is always near. The next scouring flood may wipe away many or even most individuals; conversely, a period of several years without scouring flows may allow these individuals to resist scouring effects, trap sediment, and build the floodplain. The fate of these colonists will be ascertained in future studies of these permanently marked transects to better understand the relationship between colonization and mature forest.
Title: The distribution and composition of woody species in riparian forests along the middle Sacramento River, California Funding Source: TNC from CALFED (2000-F03, FWS Agreement #11420-1-J001ERP) To: CSU Chico PI: Dr. David Wood. Status: Project completed. Report to TNC published online at: http://www.sacramentoriverportal.org/reports/beehive/apdx5.pdf. Manuscript to be submitted to *Forest Ecology and Management*.	The objectives of the study were (1) to quantify the structure and species composition of existing remnant riparian forest vegetation along the middle Sacramento River; and (2) to provide baseline information for land managers in setting goals and metrics of success for restoration and other conservation actions. Twenty 600m^2 permanent plots (20x30m) were located in eight remnant fragments in cottonwood riparian forest and mixed riparian forest communities from River Mile 165 to 218. In each plot the diameter at breast height (1.7m) of all trees was measured, and shrub and herb cover estimated. Mean basal area (in m^2 ha^{-1}) of the five most important species were: *Populus fremontii* (1960), *Salix gooddingii* (364), *Acer negundo* (282), *Juglans californica* var. *hindsii* (211), and *Quercus lobata* (28). Mean density (stems ha^{-1}) of the five most important species were: *A. negundo* (303), *P. fremontii* (104), *J. californica* var. *hindsii* (75), *S.gooddingii* (58), and *Ficus carica* (31). The most common shrub species were *Rubus discolor* (11.9% mean cover), *Sambucus mexicana* (8.2%) and *R. ursinus* (7.8%). The most common vines were *Vitis californica* (6.8%), *Toxicodendron diversiloba* (3.4%) and *Clematis ligusticifolia* (2.8%). The most common herbs were *Galium aparine* (38%), *Artemisia douglasiana* (18.6%) and *Bromus diandrus* (10.7%). Mean plot richness of all species was 24.7 but mean exotic species richness was 9.1. Non-natives such as *R. discolor*, *G. aparine* and *B. diandrus* are common. Forests are currently dominated by aging P. fremontii and *S. gooddingii* with *A. negundo* and *J. california var. hindsii* poised to dominate when cottonwoods and tree willows die off.

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Table 6 (cont.).

Title: Comparison of surface-active beetle (Order: Coleoptera) assemblages in remnant and restored riparian forests of varying ages on the middle Sacramento River, CA. Funding Source: TNC from CALFED (2000-F03, FWS Agreement #11420-1-J001ERP) To: CSU Chico PIs: Dr. David Wood, J.W., Hunt, and S. Chamberlain. Status: Project completed. Masters Thesis, CSUC completed (2004). Report to TNC published online at: http://www.sacramentoriverportal.org/reports/beehive/apdx9.pdf	Composition of epigeal (surface-active) beetle assemblages (Order: Coleoptera) from monthly invertebrate sampling within young riparian restoration sites (1-3 years old), older restoration sites (6-10 years old), and remnant riparian forests (>25 years old) were compared in order to examine effects of forest age on beetles along the Sacramento River. Pitfall sampling of epigeal beetles was carried out monthly between December 2000 and November 2001. For individual morphospecies we used either analysis of variance or a Kruskal-Wallis nonparametric test of the mean monthly trap catches to determine whether forest type significantly affected morphospecies abundance. Indicator species analysis was performed on mean monthly trap catches to calculate individual morphospecies' values as "indicators" of different forest types. Ordination and cluster analysis at the order level, and for at least three families, showed a strong response of sample assemblages to forest age. Temporal analyses of sample assemblages at the order level also showed a significant difference between forest type "trajectories" for the sample-year. There was a significant response to forest type by 31 indicator morphospecies. We conclude that: 1) samples from forests of different ages contain characteristic beetle species; 2) epigeal beetle assemblages within remnant riparian sites were most similar to one another; 3) younger restoration sites showed greater differences in composition amongst themselves and through time than did old restoration and remnant riparian forest sites. From these results it appears that riparian restoration efforts are providing habitat for many beetle species characteristic of remnant riparian forests.
Title: Local vs. landscape factors affecting restoration of riparian understory plants. Funding Source: National Science Foundation To: UCSC PIs: Dr. Karen Holl, Dr. Elizabeth Crone, Status: Project complete. Published manuscript: Holl, K. D. and E. E. Crone. 2004. *Journal of Applied Ecology* 41:922-933.	The goal of this study was to evaluate the effects of a suite of local and landscape scale factors on the establishment of understory plant species in restored forests along the Sacramento River. Cover and species richness of exotic understory plants decreased strongly with increasing overstory cover, and were lower in quadrats closer to river base flow. Native understory species richness and cover were negatively related to exotic cover and somewhat related to connectivity with remnant forest. Native wind-dispersed cover was best explained by percentage forest cover surrounding a site within a 1000-m buffer, whereas native water-dispersed cover was most strongly explained by distance to the river. Neither patch size nor time since restoration explained a significant amount of native or exotic species richness or cover. Local-scale factors explained a substantially larger proportion of the variance than landscape factors, and much of the variance remained unexplained. From a management perspective, our results suggest that restorationists should focus on establishing dense overstory cover to shade out exotic plants and enhance establishment of native understory species.
Title: Importance of hydrologic and landscape heterogeneity for restoring Bank Swallow colonies along the Sacramento River, CA. Funding Source: National Science Foundation To: UCSC PIs: Dr. Karen Holl, Dr. Elizabeth Crone, Status: Project complete. Published manuscript: Moffatt, K. C., E. E. Crone, K. D. Holl, R. W. Schlorff, and B. A. Garrison. In press. *Restoration Ecology*.	We used monitoring data of Bank Swallow distributions along a 160-km stretch of the river from 1986-1992 and 1996-2003, and to test whether bank extinctions and colonizations corresponded with changes in maximum river discharge, surrounding land cover, estimated colony size, temperature, and precipitation. Bank colonization increased with maximum discharge. Bank extinction probabilities decreased with proximity to the nearest grassland, decreased with colony size and increased with maximum discharge. To explore the implications for restoration, we incorporated the statistically-estimated effects of distance to grassland and maximum discharge, into simple metapopulation models. Under current conditions, the Bank Swallow metapopulation appears to be in continued decline, although stable or increasing numbers cannot be ruled out with the existing data. Maximum likelihood parameters from these regression models suggest the Sacramento River metapopulation could be restored to 45 colonies through moderate amounts of grassland restoration, large increases in discharge or direct restoration of nesting habitat by removing ~10% of existing bank protection (riprap) from suitable areas.

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Table 6 (cont.).

Title: Factors Affecting Planted Species at Restoration Sites Funding Source: TNC from CALFED (97-NO2 ERP) To: CSU Chico PIs: Dr. David Wood, Ryan Luster, Daryl Peterson Status: Data collection has been completed but analysis is still in progress. Manuscript to be submitted to *Restoration Ecology*.	This study monitored short- and long-term plant community dynamics at horticultural restoration sites and extended the studies of Alpert et al. (1999 *Restoration Ecology*) and Griggs and Golet (2002) on the early success of restoration techniques. We collected vegetation data (diameter at breast height, stem density, shrub and herb cover) in 20x30m plots (n = 106) at locations where soil cores were taken as part of the site assessment process prior to restoration planting. We used these soil core data to relate soil structure (texture and depth of soil strata) and groundwater depth to growth (basal area) and forest species community structure. Preliminary results show that both presence of groundwater at <3m and absence of buried gravel layers >30cm thick are good predictors of total plot basal area. Groundwater presence (a positive indicator) allows roots of woody species to grow well over the summer months without need for irrigation, while gravel layers (negative indicator) inhibit root penetration and result in death of most or all woody species following removal of irrigation. Thus sites with groundwater above any gravel layer are becoming lush forest whereas sites with gravel layers above any groundwater are dominated by exotic weeds and scattered native shrubs such as elderberry and coyote brush.
Title: Survey of planted elderberry on Sacramento River NWR riparian restoration sites for use by Valley Elderberry Longhorn Beetles. Tehama, Butte, and Glenn Counties, CA. Funding Source: USFWS To: River Partners PIs: Swagerty and Chamberlain Status: Project complete. Final report: River Partners (2004)	Below is an excerpt from the Swagerty et al. (2004) CALFED science abstract. River Partners examined approximately 10% (7,600) of the planted elderberry shrubs at several Sacramento River National Wildlife Refuge units for the presence or absence of VELB exit holes and in addition, the presence or absence of Argentine Ants (*Linepithema humile*). Refuge units surveyed lay along 66 miles of the Sacramento River (between RM 167 and RM 233), encompassing Tehama, Butte and Glenn counties. VELB exit holes were observed in most fields containing elderberry shrubs, with some shrubs containing multiple exit holes. A total of 449 exit holes in 299 planted shrubs were observed in the selected refuge units. This study shows the effectiveness of restoring elderberry habitat and the subsequent successful VELB colonization of these recently restored lands.
Title: Examination of Vertebrate Pest Species Associated with Riparian Habitat Restoration Projects along Northern California's Sacramento River Funding Source: TNC, CSUC (Agricultural Research Initiative), and CALFED (ERP-02-P27) To: CSU Chico PIs: Dr. David Wood, John Hunt. Status: Project to begin 11-04	This study will develop baseline information documenting the composition and relative abundance of potential small mammal pest species within and between 4 habitat types in the SRCA: remnant riparian forests, older riparian restoration sites ($\geq$ 10 years old), younger riparian restoration sites ($\leq$ 3 years old) and orchard lands adjacent to riparian forest and/or habitat restoration sites. Methods utilized will include live-trapping of small mammals, timed surveys for potential diurnal vertebrate pests (primarily ground squirrels) and barn owl pellet analysis from known nest boxes. Analyses will focus on relative abundances of pest species between habitat types and comparison of relative abundances between sampling methods. Information gathered in this study will be used to shed light on vertebrate pest species problems associated with riparian habitat restoration within the SRCA. This information is essential to developing practical means of addressing the problem.
Title: Manipulative Experiments in New and Old Restoration Tracts and Factors Affecting and Strategies for Facilitating the Recruitment of Native Plant Species in Restored Riparian Forest on the Upper Sacramento River. Funding Source: TNC, from CALFED (ERP-02D-P65) To: UCSC and CSUC PIs: Dr. Karen Holl and Dr. David Wood Status: Project to begin May, 2005	This project will test the hypothesis that the variability in recruitment of both native woody and understory plant species in restoration sites is affected by a combination of site-specific and landscape variables, such as competition with non-native exotic species, overstory cover, soil nutrients and texture, soil moisture, groundwater depth, and percentage remnant forest in the surrounding landscape. To test this hypothesis we will conduct both an experimental and a sampling study. A transplant experiment with six focal native species common in remnant riparian forests and potentially valuable in restoration (*Aristolochia californica, Carex barbarae, Rubus ursinus, Vitis californicus, Artemisia douglasiana,* and *Clematis ligusticifolia)* will be placed into existing restoration sites and their performance monitored for two years. Survival and fecundity data will be analyzed using ANOVA with site, distance to forest, overstory cover, and NIS cover as independent variables. The sampling study will be conducted at eight TNC restoration sites established between 1989 and 1998. Here, we will sample vegetation according to the methods described above in Projects 2 & 4 but with additional environmental measurements of soil moisture, groundwater depth, soil nutrients and texture, landform age, elevation, flood frequency, and light. We will relate environmental variables to vegetation data via multivariate ordination techniques in order to determine the best predictors of restoration forest development.

Table 7. A partial list of indicators for which quantitative data we be collected in this project. Data will be collected on these indicators to: 1) measure the response of the Sacramento River Ecosystem to restoration actions (including planting of native species); and 2) evaluate overall changes in ecosystem health. For each indicator quantitative rating values will be assigned to characterize status, and conservation goals will be determined. See Figure 3 for a conceptual model depicting the importance of individual indicators, and **Task 4**, TNC (2003) and Parrish et al. (2003) for details on how indicators will be folded into an existing ecological scorecard monitoring framework.

Task	Indicators
TASK 1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS	• area of landcover in different vegetation composition classes, • percent of canopy composed of invasive species, • area of landcover in different vegetation height classes, • area of habitat in different vegetation structure classes, • area of land reworked, • area of habitat in different floodplain age categories, • number and area of off-channel habitats of different types, • number and area of mid-channel islands of different types, • channel sinuosity*, • channel avulsion rate*, • channel meander rate*, • area of habitat in different relative elevation (surrogate for depth to groundwater) categories. **These are also proposed in a current ERP proposal led by CSUC.*
TASK 2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS	• Bird species occurrences (based on point count methodology) • Bird community diversity/species richness (based on point count methodology) • Bird species abundance (based on point count methodology) • Reproductive success of breeding focal species (based on intensive nest monitoring methodology at select sites) • Adult annual survival of breeding focal species (based on constant effort mist-netting methodology at select sites) • Vegetation composition (based on relevé survey methodology) • Canopy composition including native/non-native species (based on relevé survey methodology) • Understory and overstory vegetation layers (based on relevé survey methodology)
TASK 3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB	• Density of elderberry (absolute and relative to natural sites), • Size of elderberry (diameter and number of branches), • Elderberry condition (% dead stems, insect herbivory, bark damage), • Physical and plant community factors controlling elderberry occurrence and abundance, • VELB presence/absence, • VELB abundance, • Physical and plant community factors controlling VELB occurrence and abundance, • Predicted total number of VELB for region.

Table 8. Comments and Exceptions to Standard ERP Grant Agreement, the General Terms & Conditions and the Special Terms and Conditions, as contained in Attachment 3 to the PSP.
NOTE: We reserve the right to make additional comments and exceptions as new forms are provided for review or forms already reviewed are revised.

Exhibit Section Paragraph	**Comment/Exception**
Exhibit A, Section III, Paragraph 2	1) TNC's Project Directors do not have unlimited authority to act on behalf of the organization. Replace "[Project Director] shall have the full authority to act on behalf of the Grantee." with "[Project Director] shall act on behalf of the Grantee." 2) It is unclear what is meant by the word "binding." Propose to replace "All communications submitted to the Project Director shall be as binding as if given to the Grantee." with "All communications to Grantee shall be submitted to the Project Director."
Exhibit B, Section 1	Section 5 of this Exhibit indicates that Grantee will be paid based on actual expenses. Given this, replace "The Grantee shall invoice no more frequently than monthly based upon percent complete by task and deliverables." with "The Grantee shall invoice no more frequently than monthly based upon permitted expenses incurred towards the completion of the Project."
Exhibit B, Section 2, Paragraph 1	It is unclear why Grantee cannot invoice until agency receives a notice of satisfactory completion from ERP Grant Manager. Work progress is communicated in Progress Reports. Propose to delete "upon receipt of notice of satisfactory completion of acceptance of work by ERP's Grant Manager." and change the next sentence stating "The State will not accept an invoice for which work has not been approved and will return the invoice as a disputed invoice to the Grantee." to "The State will not accept an invoice for which adequate progress towards the Project Deliverables has not been made. The progress must be detailed in the Progress Reports."
Exhibit B, Section 2, Paragraph 3	TNC exempt employees are not paid hourly, but are paid on a salaried basis bi-weekly. If we were to attempt to calculate an hourly rate for each position, the hourly rate would be different each pay period since the number of hours worked usually varies each pay period. As has been accepted by CBDA in the past, TNC requests that hourly rates for exempt employees not be required on invoices submitted, and that staff be listed by category, not by name, to keep information confidential.
Exhibit B, Section 2, Paragraph 5	Invoices are requested to be mailed to one location only. Delete "whichever date occurs later."
Exhibit B, Section 3	Add additional paragraph stating "Full credit shall be allowed for Grantee's expenses necessarily incurred under this Grant Agreement up to the date of written cancellation."
Exhibit B, Section 4.A	Replace Section 4.A with "Line item and task adjustment(s). Grantee shall expend funds in the manner described in the approved Budget. As long as the total contract amount does not increase, the Grantee may: (1) decrease the Budget for any individual tasks by no more then 10% of the total task amount, on a cumulative basis, and increase the Budget for one or more tasks by an equal amount; and (2) adjust the Budget between individual line items within a task by no more then 10% of the total task amount for such task. Any other variances in the budgeted amount among tasks, or between line items within a task, require approval in writing by CDFG or CBDA. All cumulative variances to the approved Budget must be reported with each invoice submitted to CDFG or CBDA for payment. The total amount to be funded under this Agreement may not be increased except by amendment of this Grant Agreement. Any increase in the funding for any particular Budget item shall mean a decrease in the funding for one or more other Budget items unless there is a written amendment to this Grant Agreement pursuant to the ERP Grant/Contract Amendment Workshop process (see Exhibit A - Attachment 3 - ERP Amendment Guidelines)."
Exhibit B, Section 5.A	Need to add some mechanism to allow for rollover of unused funds from one fiscal year to the next within the term of the agreement.

(continued next page)

Table 8 (cont.).

Exhibit B, Section 5.E	As allowed previously by CBDA, allow TNC to enter into fixed-price subcontracts in which instance subcontractor detailed personnel costs would not be required in the Budget Summary nor in each invoice submitted to the State. Additionally, in the case of a fixed-price subcontract, back up documentation would not be required of subcontractors with each invoice. Fixed-price subcontracts would be competitively bid (or sole sourced) unless subcontractor was named in the proposal, per Agreement requirements. Special provisions would need to be allowed when subcontracting with universities.
Exhibit B, Section 5.F	It is stated that travel reimbursement guidelines are in accordance with the current State of CA guidelines. Per established TNC policies and procedures, TNC reimburses its employees for actual travel costs incurred; we do not pay employees a per diem for travel. Additionally, TNC follows the IRS rules for mileage reimbursement. Therefore, we propose that travel costs for TNC employees be reimbursed based on actual costs, that mileage for a personal vehicle be reimbursed at the current federal rate, and that State Travel and Per Diem Expense Guidelines are not attached as an Exhibit to the Agreement (this has been accepted by CBDA in the past).
Exhibit B, Section 6	Delete third paragraph relating to Grantee retaining 10% of subcontractor's earnings. TNC pays subcontractors at their own risk. Also, Section 8(c) of Exhibit D absolves the State of any responsibilities, including payment obligations, for subcontractors.
Exhibit B, Budget Summary and Detailed Breakdown - Equipment Detail	It is unclear from Exhibit B – Budget Summary and Detailed Breakdown – Equipment Detail, what constitutes equipment. As defined in the Sample, equipment has a normal life expectancy of one year or more and an approximate cost of $5,000 or more, yet items in the Sample's table cost $2,000 and $3,000. TNC's capitalization threshold is $50K. Anything under that amount would be booked as supplies, not equipment to our General Ledger, but we can provide reports on anything meeting the State's equipment description once this description is confirmed.
Exhibit C, Section 5	Add at the end of section "provided that Grantee shall have no indemnification obligations under this paragraph to the extent that any claim or loss is caused by the gross negligence or willful misconduct of the party seeking indemnification."
Exhibit C, Section 7	Because there may be work done and deliverables submitted that have already been approved, replace "In the event of such termination, the Grantee agrees, upon demand, to immediately repay to the CDFG or CBDA an amount equal to the amount of grant funds disbursed to the Grantee prior to such termination." with "All costs to CDFG or CBDA shall be deducted from any sum due to Grantee under this Grant Agreement and the balance, if any, shall be paid to the Grantee upon demand." Additionally, add the following paragraph "CDFG/CBDA or Grantee may terminate this Grant Agreement, without cause upon 30 days advance written notice. The Grantee shall be reimbursed for all work performed and reasonable expenses incurred up to the date of termination."
Exhibit C, Section 15, Paragraph 1	Replace the phrase "and will provide a drug-free workplace by taking the following actions" to "and will, or continue to, provide a drug-free workplace by taking, or continuing, the following actions"
Exhibit D, Section 1	Before we can agree to comply with "the adopted environmental mitigation plan," we need to know what it is.
Exhibit D, Section 3	To the following sentence "The Grantee shall notify the CDFG or CBDA at least ten (10) working days prior to any public or media event publicizing the accomplishments and/or results of this Grant Agreement and provide opportunity for attendance and participation by CDFG or CBDA representatives" add "or as soon as the event has been scheduled if it is not scheduled ten or more working days in advance."
Exhibit D, Section 4	To the following sentence "The Grantee assumes all operations and maintenance costs of the facilities and structures; the CDFG or CBDA shall not be liable for any cost of such maintenance, management or operation" add "which is not expressly set forth in the Scope of Work and/or the Budget attached to this Agreement, as amended from time to time in accordance with this Grant Agreement."
Exhibit D, Section 7	Delete "If the State and Grantee are unable to resolve the dispute, the decision of the ERP Program Manager or Designee shall be final."

(continued next page)

Table 8 (cont.).

Exhibit D, Section 8	Please provide a reference for "basic State Requirements" since this is not specified.
Exhibit D, Section 10	Replace the first sentence with "Grantee shall have the right to disclose, disseminate, and use, in whole or in part, all data, plans, drawings, specifications, reports, computer programs, operating manuals, notes, and other written or graphic work produced in the performance of this Grant, and Grantee agrees that such rights are subject to the rights of the State as set forth in this section." Additionally, we reserve the right to amend the language in this section if necessary when dealing with universities as subcontractors, subject to State approval.
Exhibit D, Section 14	Delete this section since the State is already protected by other default and termination clauses that are in conflict with this Section 14.
Exhibit D, Section 15, Paragraph 1	Replace the first sentence with "Grantee shall cooperate with the CDFG or CBDA staff, working on behalf of the Resources Agency, to ensure compliance with all applicable permitting and environmental review requirements that may be required to accomplish the project described in the Scope of Work."

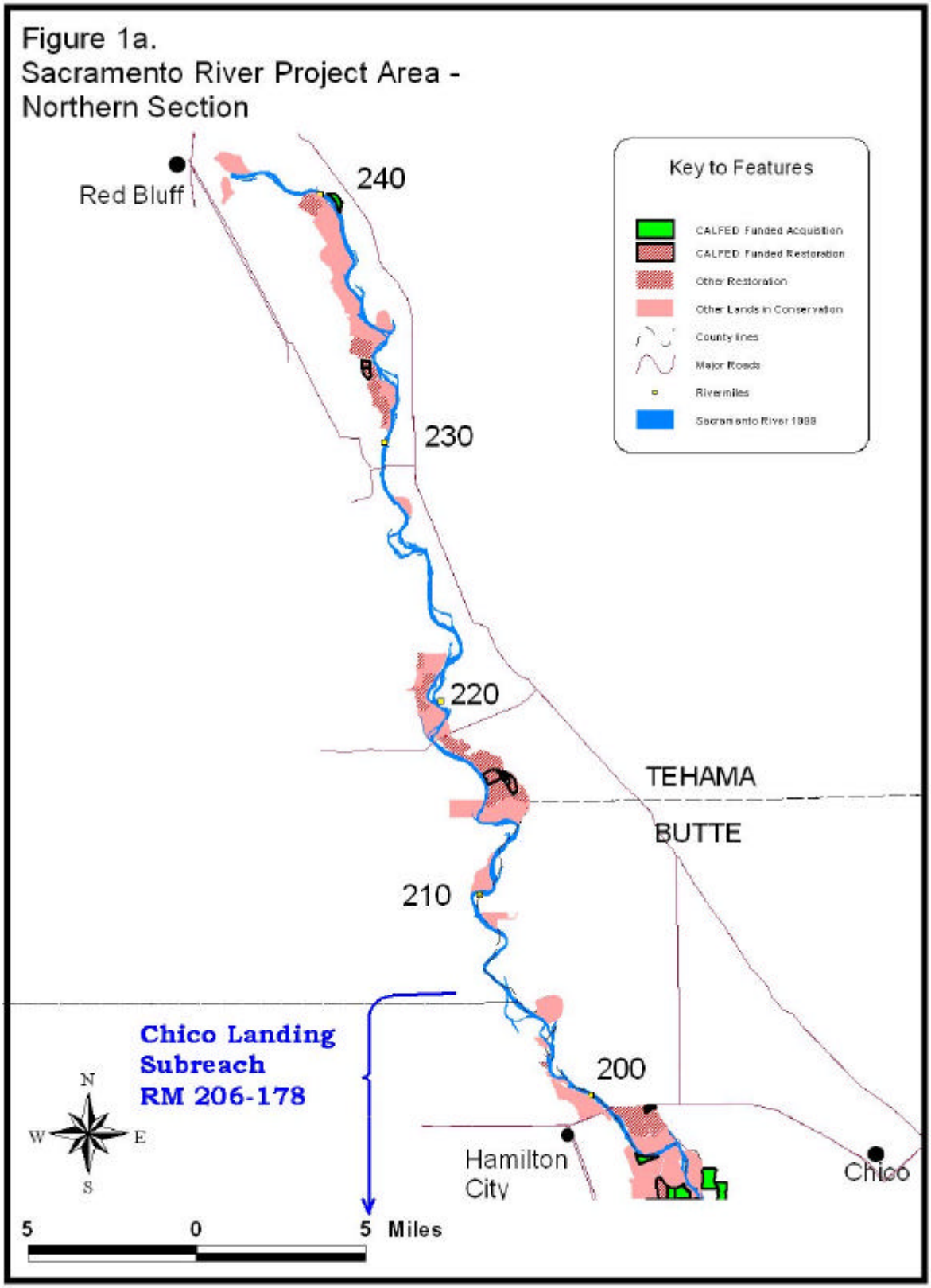


Figure 1a.
Sacramento River Project Area -
Northern Section
Red Bluff
240
230
220
210
200
TEHAMA
BUTTE
Key to Features
CALFED Funded Acquisition
CALFED Funded Restoration
Other Restoration
Other Lands in Conservation
County lines
Major Roads
Rivermiles
Sacramento River 1998
Chico Landing
Subreach
RM 206-178
N
W
E
S
Hamilton
City
Chico
5
0
5 Miles

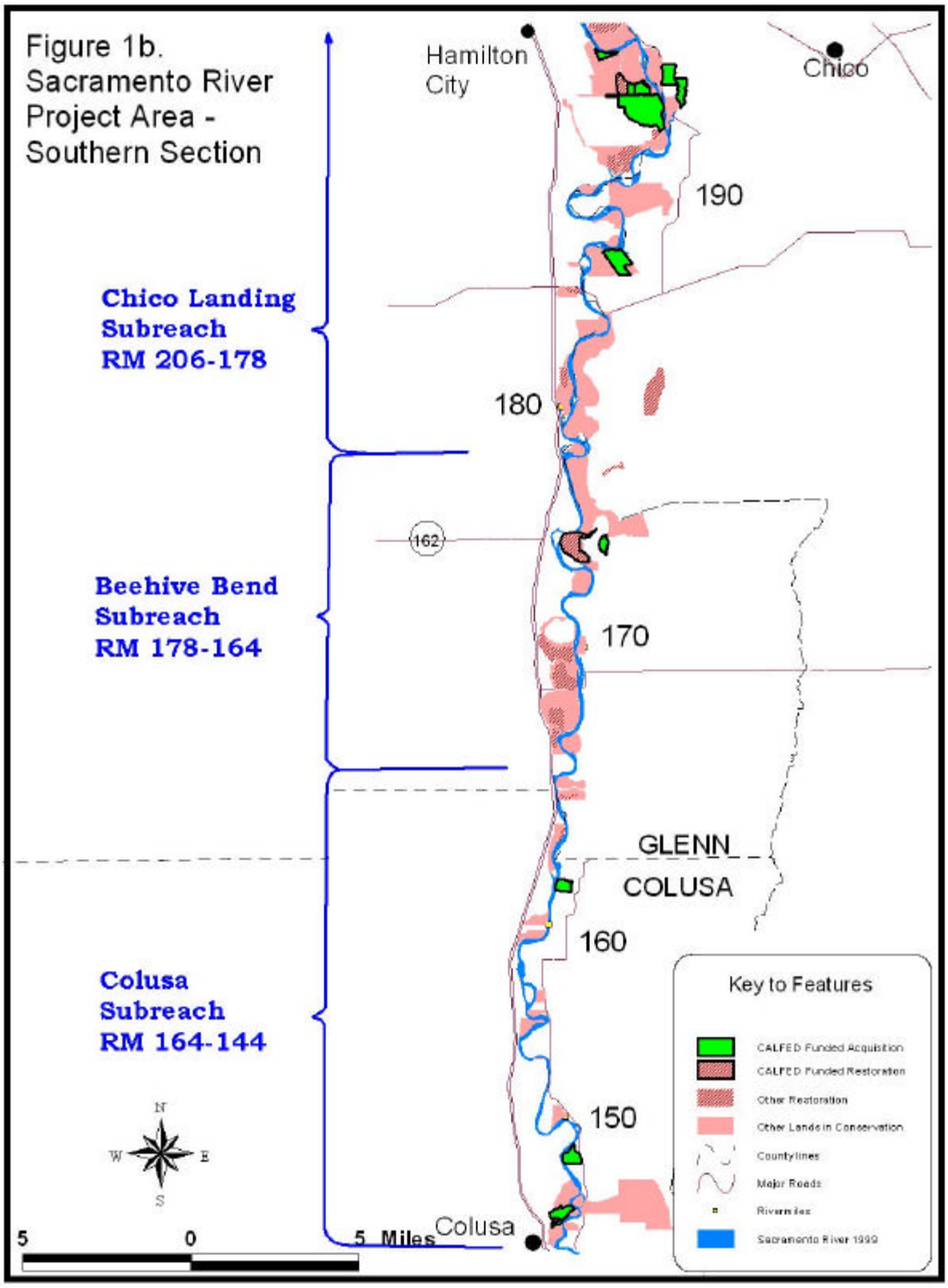


Figure 1b.
Sacramento River
Project Area -
Southern Section
Hamilton
City
Chico
190
Chico Landing
Subreach
RM 206-178
180
162
Beehive Bend
Subreach
RM 178-164
170
GLENN
COLUSA
160
Colusa
Subreach
RM 164-144
150
Key to Features
CALFED Funded Acquisition
CALFED Funded Restoration
Other Restoration
Other Lands in Conservation
County lines
Major Roads
Rivers/ies
Sacramento River 1999
N
W
E
S
5
0
5 Miles
Colusa

Figure 2. Conceptual Model of TNC Sacramento River Project's programmatic structure

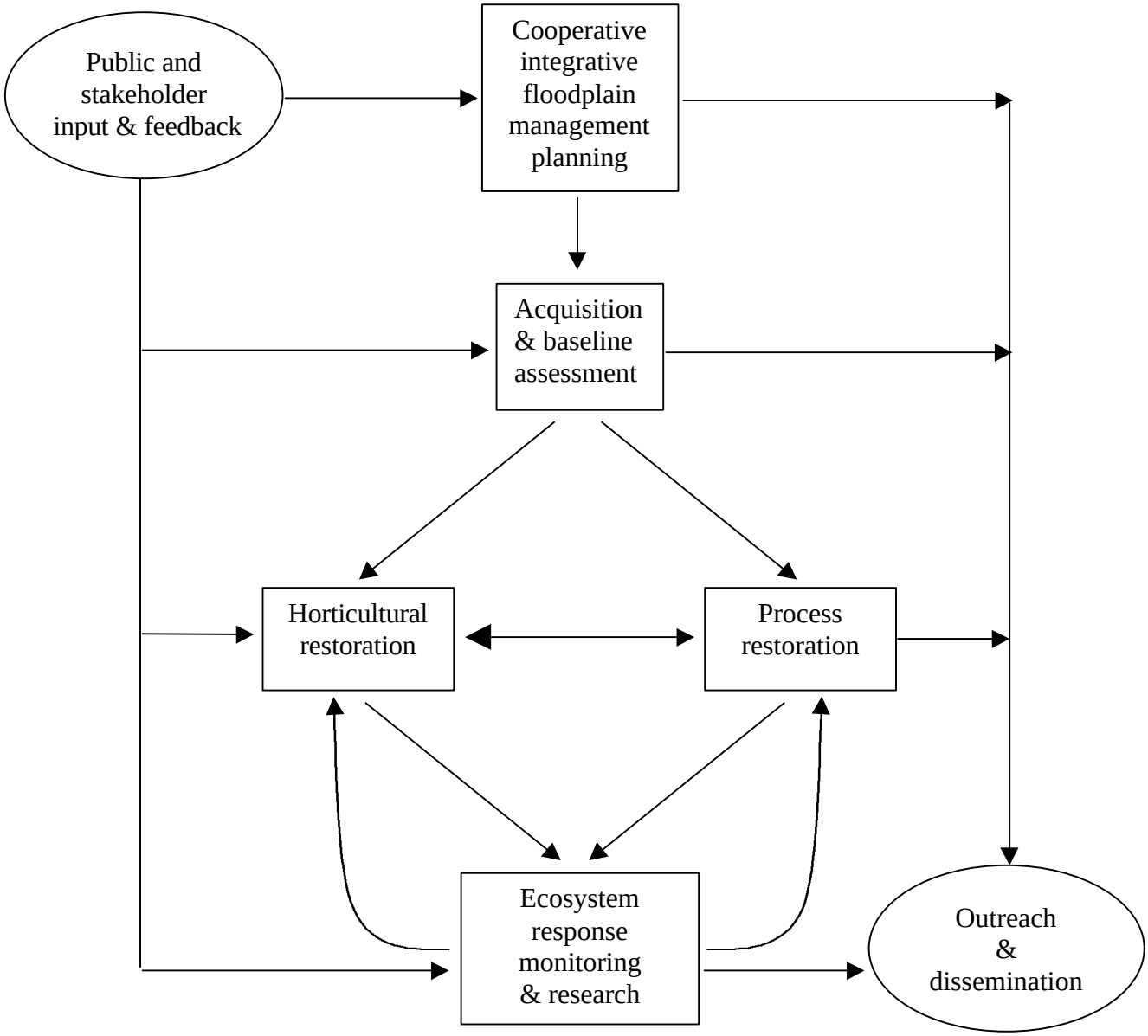


Figure 3: Conceptual model depicting relationships between physical processes, habitat (at the site-specific and landscape scale), and species response indicators. Indirect relationships are depicted with a dashed line. Quantitative monitoring data will be collected for each of the indicators listed. See **Table 7** for information on which indicators will be quantified in each task, and **Task 4**, TNC (2003) and Parrish et al. (2003) for details on how indicators will be folded into an existing ecological scorecard monitoring framework.

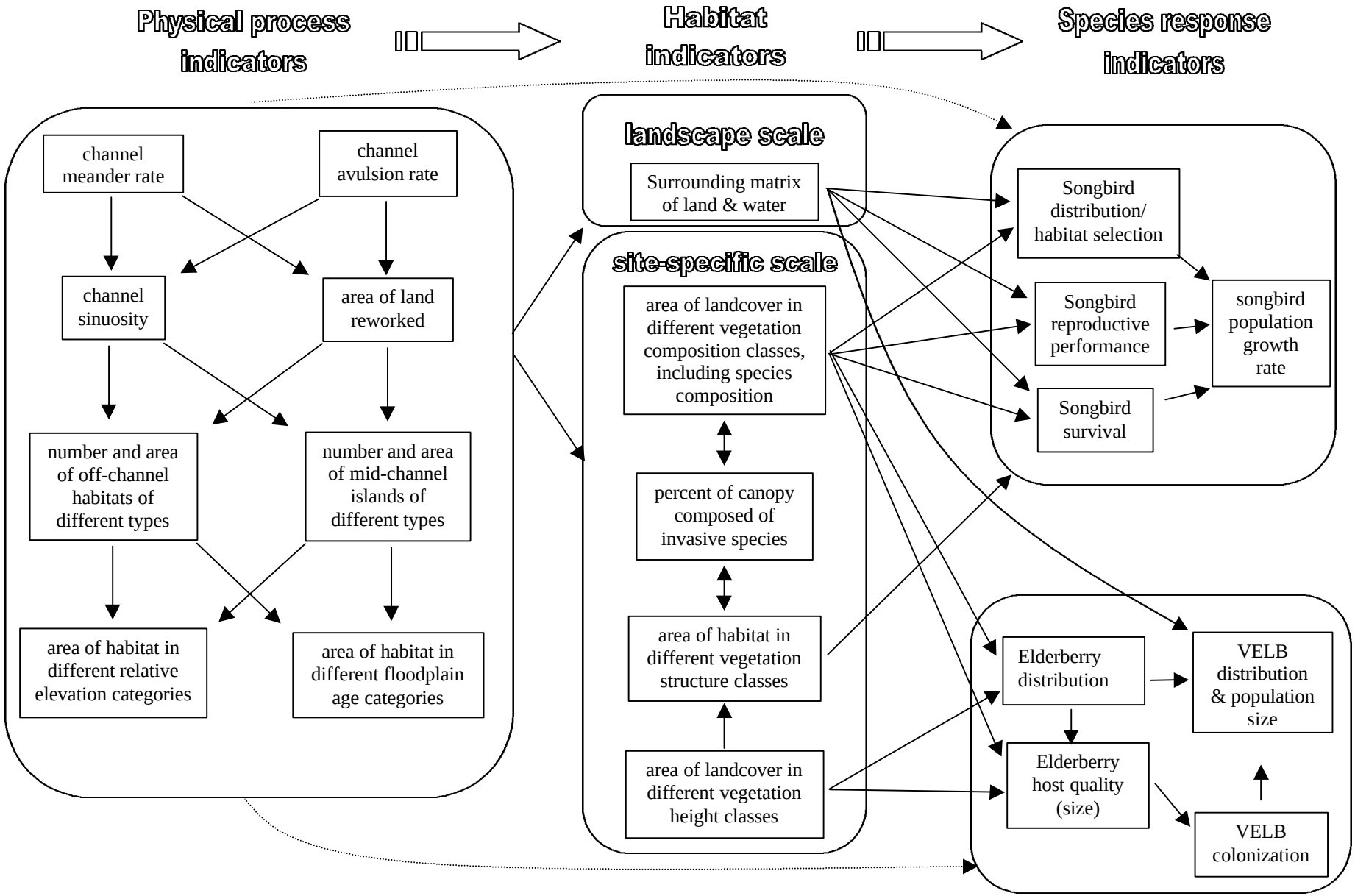
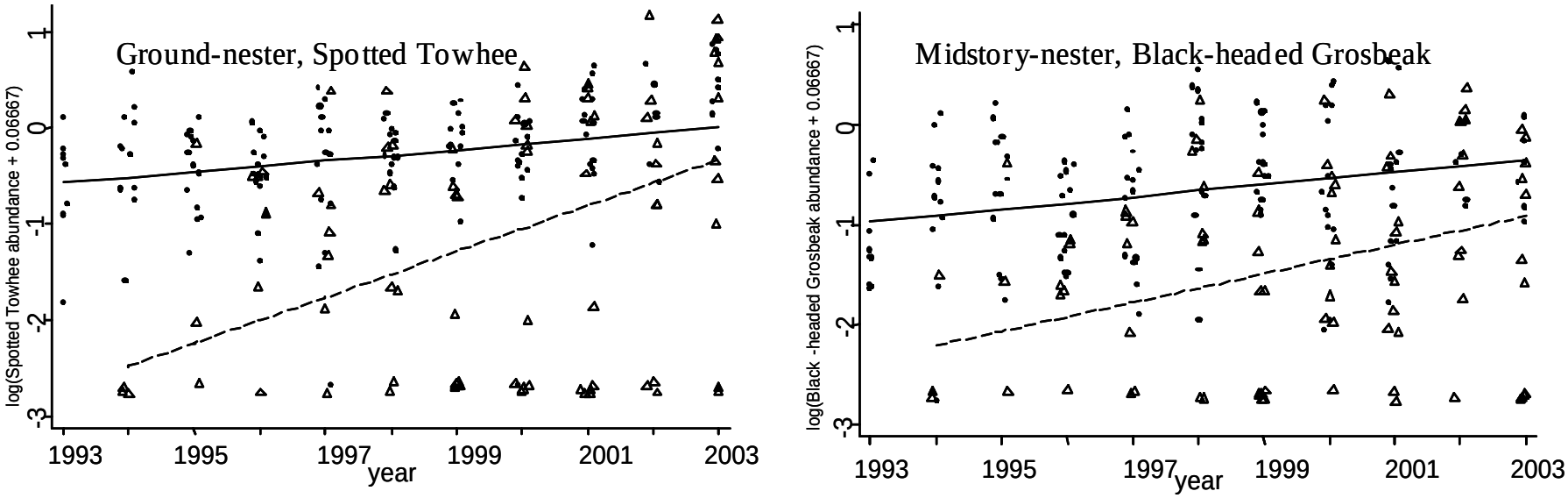
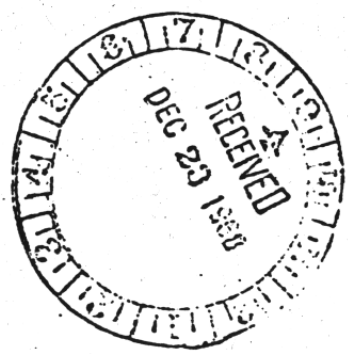


Figure 4. Point count detections of Spotted Towhees and Black-headed Grosbeaks in remnant (solid line, filled circles) and revegetated (dashed line, triangles) riparian forests in the Sacramento Valley, California, USA from 1993 to 2003. Line shows values predicted from log-linear regression. Each circle and triangle represents datum from one year for each site (points are jittered to better show data).





Internal Revenue Service
Washington, DC 20224

Date: DEC 19 1968

In reply refer to: T:I:I:1:1

The Nature Conservancy
1522 K Street, N. W.
Washington, D. C. 20005

Attention: E. R. Kingman
Vice President

Gentlemen:

This is in reply to your letter dated October 9, 1968, requesting a ruling that you qualify as a "publicly supported" organization under section 170(b)(1)(A)(vi) of the Internal Revenue Code so that contributions to you are subject to the special limitation provisions of section 170(b)(1)(A) of the Code.

Under section 170(b)(1)(A) of the Code an individual is allowed an additional deduction not exceeding 10 percent of his adjusted gross income for contributions made to certain organizations, including an organization described in section 170(b)(1)(A)(vi) of the Code.

Section 170(b)(1)(A)(vi) of the Code describes an organization referred to in section 170(c)(2) which normally receives a substantial part of its support (exclusive of income received in the exercise or performance by such organization of its charitable, educational, or other purpose or function constituting the basis for its exemption under section 501(a)) from a governmental unit referred to in section 170(c)(1) or from direct or indirect contributions from the general public.

The information submitted with your request discloses the following:

You are exempt from Federal income tax as an organization described in section 501(c)(3) of the Code, which is substantially similar to section 170(c)(2), and contributions to you are deductible under section 170 of the Code.

You were incorporated in October 1951 as a nonprofit corporation under the laws of the District of Columbia. Your purposes, as set forth in your Certificate of Incorporation, are (a) to preserve or

aid in the preservation of all types of wild nature, including natural areas, features, objects, flora and fauna, and biotic communities; (b) to establish nature reserves or other protected areas to be used for scientific, educational, and esthetic purposes; (c) to promote the conservation and proper use of natural resources; (d) to engage in or promote the study of plant and animal communities and of other phases of ecology, natural history, and conservation; and (e) to promote education in the fields of nature preservation and conservation.

It is stated that your primary objective is to acquire and to protect outstanding natural areas. By early 1968, you had been instrumental in having nearly 95,000 acres set aside as sanctuaries and preserves throughout the United States, and you anticipate that you will reach the 100,000 acre mark before the end of the calendar year. You acquire land either by gift or by purchase and a great deal of this procurement is for Federal, state and local governments. Your activities include the chartering of local subordinate chapters to perform local functions in carrying out your purposes.

Your by-laws provide for several classes of membership and specify the contribution required for membership in each membership class. Membership in your organization is open to any individual or organization approving of your objectives.

You are governed by a Board of Governors which presently consists of a Chairman of the Board, a Vice Chairman, Secretary, Treasurer and twenty-one members at large. It is stated that the members at large are chosen, insofar as possible, because of their skills, varied interests, and their deep and devoted interest in the conservation of this country's natural resources and an abiding love of the land itself. Additionally, an attempt is made to have the Board represent as many areas of the country as possible.

Your support for the four fiscal years June 30, 1965 through June 30, 1968, was derived substantially from contributions received directly and indirectly from the general public, as well as from membership dues and investment income. An article in the Sunday, November 10, 1968, issue of the Washington Post states that the Ford Foundation is giving you $6 million to buy 97 tracts of land and hold them for later government use. Your method of making financial reports available to the public has been through your publication, The Nature Conservancy News. In addition to printing a summary in the News, you have always carried a notice stating that the complete financial statement was available upon request to your national headquarters office.

The facts and circumstances presented indicate that you are a publicly supported organization described in section 170(b)(1)(A)(vi) of the Code. Accordingly, the special limitation provided in section 170(b)(1)(A) of the Code is applicable to contributions made to you by individual donors.

Very truly yours,

Chief, Individual Income Tax Branch

Internal Revenue Service

Department of the Treasury

District Director — Baltimore District

31 Hopkins Plaza, Baltimore, Md. 21201

P.O. Box 13163, Room 817
Baltimore, MD 21203

February 9, 1996

NATURE CONSERVANCY INC
1815 N LYNN STREET
ARLINGTON, VA 22209

Employer Identification Number:
53-0242652

Person to Contact:
EP/EO Tax Examiner

Telephone Number:
(410) 962-6058

Dear Sir/Madam:

This is in response to your inquiry dated January 10, 1996, requesting a copy of the letter which granted tax-exempt status to the above named organization.

Our records show that the organization was recognized as tax-exempt from federal income tax under section 501(c)(3) of the Internal Revenue Code and issued a Group Exemption Letter effective March, 1954. Your Group Exemption Number is 1351.

You are required to submit annually, at least 90 days before the close of your annual accounting period, a statement describing any changes during this period as to the purposes, character, or method of operation of your subordinates.

A copy of our letter certifying the status of the organization is not available, however, this letter may be used to verify your tax-exempt status.

Because this letter could help resolve any questions about your exempt status, it should be kept in your permanent records.

Sincerely yours,

Paul M. Harrington
District Director

Tasks And Deliverables

Measuring the Performance of Riparian Restoration Projects on the Sacramento River

Task ID	Task Name	Start Month	End Month	Deliverables
5	Project Management	1	36	**Semiannual and final reports. Periodic invoices**
1	**MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS USING REMOTE SENSING DATA**	**1**	**36**	**– A report compiling spatial data (GIS), including documentation of methodology and data structure. – A floodplain age map quantifying erosion, deposition, and fluvial processes. The product will be a continuous surface of floodplain age (GIS raster dataset) and a table of erosion and deposition per time interval at each bend. – A MSE topographic surface for the Princeton to Colusa reach in 2005 in a triangulated irregular network (TIN) model (as derived from LIDAR), a relative elevation topographic surface model of the study reach delivered in TIN and raster format. – A report summarizing the plant community mapping, including a ground–truthed land cover map of vegetation communities and canopy height with associated metadata. – A report summarizing the changes in vegetation characteristics over time on both restored and remnant sites. – manuscripts describing the management implications of the above analyses will be submitted to**

				journals
2	DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS	1	36	– A dataset integrating bird data collected in the region by PRBO from 1993 through the end of the study period that includes abundance patterns, abundance trends, habitat associations, survival, and reproductive success of riparian songbirds. – A computer model that relates the dependent variables of riparian songbird presence and abundance with the independent variables of hydrology, landcover, vegetation, and geomorphology. – A computer model that relates riparian songbird reproductive success with the independent variables of hydrology, landcover, vegetation, and geomorphology. – Deterministic population growth rate models for focal bird species in relation to spatial habitat structure. – A manuscript describing the computer model relating riparian songbird presence, abundance, and reproductive success with hydrology, landcover, vegetation, and geomorphology (e.g. for Landscape Ecology or Ecological Applications). – A manuscript on the success of previously implemented Sacramento River riparian habitat restoration projects for promoting the recovery of songbirds (e.g., for Restoration Ecology). – A manuscript that

				identifies conditions promoting source populations of riparian birds and identifies probable locations drawing on the combined GIS and field analyses (e.g., for Ecology).
3	DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB	1	36	− A manuscript on the success of previously implemented Sacramento River riparian habitat restoration projects for promoting the recovery of the threatened VELB (e.g., for Restoration Ecology) − A manuscript on the success of different kinds of riparian habitat restoration approaches for creating habitat for the threatened VELB (e.g., for Ecological Applications or Restoration Ecology). − A manuscript that estimates the regional population size for the VELB from the combined GIS and field analyses (e.g., for Biological Conservation or Landscape Ecology). − A manuscript on the combined analysis of effects of all variables on VELB persistence that will be published in an ecological or conservation journal. − We will also aid USFWS in revising the VELB recovery plan. This will be facilitated by providing USFWS with reports detailing recommendations for revising the Recovery Plan. The documents will aim to make restoration more effective and to give improved and quantitative

				estimates of what is required for species’ recovery.
4	INTEGRATE NEW INFORMATION INTO ECOLOGICAL SCORECARD FRAMEWORK	1	36	– A completed ecological scorecard for the Sacramento Project area that tabulates and synthesizes information derived from project studies to characterize the status and trends of focal biodiversity in the area. Includes archival of supporting materials. – A manuscript that communicates indicator selection, associated rating values, and health status of conservation targets in the Project area. The manuscript will describe how the assessment framework measures biodiversity health and the performance of restoration projects, and will include a recommended monitoring schedule for key indicators. Manuscript to be submitted for publication to San Francisco Estuary and Watershed Science.
6	PROJECT CLOSURE	35	36	Project Closure Summary Report and supporting information.

Comments

If you have comments about budget justification that do not fit elsewhere, enter them here.

The majority of the listed products will be presented as articles in peer–reviewed scientific publications and at conferences. We will pick a variety of journals to target managers (e.g., Environmental Management and Restoration Ecology), conservation practitioners (e.g., Biological Conservation) and ecologists (e.g., Ecology, Ecological Applications). Uncertainty in the time taken to publish articles means that scientific papers may not be accepted at the end of the project, however, drafts of all manuscripts

will be delivered as final reports by the projects end.

Budget Summary

Project Totals

Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights Of Way	Other Direct Costs	Direct Total	Indirect Costs	Total
$60,511	$24,203	$2,375	$0	$795,564	$0	$0	$500	$883,153	$220,791	$1,103,944

Do you have cost share partners already identified?
No.

If yes, list partners and amount contributed by each:

Do you have potential cost share partners?
No.

If yes, list partners and amount contributed by each:

Are you specifically seeking non−federal cost share funds through this solicitation?
No.

Measuring the Performance of Riparian Restoration Projects on the Sacramento River

Measuring the Performance of Riparian Restoration Projects on the Sacramento River

Year 1 (Months 1 To 12)

Task	Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights	Other Direct Costs	Direct Total	Indirect Costs	Total

							Of Way				
5: project management (12 months)	**15079**	**6032**	**400**	**0**	**0**	**0**	**0**	**100**	$21,611	**5403**	$27,014
1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS USING REMOTE SENSING DATA (12 months)	**2725**	**1090**	**0**	**0**	**222772**	**0**	**0**	**0**	$226,587	**56647**	$283,234
2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS (12 months)	**851**	**340**	**0**	**0**	**86176**	**0**	**0**	**0**	$87,367	**21842**	$109,209
3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB (12 months)	**851**	**340**	**0**	**0**	**42685**	**0**	**0**	**0**	$43,876	**10969**	$54,845
4: INTEGRATE NEW INFORMATION INTO ECOLOGICAL SCORECARD FRAMEWORK (12 months)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	$0	**0**	$0
Totals	**$19,506**	**$7,802**	**$400**	**$0**	**$351,633**	**$0**	**$0**	**$100**	**$379,441**	**$94,861**	**$474,302**

Year 2 (Months 13 To 24)

Task	Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights Of Way	Other Direct Costs	Direct Total	Indirect Costs	Total
5: project management (12 months)	**6911**	**2764**	**450**	**0**	**0**	**0**	**0**	**200**	$10,325	**2581**	$12,906
1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS USING REMOTE SENSING DATA (12 months)	**2820**	**1128**	**0**	**0**	**75939**	**0**	**0**	**0**	$79,887	**19972**	$99,859
2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS (12 months)	**881**	**352**	**0**	**0**	**89530**	**0**	**0**	**0**	$90,763	**22691**	$113,454
3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB (12 months)	**881**	**352**	**0**	**0**	**73966**	**0**	**0**	**0**	$75,199	**18800**	$93,999
4: INTEGRATE NEW INFORMATION INTO	**5797**	**2319**	**380**	**0**	**0**	**0**	**0**	**0**	$8,496	**2124**	$10,620

ECOLOGICAL SCORECARD FRAMEWORK (12 months)											
Totals	**$17,290**	**$6,915**	**$830**	**$0**	**$239,435**	**$0**	**$0**	**$200**	**$264,670**	**$66,168**	**$330,838**

Year 3 (Months 25 To 36)

Task	Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights Of Way	Other Direct Costs	Direct Total	Indirect Costs	Total
5: project management (12 months)	**6447**	**2579**	**485**	**0**	**0**	**0**	**0**	**200**	$9,711	**2428**	$12,139
1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS USING REMOTE SENSING DATA (12 months)	**2919**	**1168**	**0**	**0**	**44420**	**0**	**0**	**0**	$48,507	**12127**	$60,634
2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS (12 months)	**911**	**364**	**0**	**0**	**84296**	**0**	**0**	**0**	$85,571	**21393**	$106,964
3: DETERMINE THE CONTRIBUTION OF	**911**	**364**	**0**	**0**	**75780**	**0**	**0**	**0**	$77,055	**19264**	$96,319

RIPARIAN HABITATS TO RESTORING THE VELB (12 months)											
4: INTEGRATE NEW INFORMATION INTO ECOLOGICAL SCORECARD FRAMEWORK (12 months)	**12000**	**4800**	**660**	**0**	**0**	**0**	**0**	**0**	$17,460	**4365**	$21,825
6: PROJECT CLOSURE (2 months)	**527**	**211**	**0**	**0**	**0**	**0**	**0**	**0**	$738	**185**	$923
Totals	**$23,715**	**$9,486**	**$1,145**	**$0**	**$204,496**	**$0**	**$0**	**$200**	**$239,042**	**$59,762**	**$298,804**

Budget Justification

Measuring the Performance of Riparian Restoration Projects on the Sacramento River

Labor

Task 1–Year 1 Project Director I – 55 hours – $62,000/yr Program Manager I – 18 hours – $50,000/yr Program Assistant II – 18 hours – $36,000/yr Task 1–Year 2 Project Director I – 55 hours – $64,170/yr Program Manager I – 18 hours – $51,750/yr Program Assistant II – 18 hours – $37,260/yr Task 1–Year 3 Project Director I – 55 hours – $66,416/yr Program Manager I – 18 hours – $53,561/yr Program Assistant II – 18 hours – $38,564/yr Task 2–Year 1 Program Manager I – 18 hours – $50,000/yr Program Assistant II – 18 hours – $36,000/yr Task 2–Year 2 Program Manager I – 18 hours – $51,750/yr Program Assistant II – 18 hours – $37,260/yr Task 2–Year 3 Program Manager I – 18 hours – $53,561/yr Program Assistant II – 18 hours – $38,564/yr Task 3–Year 1 Program Manager I – 18 hours – $50,000/yr Program Assistant II – 18 hours – $36,000/yr Task 3–Year 2 Program Manager I – 18 hours – $51,750/yr Program Assistant II – 18 hours – $37,260/yr Task 3–Year 3 Program Manager I – 18 hours – $53,561/yr Program Assistant II – 18 hours – $38,564/yr Task 4–Year 2 Science Specialist II – 182 hours – $57,960/yr Task 4–Year 3 Science Specialist II – 364 hours – $59,989/yr Task 5–Year 1 Science Specialist II – 455 hours – $56,000/yr Director of Operations – 18 hours – $60,000/yr Office Services Administrator – 18 hours – $38,000 Task 5–Year 2 Science Specialist II – 182 hours – $57,960/yr Director of Operations – 18 hours – $62,100/yr Office Services Administrator – 18 hours – $39,330/yr Task 5–Year 3 Science Specialist II – 182 hours – $59,989/yr Director of Operations – 18 hours – $64,274/yr Office Services Administrator – 18 hours – $40,717/yr Task 6–Year 3 Science Specialist II – 16 hours – $59,989/yr

Note: Compensation shown represents annual average salaries for the position (weighted for the particular region) over 3 years (adjusted for expected increases in year's 2 and 3), not any employee's actual salary. Hours are estimates per year.

Benefits

40% for all categories.

Travel

Travel for task 4 in years 2 ($380)and 3 ($660) is for the purpose of conducting meetings with non−local experts for consultations on technical issues (indicator selections and rating values) Travel for task 5 in all years (Yr1−$400, Yr2−$450, Yr3−$485)is to cover allowable travel expenses for coordination meetings. This is necessary given that project participants live in different towns (indluding Davis, Novato, Chico) scattered about Northern California, and that the overall project is highly integrated.

Supplies And Expendables

none

Services And Consultants

TASK 1: MEASURE AND CHARACTERIZE RIPARIAN HABITATS TO SUPPORT ECOLOGICAL CHANGE ANALYSIS $253,131 is budgeted to: 1) Analyze new aerial photos to define channel and floodplain features important for vegetation, songbirds and the VELB in relation to water feature classification, channel position, and vegetation composition; 2) Analyze LIDAR data to define channel and floodplain features important for vegetation, songbirds and the VELB to obtain topographic/elevation data; 3) Analyze IKONOS data channel and floodplain features to characterize native and non−native plant species important for vegetation, songbirds and the VELB; and 4) Analyze the relative importance of different parameters for predicting the distribution and condition of vegetation communities. This work will be performed by professors Larsen and Greco and their students at U.C. Davis under a contract that will cover expenses for salary, travel, and supplies. $12,500 is to obtain IKONOS data for the Sacramento River Project Area. A contractor has not been identified to supply this product.

$15,000 is budgeted to obtain new high resolution aerial orthorectified photographs of the Sacramento River Project Area. A contractor has not been identified for this activity. $75,000 is budgeted for landcover to be mapped based upon analysis of these photos and ground truthing. A contractor has not been identified for this activity. TASK 2: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING BIRD POPULATIONS $260,002 is budgeted to: 1) characterize variation in bird population indicators across space, at three spatial scales: (i) the entire Project area, (ii) at a subset of sites with more extensive information on birds and the habitat attributes that influence bird populations, and (iii) within sites; 2) characterize variation in bird population indicators across time (between years, and extrapolated to longer time periods through modeling efforts described in this proposal); 3) compare riparian restoration sites with each other and with reference riparian sites in order to evaluate the contribution of restoration activities and characterize the value of one type of restoration project compared to others; and 4) determine contribution of restoration to current and future population viability of songbirds through establishing the linkage between information on avian abundance and underlying demographic processes (i.e., reproductive success and survival). This work will be performed by researchers Nur, Gardali, Howell, and Geupel at PRBO Conservation Science under a contract that will cover expenses for salary, travel, and supplies. TASK 3: DETERMINE THE CONTRIBUTION OF RIPARIAN HABITATS TO RESTORING THE VELB $192,431 is budgeted to: 1) Estimate the amount of VELB habitat that has been created; and 2) determine the occupancy of VELB in natural and planted habitats. This work will be performed by professor Holyoak and a post−doctoral researcher at U.C. Davis under a contract that will cover expenses for salary, travel, and supplies.

Equipment

none

Lands And Rights Of Way

none

Other Direct Costs

$500 in total for contracted printing and presentation supplies costs.

Indirect Costs/Overhead

The Nature Conservancy (TNC) has a Provisional Negotiated Indirect Cost Rate (NICRA) of 25% which was negotiated and approved by TNC’s cognizant agency, U.S. Department of Interior, and calculated in compliance with the requirements of OMB Circular A−122, and bound into our annual OMB Circular A−133 audit reports. TNC’s indirect cost per the NICRA includes salaries, fringe benefits, fees and charges, supplies and communication, travel, occupancy, and equipment for general and administrative regional and home office staff. These costs are reflected in the Indirect Costs category of this proposal and are not reflected anywhere else in the proposal budget. Direct staff costs are reflected in the salary and benefits categories of the proposal budget.

Comments

Environmental Compliance

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CEQA Compliance

Which type of CEQA documentation do you anticipate?
X none
− negative declaration or mitigated negative declaration
− EIR
− categorical exemption

If you are using a categorical exemption, choose all of the applicable classes below.
− Class 1. Operation, repair, maintenance, permitting, leasing, licensing, or minor alteration of existing public or private structures, facilities, mechanical equipment, or topographical features, involving negligible or no expansion of use beyond that existing at the time of the lead agency's determination. The types of "existing facilities" itemized above are not intended to be all−inclusive of the types of projects which might fall within Class 1. The key consideration is whether the project involves negligible or no expansion of an existing use.
− Class 2. Replacement or reconstruction of existing structures and facilities where the new structure will be located on the same site as the structure replaced and will have substantially the same purpose and capacity as the structure replaced.
− Class 3. Construction and location of limited numbers of new, small facilities or structures; installation of small new equipment and facilities in small structures; and the conversion of existing small structures from one use to another where only minor modifications are made in the exterior of the structure. The numbers of structures described in this section are the maximum allowable on any legal parcel, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.
− Class 4. Minor public or private alterations in the condition of land, water, and/or vegetation which do not involve removal of healthy, mature, scenic trees except for forestry or agricultural purposes, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.
− Class 6. Basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies. These may be strictly for information gathering purposes, or as part of a study leading to an action which a public agency has not

yet approved, adopted, or funded.
− Class 11. Construction, or placement of minor structures accessory to (appurtenant to) existing commercial, industrial, or institutional facilities, except where the project may impact on an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted pursuant to law by federal, state, or local agencies.

Identify the lead agency.

Is the CEQA environmental impact assessment complete?

If the CEQA environmental impact assessment process is complete, provide the following information about the resulting document.

Document Name
State Clearinghouse Number

If the CEQA environmental impact assessment process is not complete, describe the plan for completing draft and/or final CEQA documents.

NEPA Compliance

Which type of NEPA documentation do you anticipate?
X none
− environmental assessment/FONSI
− EIS
− categorical exclusion

Identify the lead agency or agencies.

If the NEPA environmental impact assessment process is complete, provide the name of the resulting document.

If the NEPA environmental impact assessment process is not complete, describe the plan for completing draft and/or final NEPA documents.

Successful applicants must tier their project's permitting from the CALFED Record of

Decision and attachments providing programmatic guidance on complying with the state and federal endangered species acts, the Coastal Zone Management Act, and sections 404 and 401 of the Clean Water Act.

Please indicate what permits or other approvals may be required for the activities contained in your proposal and also which have already been obtained. Please check all that apply. If a permit is *not* required, leave both Required? and Obtained? check boxes blank.

Local Permits And Approvals	Required?	Obtained?	Permit Number (If Applicable)
conditional Use Permit	–	–	
variance	–	–	
Subdivision Map Act	–	–	
grading Permit	–	–	
general Plan Amendment	–	–	
specific Plan Approval	–	–	
rezone	–	–	
Williamson Act Contract Cancellation	–	–	
other	–	–	

State Permits And Approvals	Required?	Obtained?	Permit Number (If Applicable)
scientific Collecting Permit	–	–	
CESA Compliance: 2081	–	–	
CESA Complance: NCCP	–	–	
1602	–	–	
CWA 401 Certification	–	–	
Bay Conservation And Development Commission Permit	–	–	
reclamation Board Approval	–	–	
Delta Protection Commission Notification	–	–	
state Lands Commission Lease Or Permit	–	–	
action Specific Implementation Plan	–	–	

other	–	–	

Federal Permits And Approvals	Required?	Obtained?	Permit Number (If Applicable)
ESA Compliance Section 7 Consultation	–	–	
ESA Compliance Section 10 Permit	–	–	
Rivers And Harbors Act	–	–	
CWA 404	–	–	
other	–	–	

Permission To Access Property	Required?	Obtained?	Permit Number (If Applicable)
permission To Access City, County Or Other Local Agency Land Agency Name	–	–	
permission To Access State Land Agency Name **California Department Of Fish And Game**	X	–	
permission To Access Federal Land Agency Name **U.S. Fish And Wildlife Service**	X	–	
permission To Access Private Land Landowner Name	–	–	

If you have comments about any of these questions, enter them here.

Representatives of the California Department of Fish and Game and the U.S. Fish and Wildlife Service are in support of our project and permits will be issued in advance of any field work being conducted.

Land Use

Measuring the Performance of Riparian Restoration Projects on the Sacramento River

Does the project involve land acquisition, either in fee or through easements, to secure sites for monitoring?
X No.
– Yes.

How many acres will be acquired by fee?

How many acres will be acquired by easement?

Describe the entity or organization that will manage the property and provide operations and maintenance services.

Activities proposed under this project involve no changes in land use.

Is there an existing plan describing how the land and water will be managed?
– No.
– Yes.

Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?
– No.
X Yes.

Describe briefly the provisions made to secure this access.

We will apply to the USFWS for a special-use permit before conducting research on this agency's lands. We have received permits from the USFWS for this purpose previously. We will request permission from CDFG to collect data on their lands. Although no permits are required to conduct research and monitoring activities on DFG lands, we will nonetheless keep Department staff appraised of our activities. Our project has the support of personnel at both of these agencies. We will

not conduct any research on private lands without the expressed written consent of the landowners. The success of this project is not dependent upon access being granted at any one individual property.

Do the actions in the proposal involve physical changes in the current land use?
X No.
– Yes.

Describe the current zoning, including the zoning designation and the principal permitted uses permitted in the zone.

Describe the general plan land use element designation, including the purpose and uses allowed in the designation.

Describe relevant provisions in other general plan elements affecting the site, if any.

Is the land mapped as Prime Farmland, Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance under the California Department of Conservation's Farmland Mapping and Monitoring Program?
– No.
X Yes.

Land Designation	Acres	Currently In Production?
Prime Farmland	**?**	**–**
Farmland Of Statewide Importance	**?**	**–**
Unique Farmland	**?**	**–**
Farmland Of Local Importance	**?**	**–**

Is the land affected by the project currently in an agricultural preserve established under the Williamson Act?
– No.
X Yes.

Is the land affected by the project currently under a Williamson Act contract?
– No.
X Yes.

Why is the land use proposed consistent with the contract's terms?

We have not calculated the exact acres, however some lands within the Project area are under Williamson Act contracts. Our monitoring activites will not affect land use in any way.

Describe any additional comments you have about the projects land use.

Activities proposed in this project will not alter land use.