Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

Project Information

1. **Proposal Title:**

   Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

2. **Proposal applicants:**

   Geoffrey Geupel, Point Reyes Bird Observatory
   Nadav Nur, Point Reyes Bird Observatory
   Mary Chase, Point Reyes Bird Observatory
   Grant Ballard, Point Reyes Bird Observatory
   Diana Stralberg, Point Reyes Bird Observatory

3. **Corresponding Contact Person:**

   Geoff Geupel
   Point Reyes Bird Observatory
   4990 Shoreline Highway Stinson Beach, CA 94970
   415 868-0655
   ggeupel@prbo.org

4. **Project Keywords:**

   Bioindicators and Biomonitoring
   Habitat Restoration, Riparian
   Ornithology

5. **Type of project:**

   Monitoring

6. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   No

7. **Topic Area**:

   Riparian Habitat

8. **Type of applicant:**

Private non-profit

9. **Location - GIS coordinates:**

   Latitude: 39.287

   Longitude: -121.780

   Datum:

   Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.

   This project involves the analysis of data from multiple locations along the Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers, as well as multiple tributary creeks. A table with details of all the site locations and a corresponding map are included in the proposal itself.

10. **Location - Ecozone:**

    3.1 Keswick Dam to Red Bluff Diversion Dam, 3.2 Red Bluff Diversion Dam to Chico Landing, 3.3 Chico Landing to Colusa, 3.4 Colusa to Verona, 3.5 Verona to Sacramento, 4.1 Clear Creek, 4.2 Cow Creek, 4.4 Battle Creek, 5.2 Lower Cottonwood Creek, 6.1 Stony Creek, 6.3 Thomas Creek, 7.1 Paynes Creek, 7.4 Deer Creek, 7.5 Big Chico Creek, 7.6 Butte Creek, 7.7 Butte Sink, 8.1 Feather River, 8.2 Yuba River, 8.4 Sutter Bypass, 9.2 Lower American River, 10.1 Cache Creek, 10.2 Putah Creek, 12.1 Vernalis to Merced River, 12.2 Merced River to Mendota Pool, 12.3 Mendota Pool to Gravelly Ford, 12.4 Gravelly Ford to Friant Dam, 13.1 Stanislaus River, 13.2 Tuolumne River, 13.3 Merced River, 11.1 Cosumnes River, 11.2 Mokelumne River, Code 15: Landscape

11. **Location - County:**

    Butte, Colusa, Fresno, Glenn, Kern, Kings, Madera, Merced, Sacramento, San Joaquin, Shasta, Siskiyou, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    No

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    2,3,5,11,18,19,20

15. **Location:**

California State Senate District Number: 1,4,5,6,12,14,16

California Assembly District Number: 2,3,5,8,10,17,25,26,29,30,31

16. **How many years of funding are you requesting?**

    3

17. **Requested Funds:**

    a) Are your overhead rates different depending on whether funds are state or federal?

    No

    If no, list single overhead rate and total requested funds:

    Single Overhead Rate: 29

    Total Requested Funds: $356,876

    b) Do you have cost share partners already identified?

    Yes

    If yes, list partners and amount contributed by each:

    David and Lucile Packard Foundation $67,669

    National Fish and Wildlife Foundation $13,694

    c) Do you have potential cost share partners?

    No

    d) Are you specifically seeking non-federal cost share funds through this solicitation?

    No

    If the total non-federal cost share funds requested above does not match the total state funds requested in 17a, please explain the difference:

18. **Is this proposal for next-phase funding of an ongoing project funded by CALFED?**

    No

    Have you previously received funding from CALFED for other projects not listed above?

Yes

If yes, identify project number(s), title(s) and CALFED program.

1999-B193	**McCormack-Williamson Tract Phase II Monitoring Program**	**ERP**
2001-C205	**San Joaquin River National Wildlife Refuge Riparian Habitat Protection and Floodplain Restoration Project Phase II**	**ERP**
1998-F15	**Lower Clear Creek Floodway Restoration**	**ERP**
2001-J200	**Genetic Identification of Management Units for Watershed-Dependent Species of Special Concern**	**ERP**
1999-B169	**Understanding Tidal Marsh Processes and Patterns**	**ERP**
1997-NO3	**Ecosystem and Natural Process Restoration on the Sacramento River: Active Restoration of Riparian Forest**	**ERP**

19. **Is this proposal for next-phase funding of an ongoing project funded by CVPIA?**

No

Have you previously received funding from CVPIA for other projects not listed above?

No

20. **Is this proposal for next-phase funding of an ongoing project funded by an entity other than CALFED or CVPIA?**

No

Please list suggested reviewers for your proposal. (optional)

Diana Craig	**USDA Forest Service**	**707 562 8930**	**dcraig01@fs.fed.us**
Reginald Barrett	**University of California, Berkeley**	**510 642 7261**	**rbarrett@nature.berkeley.edu**
Debra Schlafman	**US Fish and Wildlife Service**	**916 414 6464**	**debra_schlafman_fws.gov**
Dan Cooper	**National Audubon Society**	**626 395 7553**	**dcooper1@pacbell.net**

21. **Comments:**

Environmental Compliance Checklist

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

1. **CEQA or NEPA Compliance**
   a) Will this project require compliance with CEQA?

      No
   b) Will this project require compliance with NEPA?

      No
   c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

      This proposal does not include any on-the-ground actions. We propose to conduct analyses using data that have already been collected, or will be collected, under funding from other proposals and funders.

2. **If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies).** *If not applicable, put "None".*

   CEQA Lead Agency:
   NEPA Lead Agency (or co-lead:)
   NEPA Co-Lead Agency (if applicable):

3. **Please check which type of CEQA/NEPA documentation is anticipated.**

   CEQA
   -Categorical Exemption
   -Negative Declaration or Mitigated Negative Declaration
   -EIR
   Xnone

   NEPA
   -Categorical Exclusion
   -Environmental Assessment/FONSI
   -EIS
   Xnone

   If you anticipate relying on either the Categorical Exemption or Categorical Exclusion for this project, please specifically identify the exemption and/or exclusion that you believe covers this project.

4. **CEQA/NEPA Process**
   a) Is the CEQA/NEPA process complete?

      None

b) If the CEQA/NEPA document has been completed, please list document name(s):

5. **Environmental Permitting and Approvals** (*If a permit is not required, leave both Required? and Obtained? check boxes blank.*)

LOCAL PERMITS AND APPROVALS

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

Scientific Collecting Permit

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land.
Agency Name:

Permission to access state land.
Agency Name:

Permission to access federal land.
Agency Name:

Permission to access private land.
Landowner Name:

6. **Comments.**

Land Use Checklist

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

1. **Does the project involve land acquisition, either in fee or through a conservation easement?**

   No

2. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

   No

3. **Do the actions in the proposal involve physical changes in the land use?**

   No

   If you answered no to #3, explain what type of actions are involved in the proposal (i.e., research only, planning only).

   This proposal is for research and monitoring actions (i.e., data analysis, developing recommendations) only.

4. **Comments.**

Conflict of Interest Checklist

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

Please list below the full names and organizations of all individuals in the following categories:

- Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal or who will benefit financially if the proposal is funded.
- Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.
- Individuals not listed in the proposal who helped with proposal development, for example by reviewing drafts, or by providing critical suggestions or ideas contained within the proposal.

The information provided on this form will be used to select appropriate and unbiased reviewers for your proposal.

Applicant(s):

Geoffrey Geupel, Point Reyes Bird Observatory
Nadav Nur, Point Reyes Bird Observatory
Mary Chase, Point Reyes Bird Observatory
Grant Ballard, Point Reyes Bird Observatory
Diana Stralberg, Point Reyes Bird Observatory

Subcontractor(s):

Are specific subcontractors identified in this proposal? No

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

If yes, please list the name(s) and organization(s):

Stacy Small **University of Missouri and Point Reyes Bird Observatory**

Jeanne Hammond **Point Reyes Bird Observatory**

Comments:

Budget Summary

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

Please provide a detailed budget for each year of requested funds, indicating on the form whether the indirect costs are based on the Federal overhead rate, State overhead rate, or are independent of fund source.

Independent of Fund Source

Year 1												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Inventory and organize existing data, incorporate new data.	1039	23987	8156	0	1000	0	0	0	33143.0	9611	42754.00
2	Develop and validate predictive models.	1039	23360	7942	413	1000	0	0	0	32715.0	9487	42202.00
5	Project mnagement	173	4025	1369	0	0	0	0	0	5394.0	1564	6958.00
		2251	51372.00	17467.00	413.00	2000.00	0.00	0.00	0.00	71252.00	20662.00	91914.00

Year 2												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Inventory and organize existing data, incorporate new data	606	15152	5152	0	0	0	0	0	20304.0	5888	26192.00
2	Develop and validate predictive models.	1472	34649	11780	412	0	0	0	0	46841.0	13584	60425.00
3	Develop dynamic models.	866	21126	7183	413	0	0	0	0	28722.0	8329	37051.00
5	Project mnagement	173	4226	1437	0	0	0	0	0	5663.0	1642	7305.00
		3117	75153.00	25552.00	825.00	0.00	0.00	0.00	0.00	101530.00	29443.00	130973.00

Year 3												
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1	Inventory and organize existing data, incorporate new data.	606	15909	5409	0	0	0	0	0	21318.0	6182	27500.00
3	Develop dynamic models.	1386	33981	11553	412	0	0	0	0	45946.0	13324	59270.00
4	Evaluate bird monitoring strategy	953	22264	7570	825	0	0	0	0	30659.0	8891	39550.00
5	Project management	173	4437	1508	0	0	0	0	0	5945.0	1724	7669.00
		3118	76591.00	26040.00	1237.00	0.00	0.00	0.00	0.00	103868.00	30121.00	133989.00

Grand Total=356876.00

Comments.

Budget Justification

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

Direct Labor Hours. Provide estimated hours proposed for each individual.

Program Director- Geupel, 1039 total hours Project Leader- Chase, 3118 total hours Quantitative Ecologist-Nur, 1559 total hours Data Manager- Ballard, 1559 total hours GIS Specialist-Stralberg, 1212 total hours

Salary. Provide estimated rate of compensation proposed for each individual.

Program Director- Geupel; monthly rate $4813 Project Leader- Chase; monthly rate $3237 Quantitative Ecologist-Nur; monthly rate $5250 Data Manager- Ballard; monthly rate $4000 GIS Specialist-Stralberg; monthly rate $3149 A 5% cost of living increase is added for each individual in year 2 and year 3.

Benefits. Provide the overall benefit rate applicable to each category of employee proposed in the project.

All indviduals are full time employees and thus are assessed a benefit rate of 34% of their salary.

Travel. Provide purpose and estimate costs for all non-local travel.

For each task (2,3,and 4), we estimate 2 presentations at scientifc meetings at cost of $825 per task. This inlcludes food and lodging at $83 per night for 6 nights and 1000 miles at @$.325 per mile.

Supplies & Expendables. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies.

For tasks 1 and 2, $1000 per task is allocated to purchase newly-available GIS data and aerial photos and/or new software for statistical modeling, GIS analysis or image processing.

Services or Consultants. Identify the specific tasks for which these services would be used. Estimate amount of time required and the hourly or daily rate.

Not applicable.

Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than $5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items.

Not applicable.

Project Management. Describe the specific costs associated with insuring accomplishment of a specific project, such as inspection of work in progress, validation of costs, report preparation, giving presentatons, reponse to project specific questions and necessary costs directly associated with specific project oversight.

Program Director G. Geupel and Project Leader M. Chase will spend half a month per year ensuring standardization of data collection among the various sites, report preparation, and presentations of results at scientific meetings, Joint Ventures, and various land management agencies.

Other Direct Costs. Provide any other direct costs not already covered.

Not applicable

Indirect Costs. Explain what is encompassed in the overhead rate (indirect costs). Overhead should include costs associated with general office requirements such as rent, phones, furniture, general office staff, etc., generally distributed by a predetermined percentage (or surcharge) of specific costs.

Indirect cost is a project's share of PRBO's general and administrative cost. Its elements include: the salaries and benefits of general office staff, general office support costs (telephone/communications costs, copying costs, postage, office supplies, etc) facilities costs (rent, repairs & maintenance, utilities, taxes & licenses), outside services (payroll services, tax and accounting fees, etc), finance & insurance costs (liability/property/officers/accident insurance costs, bank charges), furniture/equipment/computers (if greater than $2,500, then current depreciable portion thereof; otherwise, total amount), and other general office/organization costs.

Executive Summary

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs. In California, riparian areas have been identified as the single most important habitat for the protection and conservation of songbirds. However, the loss and degradation of riparian habitats has had dramatic deleterious effects on riparian birds and other wildlife. Therefore, public and private organizations are investing millions of dollars in riparian habitat restoration, with thousands of acres slated for restoration along the Sacramento and San Joaquin Rivers and tributaries. However, there are still many scientific uncertainties about the most effective ways to restore and manage riparian habitat. In the face of such uncertainty, future restoration and management decisions can be optimized by evaluating the success of past management actions within an adaptive management framework. We propose to use existing data to develop and evaluate alternative models for how best to promote self-sustaining bird communities through riparian restoration and management. The Point Reyes Bird Observatory (PRBO) has been conducting intensive monitoring of riparian bird systems in the CALFED region since 1991, in partnership with federal, state, and non-profit agencies. Here we propose to synthesize the results of past and current research and monitoring across the entire CALFED region. Our goals are to identify the major factors influencing the success of hydrological, vegetation management, and restoration activities in providing habitat for self-sustaining bird populations, to develop recommendations for how such activities can best benefit breeding songbirds, and to evaluate the songbird monitoring strategy itself. To reach these goals, we will: 1) develop valley-wide predictive models that link bird population information with local and landscape scale habitat characteristics, restoration actions, and management; 2) evaluate whether these habitat relationships are constant over space and time, 3) develop population-dynamic models to explain the trajectory of bird responses to restoration and to assess population viability, 4) use this information to identify and validate region-wide and watershed-specific indicators of riparian habitat restoration success; and 5) test and revise existing restoration and management recommendations and monitoring strategies for the region.

Proposal

Point Reyes Bird Observatory

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and the evaluation of monitoring programs.

Geoffrey Geupel, Point Reyes Bird Observatory
Nadav Nur, Point Reyes Bird Observatory
Mary Chase, Point Reyes Bird Observatory
Grant Ballard, Point Reyes Bird Observatory
Diana Stralberg, Point Reyes Bird Observatory

Songbird population responses to riparian management and restoration at multiple scales: comparative analysis, predictive modeling, and evaluation of monitoring programs.

A. Project description

1. Problem

Riparian habitat is one of the most productive types of habitat in North America and supports a large diversity of aquatic and terrestrial wildlife (Knopf et al. 1988). In California, riparian areas have been identified as the single most important habitat for the protection and conservation of songbirds (Gaines 1977, Davidson 1995, RHJV 2000). In the Central Valley, however, it is estimated that at least 98% of riparian habitat has been lost over the past century and a half (Katibah 1984, Smith 1977). The loss and degradation of riparian habitats has had deleterious effects on riparian birds and other wildlife. The overall numbers and breeding range of some bird species have been drastically reduced in the CALFED region (e.g., Least Bell's Vireo, Yellow-billed Cuckoo), and many species that still breed in the region currently experience extremely low nesting success (Geupel et al. 1997, Table 1).

Public and private organizations are investing millions of dollars in riparian habitat restoration, with thousands of acres slated for restoration along the Sacramento and San Joaquin Rivers and tributaries. However, there are still many scientific uncertainties about the most effective ways to restore and manage riparian habitat. For example, at a local scale, managers need to know how many and which plant species should be planted to best promote healthy bird populations. At a broader scale, conservation planners need to know which types of adjacent land uses are compatible with a healthy riparian ecosystem. In the face of such uncertainty, future restoration and management decisions can be optimized by evaluating the success of past management actions within an adaptive management framework (Figure 1).

Birds are potential indicators of ecosystem health in general, and of riparian habitat quality in particular. This is because bird populations are sensitive to a number of important components of riparian ecosystem health, including the levels of primary and secondary productivity in the system, the structural and species diversity of vegetation, and the size and connectivity of habitat patches (Figure 2). In addition, bird numbers have been demonstrated to respond quickly and positively to some, but not all, habitat restoration efforts (Figure 3). Thus, bird population health is both a conservation goal in itself, and an indicator of the success of riparian habitat management and restoration.

We propose to use new and existing data to test alternative models for how best to promote self-sustaining bird communities through riparian restoration and management. PRBO has been conducting intensive investigations of riparian bird systems in the CALFED region since 1991, in partnership with federal, state, and non-profit agencies. Here we propose to synthesize the results of past and current research and monitoring across the entire CALFED region. Our goals are to identify the major factors influencing the success of hydrological, vegetation management, and restoration activities in providing habitat for self-sustaining bird populations, to develop recommendations for how such activities can best benefit breeding songbirds, and to evaluate the songbird monitoring strategy itself. To reach these goals, we will take advantage of existing data from several past PRBO projects and several ongoing CALFED-supported projects (Figure 4,

Table 2). All of these studies include a bird monitoring component (see Approach for details of individual projects). Here, we outline a plan for combining the results from these separate projects in a synergistic analysis of how best to promote self-sustaining bird communities.

The specific objectives of this project are: 1) to develop valley-wide models that link bird population information with local and landscape scale habitat characteristics, restoration actions, and management; 2) to evaluate whether these habitat relationships are constant over space and time, 3) to use this information to identify and validate watershed-specific and region-wide indicators and measures of riparian habitat restoration success; and 4) to test and revise existing restoration and management recommendations and monitoring strategies for the region.

2. Justification (model, hypotheses)

Conceptual model

Bird populations in riparian habitats are believed to respond to stressors such as human land conversion and altered hydrology via several mechanisms (Figure 2). Agricultural activities and urban development within floodplains may reduce the amount of riparian habitat available for birds, directly reducing population sizes. More indirectly, floodplain development also fragments and isolates remaining habitat patches and may affect the number and type of predators or parasites in the system (Robinson et al. 1995). This in turn interferes with the functioning of demographic processes, such as reproductive success and dispersal, that are crucial to maintaining bird population sizes and preventing local extinctions (Soulé et al. 1988). For example, several species of birds (Lazuli Bunting, Spotted Towhee, and others) are experiencing poor nesting success along the Sacramento and San Joaquin Rivers due to high levels of nest predation and parasitism by Brown-headed Cowbirds (Table 1). Preliminary analyses strongly suggest that these rates of nest failure are too high to allow populations to be self-sustaining (Geupel et al. 2001). Changes in hydrology and geomorphology caused by dams, levees and bank protection also affect the natural progression of plant community succession in riparian ecosystems (Goodwin et al. 1997). These changes in the structure and diversity of riparian vegetation influence resource availability, predator and parasite populations, and in turn the abundance and demography of songbirds and other wildlife dependent on riparian habitat (Klebenow and Oakleaf 1984, Griggs and Small 2000).

Restoration actions affect birds by mitigating the effects of land conversion and altered hydrology. For example, agricultural land adjacent to rivers can be re-planted with native riparian vegetation and natural hydrological processes can be mimicked by breaching levees or changing flow regimes. When riparian habitat is restored, the newly available resources can be used by recolonizing wildlife. PRBO's results from monitoring along the Sacramento River demonstrate that birds will return to some restored riparian sites (Figure 3). By monitoring the habitat use of individual species, PRBO has been able to make specific recommendations for improving future restoration projects (Small et al. 1999, RHJV 2000). However, poor reproductive success of species nesting in understory vegetation continues to be a critical problem for population viability (Table 1). A better understanding of how to promote higher reproductive success requires the synthesis of results from multiple sites and river systems which differ in crucial parameters such as the frequency of flooding, type of adjacent land-use and local habitat characteristics. To understand the long-term responses of birds to habitat changes, we

also need a basic understanding of the sources of background annual variation, including temperature, precipitation and other climatological factors.

Wildlife populations can be influenced by habitat features that vary over multiple spatial scales (Forman and Godron 1986). For example, birds breeding in Central Valley riparian habitat are likely to be affected both by the type of vegetation available within their territory, and by the type of land use that exists in the surrounding landscape. In this project, we will analyze bird responses to riparian habitat characteristics over three distinct spatial scales. First, we will examine the responses of birds to habitat variation within individual study sites, such as variation in the density of plants that are preferred as nesting substrates. Second, we will compare how birds respond to differences among study sites. For example, we will compare avian reproductive success and species composition among sites with remnant riparian habitat vs. planted restoration sites vs. passive (i.e., process-based) restoration sites, and among sites which differ in the type of adjacent agricultural land uses. Finally, we will also analyze bird population characteristics at the regional scale, by contrasting bird populations within several river systems.

Adaptive management model

The first step in the adaptive management process is to collect basic information on the management challenges in an ecosystem (Figure 1). This information can be used to model biological relationships, and these initial models are then used to make recommendations for management actions, including restoration efforts. The next steps are to scientifically evaluate the results of these actions and to use this information to evaluate the initial models and revise management recommendations. PRBO's work on the Sacramento River has been particularly valuable for both assessing the fundamental problems faced by birds in riparian habitat and in evaluating management actions. Results from this and other individual projects have been used to design recommendations for restoration and management in California's riparian habitats (RHJV 2000). Here, we propose to close the feedback loop of adaptive management (Figure 1) by testing these preliminary results across multiple river systems and by evaluating previous management recommendations. In addition, we will develop new models using the most complete and up-to-date data available. To achieve this, we will accomplish the following four tasks.

TASK 1. Inventory and organize data from eight intensive monitoring projects and three extensive monitoring projects into a single, easily queried, and accessible database. Incorporate data from ongoing projects.

This is the first step toward taking advantage of all available data on songbirds in the CALFED region. We will consolidate data from individual projects (Table 2) into a single, easily accessible database. We will present information from this database on a Web page, including site locations, the history of data collection at each site, the type of data available, and the contact person for each project. Information on CALFED-supported projects will be cross-linked with information from other projects of California Partners in Flight. This will assist land managers, project planners, and researchers in planning and implementing scientifically-sound management and restorations actions that will benefit riparian songbirds.

TASK 2: Develop and validate statistical, predictive models relating bird community and population parameters to habitat, landscape features, hydrology, and, ultimately, to management and restoration activities.

We will use all available data to evaluate the relative importance of local and landscape scale habitat attributes for bird abundance, species composition, and nesting success. Our primary focus will be on the effects of 1) riparian habitat characteristics that are influenced by management and restoration actions, and 2) the types of agricultural land use adjacent to riparian habitats. Including the relationship of riparian habitats to agricultural habitats is crucial because many restored habitats will be located adjacent to agricultural land. By focusing on those habitat features that can be influenced by management activities, or which may be useful in prioritizing sites for restoration, we will provide information that land managers can use in making management decisions.

Subtask A. Develop and validate valley-wide, multi-scale models relating population parameters of multiple bird species with vegetation and landscape characteristics.

The ultimate goal of riparian restoration is to recreate habitat that will support native species of birds and other wildlife. To reach this goal, habitat must be restored and managed with consideration for the primary demographic parameters and behaviors that determine the health of bird populations. Therefore, we will model bird community composition metrics such as species diversity and the distribution and abundance of individual species, but also the underlying processes such as nest site selection, and reproductive success. The local extirpation of Yellow Warblers, Song Sparrows, and Warbling Vireos from parts of the Central Valley is of particular conservation concern; therefore, one of the model sets that we will develop will relate their occurrence to local and landscape features.

Effects of Local Habitat Characteristics: First, we will test the hypothesis that songbird parameters are strongly dependent on the quality and quantity of understory and overstory vegetation in both restored and remnant habitats. By evaluating community composition, individual species abundance, and reproductive success we will be able to generate a more complete picture of how various species respond to riparian habitat and landscape context. We will also relate habitat characteristics to alternative management and restoration activities to determine how management and restoration affects birds.

In addition, we will examine the influence of spatial dependence (in terms of standard distance as well as linear creek distance) on population parameters and community composition. Spatial dependence may be related to the movements of individual birds over large areas, as well as underlying gradients in biotic and abiotic habitat conditions, including topography, soil, and vegetation. Controlling for spatial dependence will provide additional statistical rigor to our models, helping to separate the effects of geography from restoration parameters of interest.

Effects of Habitat Configuration and Landscape Context: Controlling for variation in local habitat characteristics, we will also address the effects of habitat configuration and landscape context on riparian bird communities. Given that riparian corridors are linear and naturally fragmented to a certain extent, we will develop fragmentation indices that are appropriate for this

system, rather than necessarily looking at traditional representations of patch size, shape and isolation. Although these factors are likely to be important for birds, we will focus on identifying the appropriate scale, and incorporate stream connectivity and watershed boundaries into measures of isolation and habitat fragmentation. Furthermore, we will look at alternative ways to quantify patch size that may be driven by floodplain characteristics, rather than the presence of woody vegetation *per se*. This will help land managers plan restoration projects so that the habitat configuration is optimal for supporting bird as well as fish populations.

In terms of landscape context, we will evaluate surrounding land use and land cover at a range of scales, including immediately adjacent land use as well as pattern and composition across larger areas. Land use composition and pattern may be particularly important for migratory species, which may cue in on larger landscape features, as well as species that move up-slope or to other upland habitats during the winter.

One landscape characteristic of potential importance is the amount and configuration of natural upland vs. various types of agricultural land uses, including row crops, orchards, rice fields, dry pasture, irrigated pasture and fallow fields. In addition, levels of urban and suburban development may be important factors in some areas. This can be analyzed at the local scale, by quantifying the prevalence of human structures, roads, and other development features (potentially through air photo interpretation), or by using GIS land use data to quantify larger-scale patterns.

In addition, we will develop appropriate landscape metrics to characterize differences in landscape pattern. Frequently used metrics include fractal dimension, mean patch size, total core area, Shannon's diversity and evenness indices, mean nearest neighbor distance, and contagion indices (McGarigal and Marks 1994). A suite of available landscape metrics will be evaluated and calculated as deemed suitable for the landscapes of interest. Due to the large number of study sites available for analysis, we will have the opportunity to compare across different landscapes, with sample sizes large enough to actually detect cross-landscape differences.

Subtask B: Evaluate whether the relationships modeled in Subtask A are consistent over multiple spatial scales, in order to identify the geographical scope of management recommendations.

Here we will test the hypothesis that birds may respond to habitat characteristics differently in different sites and river systems (Figure 5), and across years and climate cycles, and that these differences may be related to variation in flood recurrence intervals, as well as upland land use differences. The results of this “meta-analysis” will allow the management recommendation to be refined and specific to each river system.. We will also assess whether this relationship is influenced by other factors that may vary among sites within a watershed (e.g. cultivated vs. “passive” restoration sites).

We will also test the scale-dependence of habitat relationships by comparing results across progressively larger scales of aggregation—i.e., site, river system, and region. For example, some habitat characteristics may be important predictors of variation within a local population, but may be overshadowed by other factors (e.g., variations in land use, elevation, or climate

regimes) at the regional scale. This is important in determining appropriate management and restoration targets across the CALFED region, and separating site-specific recommendations from more general recommendations.

Subtask C: Evaluate riparian habitat restoration recommendations across the entire CALFED region.

PRBO's work at several intensive monitoring sites in the CALFED region from 1993 to 1995, focusing on the Sacramento River, was used to generate multiple recommendations for how to successfully restore habitat for riparian birds (Geupel et al. 1997, Small et al. 1999, RHJV 2000). In an adaptive management framework, these recommendations should be treated as hypotheses and subjected to further testing as they are applied throughout the region. This step in the adaptive management process allows the recommendations to be refined so as to increase their value to land managers and restoration planners. We will evaluate the recommendations in two ways: 1) by testing whether the habitat relationships on which they were based hold true with the addition of more years of data (1996-2005, and 2) by testing whether these relationships vary geographically. Much of the analysis used to evaluate the recommendations will be conducted in Subtasks A and B.

For example, an important result of PRBO's work along the lower Sacramento River was the finding of a positive association between shrub species diversity and bird diversity (Geupel et al. 1997). This led to the development of the recommendation that a minimum of two or more species of native shrubs or trees should be planted in cultivated restoration sites (RHJV 2000). Here, we propose to evaluate this recommendation at the scale of the entire CALFED region, by determining if this positive association is present in multiple river systems, or if it varies among river systems. This approach will be applied to a large set of hypotheses derived from the results of the multiple site-specific studies.

What follows is a list of the primary results that have been used to develop management and restoration recommendations for Central Valley riparian habitat. Many of these results are from PRBO's longest-running monitoring project along the Lower Sacramento River (Geupel et al. 1997, Small et al. 2000); here we propose to validate them by conducting similar analyses using data from later years and from multiple watersheds. Others are results of research in other ecosystems that have not yet been tested in the CALFED watersheds.

Bird Diversity:

- Increased diversity of shrubs, trees, and herbs is associated with increased bird diversity (Table 3).
- The presence of several specific plants is associated with bird diversity (Table 4).

Bird Species Distribution and Abundance:

- The retention of older trees in restoration sites is associated with the abundance and distribution of cavity-nesting birds.
- Patches of riparian habitat with links to other patches support more species of sedentary riparian birds than do isolated patches.

Nest site selection:

- Valley oak and native shrubs are preferred nesting substrates for Black-headed Grosbeak, Lazuli Bunting, Spotted Towhee, Western Kingbird and Western Wood-pewee.
- Native grasses and sedges are preferred nesting substrates for Common Yellowthroat and Spotted Towhee.

Avian reproductive success:

- Increased density of native shrubs, forbs and grasses enhances the reproductive success of understory-nesting birds (Table 5).
- The presence of willows and other native trees species enhances the reproductive success of riparian birds (Table 5).

TASK 3: Develop appropriate models to explain temporal and spatial variation in bird community and population parameters, especially as they pertain to restoration activities.

Subtask A. Estimate the trajectory over time of diversity, species composition, abundance, and demographic parameters in restored riparian habitat.

Here we propose to evaluate the responses of riparian birds to the creation of new riparian habitat. We will combine and contrast results from ongoing and new studies of 14 restoration projects along the Sacramento, San Joaquin, Cosumnes, and Mokelumne Rivers, and Clear Creek (Table 6). We will address the question of whether the responses of bird populations to restoration differ among sites or river systems, and analyze these differences in relation to alternative restoration techniques (e.g., cultivated restoration vs. passive, i.e., process-based, restoration).

Understanding the responses of bird populations to restoration and management activities over time also requires an understanding of background variation in bird population attributes (Inouye 1995). Therefore, we will also evaluate potential sources of inter-annual variation in bird population parameters. In particular, we will address the following areas of scientific uncertainty:

- What factors explain the high annual variation in nesting success?
- To what extent does annual climatic variation or large annual variation in flooding (e.g.,1997 and1998 floods) cause annual variation in bird population parameters?
- Is annual variation in nest success or adult survival correlated among sites? (i.e., is there spatial synchrony?)
- Do nest success and adult survival themselves covary?

Subtask B. Develop population-dynamic models, which incorporate and synthesize population parameter estimates, to explain the trajectories estimated in Subtask 3A and to assess population viability.

We will model bird demography (nest success and adult survival) in restoration sites and remnant riparian sites in order to evaluate whether Central Valley and Delta riparian restoration sites support viable populations of songbirds. Modeling will focus on four species that are widely

distributed in our study sites and for which we have sufficient data (Song Sparrow, Spotted Towhee, Lazuli Bunting, and Black-headed Grosbeak).

TASK 4: Evaluate multi-species bird monitoring program in the CALFED region.

Our ability to learn from the results of past restoration and management efforts depends in part on the identification of indicators of ecosystem health and the monitoring of these indicators over time. In addition, to develop an effective program of using birds as adaptive management tools, indicators must be validated and existing monitoring programs must be revised and extended based on scientific evaluations of their effectiveness (Noss 1990, Ringold et al. 1996).

It is probably impossible to conduct long-term, intensive bird monitoring at all riparian restoration sites due to logistic and financial constraints. Therefore, a comprehensive strategy must be developed that will include short-term or intermittent monitoring at many sites, and more intensive, long-term, constant monitoring at selected sites. Monitoring can be made more efficient by focusing efforts on a few selected species that can serve as indicators, but first the relationship between indicators and environmental conditions must be validated scientifically (Noss 1990). Also, data from initial monitoring efforts should be used to identify which monitoring techniques are most efficient and should be used extensively, and which should be used intensively at a subset of sites.

Subtask A. Identify which bird species are the best indicators of environmental quality/stressors and of overall bird population trends.

This will allow us to make recommendations for future monitoring programs. We will address the following areas of scientific uncertainty concerning the validity of indicator species:

- Should nest data be collected from multiple species or from selected species that may serve as indicators for their nesting guild (e.g. understory nesters, mid-low canopy nesters)?
- Are certain species better indicators at one spatial or temporal scale than others?
- Do different species respond to similar or different suites of habitat features?
- Which species are most consistent in their responses to environmental factors of interest?

Subtask B. Evaluate which combination of monitoring techniques is most effective and determine how can they be made more efficient.

Here we propose to evaluate the effectiveness of standardized point counts, nest searching, and mist netting protocols (as recommended by Ralph et al. 1993), and to make recommendations for the design of future monitoring projects. Land managers will be able to use this information to choose the type and level of bird monitoring that should be implemented in riparian habitats. Some of the specific areas of scientific uncertainty to be addressed are:

- Is information gathered by point counts (richness, diversity, relative abundance) correlated with variation in demographic parameters?

- Do mist-netting and nest monitoring provide comparable indices of the reproductive success of target species?
- What are the temporal and spatial scales over which these monitoring techniques should be implemented?
- What is the necessary sampling effort and for which species can sufficient sample sizes be achieved so that mist-netting can provide enough data to estimate survival values with sufficient precision to guide management?

3. Approach

Study Areas

Songbird monitoring has been conducted as part of nine projects (Table 2) located in the Sacramento, San Joaquin, Cosumnes, and Clear Creek river systems (Figure 4). Data collection is planned to continue at most of these locations for the duration of our proposed project, and these data will be added to our unified database as it is collected. At least six of these projects are funded by CALFED, or may be funded by CALFED in the future (with PRBO as a subcontractor); one project in a new location (Mokelumne River) is being proposed a separate PSP. These projects include the monitoring of 13 existing restoration sites and at least two proposed restoration sites (Table 6), as well as a number of remnant patches of riparian forest and some agricultural habitats.

Standardized methods were used to collect data on the abundance, distribution, breeding success, and survival of songbirds within each project area. The types of data available from each site for our synthetic analyses are outlined in Tables 2 and 6. Below we outline the methods used; more details can be found in Ralph et al.(1993) and Nur et al. (1999).

Standardized methods of data collection

The distribution and relative abundance of birds have been monitored extensively with point counts at each study site (Table 2). In this method, skilled observers record all birds detected within 50 m of each sampling station during 5 minutes of observation, and counts may be repeated up to three times per year. The point count method is a standardized and widely applied census method that also contains a vegetation assessment component. The point count method is used to monitor population changes of breeding landbirds over time and is the standard for obtaining information on the diversity and richness of birds in a given area. The vegetation assessment component can be used to relate changes in bird composition and abundance to temporal or inter-site differences in vegetation.

The breeding success of birds has been assessed using nest monitoring methods at numerous study sites in each river system (Table 2). This intensive method was conducted by biologists throughout the breeding season (approximately May through July). Nest monitoring measures breeding productivity, including such important components of individual fitness as nesting success, clutch size and the number of young fledged. Nest vegetation assessment has also been conducted at each site where nests were found, as well as at randomly-chosen locations within the same area, in order to identify habitat influences on breeding productivity and ultimately population health (Martin and Geupel 1993). The density of breeding birds was also surveyed using territory mapping methods at each nest monitoring plot, and at several additional restoration sites.

Finally, constant-effort mist-netting was implemented within each project area. At each site an array of 10 mist nets were opened and operated in a consistent manner, according to the methodology outlined in Ralph et al. (1993) and coordinated by the "MAPS" program (DeSante et al. 1993). In summary, nets were operated for five to six hours at each of the sites, beginning 15 minutes after local sunrise. Morphometric measurements were recorded, age and sex were determined, and all birds captured (except hummingbirds) received a USFWS aluminum band. Capture/recapture data will be used to assess productivity and estimate adult survival (Nur et al. 1999).

Preliminary data inventory

In summary, data on species abundance and distribution are available from approximately 1500 point count stations in the CALFED region. Available data on reproductive success include the results of monitoring over 900 nests along the Sacramento River, 1300 nests along the Cosumnes River, and over 250 nests along the San Joaquin River. Data on annual survival rates are available from approximately 20 mist-netting stations. Please see Table 2 for further details.

Statistical Analysis

Bird population data will be analyzed using standard statistical techniques, as detailed in Nur et al. (1999). Specifically, point count data will be used to calculate the species diversity, relative abundance, and probability of occurrence of bird species, and these values will be related to habitat features using regression analysis. Least-squares regression analysis will be used when data fit the assumptions of this method; otherwise, generalized linear models will be developed using appropriately specified distributions (e.g., logistic or Poisson regression).

Reproductive success will be analyzed using nest-monitoring data, with a focus on nest survivorship. Nest survivorship will be calculated according to the Mayfield method, and the probability of nesting success in relation to habitat variables will be analyzed with logistic regression. Mist-netting data will be used to calculate an additional index of reproductive success (based on the number of juvenile birds captured; Nur and Geupel 1993) and also to estimate adult survival using capture/recapture models (programs SURGE (Cooch et al. 1996) and MARK (Cooch and White 2001)).

We will use ArcView 3.2a (ESRI 2000) and Patch Analyst (Elkie et al. 1999) to quantify the landscape context of riparian study sites (e.g., adjacent land use and surrounding landscape composition), as well as floodplain extent and riparian habitat configuration (e.g., riparian width, patch size and distance to nearest mature riparian forest). GIS data sources include Chico State / DWR maps of the Sacramento River riparian habitat, DWR Central Valley land use maps, FEMA floodplain maps, and high-resolution digital elevation models from the Army Corps of Engineers, where available. USGS 3.25' digital orthophotos and other existing aerial photos will be used to update land use maps as necessary.

4. Feasibility

PRBO has been conducting long-term monitoring of terrestrial bird populations for more than 35 years. Ongoing programs at PRBO (Palomarin and Southeast Farallon Island Field stations) represent two of the oldest databases on landbird populations in North America.

Results of these studies have contributed significantly to current protocols now used to monitor and assess bird populations throughout the new world (e.g. DeSante and Geupel 1987, Pyle et al. 1987, Ralph et al. 1993, Geupel and Warkentin 1995, Geupel and Nur 1993, Martin and Geupel 1993, Nur et al. 1999). PRBO biologists have been instrumental in the development, standardization, and validation of the integrated methods of monitoring used for terrestrial birds (Nur and Geupel 1993, Silkey et al 1999,). The analyses and interpretation of bird monitoring data have also been the focus of recent publication by PRBO staff (Nur et al. 1999, Nur et al. 2000). Project staff are also well-versed in population dynamic models and population viability analyses (Nur & Sydeman 1999; Nur et al. 2001).

PRBO has been conducting intensive investigations of riparian bird systems in the Central Valley and its tributaries since 1991, beginning with the assessment of impact of the Cantara Spill (Nur et al. MS, in review). On the lower reaches of the Sacramento River, PRBO has been conducting integrated bird and vegetation monitoring since 1993 (Geupel et al 1997, Small et al. 2000) in partnership with federal, state, and non-profit agencies. Additional riparian bird monitoring projects have occurred throughout the valley in the following watersheds: San Joaquin (Ballard and Geupel 1999), Clear Creek (Gardali et al. 1999), Cosumnes (Haff et al. 2000), and the Lassen Foothills area. PRBO inventoried numerous other watersheds in 1998 and 1999 as a part of Packard Foundation-funded riparian bird initiative (Geupel et al. 1999).

Recommendations from these studies are currently being used by numerous agencies, including recipients of CALFED funded projects, to evaluate and adaptively mange riparian restoration (Griggs and Small 2000, Small et al. 2000) and have formed the basis of a statewide Riparian Bird Conservation Plan (RHJV 2000).

All data to be analyzed in this project was, and will continue to be, collected under the required permits from regulatory agencies. PRBO currently holds all applicable federal and state banding and collecting permits for the marking and handling of migratory birds (non-listed species) as well as research, special use, and similar permits from all principal land owners (USFWS, BLM, California State Parks, California Fish and Game, and The Nature Conservancy).

5. Performance measures

Evaluation of performance measures is a central component of this proposal, as discussed in Task 4 (Evaluate multi-species bird monitoring program in the CALFED region). In many ways, the proposed project is itself an evaluation of restoration performance and existing monitoring techniques. The adaptive management model outlined in Figure1 will be used to evaluate our own performance, as well as that of land managers, in preserving riparian bird populations.

In addition, we will seek peer review of all reports that are submitted for publication in scientific journals and use presentations at scientific meetings to solicit additional feedback from other independent researchers and managers.

Finally, statistical power analyses will be conducted to determine sample size requirements as described in Nur et al. (1999); results will be used to evaluate the statistical adequacy of our data and analytical methods and to develop future monitoring methods.

6. Data handling and storage

PRBO and project staff have extensive experience with data base management, in particular with the types of data described in the proposal. Data 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 www.prbo.org. PRBO maintains daily, weekly, and seasonal backup copies of all data collected as standard procedure.

7. Expected Products/Outcomes

Relevant results and recommendations for restoration and management of riparian habitat will be included in an updated version of the Riparian Bird Conservation Plan and in the semiannual publication *Flight Log*. The Riparian Habitat Joint Venture will provide the means to implement recommendations. Scientific presentations will be made at annual meetings of The Cooper Society, The Wildlife Society, and California Partners in Flight. All reports (see table below) will be submitted for publication in the journals of the above societies and other peer-reviewed scientific journals (e.g., Conservation Biology, Restoration Ecology).

TASKS	**Deliverables**
TASK 1: Inventory and organize existing data, incorporate new data.	On-line, queriable database of project information.
TASK 2: Develop and validate predictive models.	
Subtask A. Develop models.	Report: Analysis of riparian bird-habitat relationships.
Subtask B. Evaluate model consistency	Report: Geographical variation in bird-habitat relationships.
Subtask C: Evaluate restoration recommendations.	Report: New version of RHJV Riparian Bird Conservation Plan.
TASK 3: Develop dynamic models.	
Subtask A. Model response to restoration.	Report: Bird responses to habitat restoration.
Subtask B. Develop population dynamic models.	Report: Population models for four species of riparian birds.
TASK 4: Evaluate bird monitoring strategy.	
Subtask A. Validate indicator species.	Report: Avian indicators in riparian habitats.
Subtask B. Evaluate techniques.	Report: Monitoring recommendations for California riparian birds.

8. Work Schedule

Tasks will be conducted simultaneously over the entire 3-year grant period, with products delivered in each year (see table below, cross reference with deliverables above). All tasks and

subtasks are conceivably separable except Task 1 (necessary for all others) and Task 2, subtasks A & B. If project is not fully funded, it would be possible to incrementally fund the proposed work task by task in any order, assuming Task 1 was supported first.

TASKS	Start and Completion dates
TASK 1: Inventory and organize existing data, incorporate new data.	Initial inventory, database and website development: Sep 2002 – Sep 2003 Ongoing updates: through Sep 2005
TASK 2: Develop and validate predictive models.	
Subtask A. Develop models.	Oct 2002 – Oct 2003
Subtask B. Evaluate model consistency	Dec 2002 – Dec 2003
Subtask C: Evaluate restoration recommendations.	Sep 2003 – Sep 2004
TASK 3: Develop dynamic models.	
Subtask A. Model response to restoration.	Jan 2004 – Jan 2005
Subtask B. Develop population dynamic models.	Sep 2004 – Sep 2005
TASK 4: Evaluate bird monitoring strategy.	
Subtask A. Validate indicator species.	Sep 2004 – Mar 2005
Subtask B. Evaluate techniques.	Apr 2004 – Sep 2005
Project Management	March and September, all years: meetings with all PI's and field project leaders to coordinate existing and ongoing data collection to best support this project.
	Monthly, throughout: meetings with PRBO administrative staff to assure correct billing process and account management in relation to deliverables and funding cycles.
	Monthly meetings among PI's to ensure that deliverables are produced on schedule.

B. Applicability to CALFED ERP and Science Program Goals and Implementation Plan and CVPIA Priorities

1. ERP, Science Program and CVPIA Priorities

General ERP goals: The restoration of habitats that support sustainable population of diverse and valuable native animals is fundamental objective of the ERP program. This project proposes to use birds as indicators of the success of ecosystem restorations. By analyzing the habitat responses of multiple species of birds that are dependent on diverse and specialized micro-habitats, we will be able to evaluate the success of natural process restoration and management activities (Martin 1995). Furthermore this proposed project will identify the population parameters that support viable bird populations and, indirectly, other

less visible wildlife in the Sacramento river meander zone. Results will be compared to other riparian zones throughout the entire Bay/Delta watershed allowing adaptive management recommendations to be applicable to most watersheds. This project also addresses several specific areas of scientific uncertainty that directly influence the ability of CALFED projects to achieve the goals of the ERP.

Goal 1 of ERP: Understanding why some species are in decline and how they respond to ecosystem modifications is necessary to achieve recovery of at-risk species in the CALFED watershed. A multi-species approach to understanding the causes of population declines is valuable to prevent the need for future listing of endangered species. This proposal will provide information to assist the recovery of Yellow Warblers, a priority species in the Multi-Species Conservation Strategy (see Objective 2), and help enhance populations of a broad array of neotropical migratory birds (Objective 3).

Goal 4 of ERP: The ERP Draft Stage 1 Implementation Plan identified the relationship of upland areas to the riparian zone as an area where more work is needed to achieve the ERP goal of protecting and restoring functional habitat types in the Bay-Delta estuary and its watershed. This proposal will address Objective 2, which seeks to restore "sufficient connectivity" among habitats in the Central Valley; the proposed work will identify the degree and nature of connectivity needed to enhance riparian bird populations and communities. The proposed work will also help land owners "manage agricultural lands in ways that are favorable to birds and other wildlife."

General Science Program Goals: In addition, this project contributes to the overall goal of the CALFED Science Program: building a body of knowledge that can be used to improve the effectiveness of restoration actions and to track restoration progress. Specifically, this project evaluates the effectiveness of using birds as performance measures to track the success of restoration. The project is also explicitly designed to take advantage of existing data that can be used to support the adaptive management process, advance understanding of ecological processes, address landscape scale issues, and guide the extension of existing monitoring projects.

2. Relationship to other Ecosystem Restoration Projects

Bird monitoring has been included in only a few current ERP's, mostly to assess the presence/absence or relative abundance of selected species. In 2001 PRBO subcontracted with San Francisco State University on an ERP to investigate the use of molecular genetics to link populations of 4 bird species of special concern in the Central Valley. The Nature Conservancy and other agencies and private foundations have provided funding for intensive demographic monitoring on several existing CALFED projects (Tables 2 and 6). The proposed analysis will allow comparisons across existing CALFED projects in different watersheds. Results will provide information necessary to enhance and restore numerous bird (and indirectly other wildlife) populations dependent on valley riparian systems.

3. Requests for Next-Phase funding

Not applicable.

4.Previous recipients of CALFED or CVPIA funding
PRBO has had 8 'service contracts' with agencies receiving CALFED funding: The Nature Conservancy (project on Sacramento River); Sacramento River Partners (Sacramento River); University of California, Davis (McCormack-Williamson Tract, Cosumnes River); US Fish and Wildlife Service, San Joaquin National Wildlife Refuge; Northern Shasta Resource Conservation District (Clear Creek); San Francisco State University (Genetic Identification of Management Units throughout Central Valley); University of Washington (BREACH II: Tidal Marsh Project in Suisun and San Pablo Bays). PRBO has not been the lead agency or organization on any CALFED or CVPIA grants.

5. System-wide Ecosystem Benefits
The use of standardized data collection techniques allows the comparison of results across space and time, within and between river systems, throughout the CALFED region. Moreover, one of the strengths of this project is that it will address the question of whether factors influencing riparian bird population viability are consistent across river systems. Management recommendations generated by this study should have broad applications to the enhancement and restoration of birds and other wildlife populations in riparian systems not only throughout the Bay Delta watershed, but throughout California and other Western states (RHJV 2000).

6. Additional Information for Proposals Containing Land Acquisition.
Not applicable.

C. Qualifications

Geoffrey R. Geupel has a degree from Lewis and Clark College (BS Biology 1978) and has been employed as a biologist at PRBO for 21 years. He is currently Director of the Terrestrial Program at PRBO, has over 20 years experience in ornithological monitoring and research and has authored over 30 reviewed publications. Recent publications and presentations have helped define bird-monitoring protocols now used throughout North America. He has taught numerous technical workshops on bird monitoring and currently oversees 40 field biologists annually. Current areas of interest include breeding and 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 member of both the National Cowbird Advisory Council and Important Bird Area (IBA) National Technical Committee

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 quantitative and population ecologist for the Point Reyes Bird Observatory. In January 2000 he became the Directory of Population Ecology at PRBO. He is also an adjunct professor at San Francisco State University since 1998. 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, CDF&G, and

CALFED). 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 US Fish & Wildlife Service. He has served on two working groups of the CMARP arm of CALFED.

Mary K. Chase received a Ph.D. in Biology from the University of California, Riverside, in 2001. She has authored several scientific articles on the population and community ecology of songbirds, including an evaluation of bird and small mammal species as ecological indicators in California coastal sage scrub habitats. She has over 10 years experience conducting ornithological research within academic, government, and non-profit organizations. She currently is Terrestrial Program Science Coordinator for PRBO. Her research interests include: the determinants and consequences of natal dispersal and habitat selection; the effects of landscape fragmentation on individuals and populations; the identification and use of indicator and umbrella species in conservation planning; and the development and evaluation of multi-species habitat-management recommendations.

Grant Ballard has over fifteen years of experience with computer programming, database management and Geographic Information Systems. He received his BA from Cornell University in 1989 and has been responsible for the management of PRBO's databases (covering over 30 years of extensive ecological observations) since 1992. Grant is responsible for quality control and field methodology training for PRBO's terrestrial program and has authored or co-authored several scientific papers, reports, and avian conservation plans. He has been a member of the Riparian Habitat Joint Venture's technical committee, editor of the California Partners In Flight newsletter from 1996-1999 and has co-led biannual professional biologist field training workshops since 1995. Current research includes avian response to habitat variables in California's riparian systems and analyses of population trends from long-term monitoring data. For this project, Grant would continue to manage PRBO's databases, assist with statistical analyses, and integrate data into GIS and Web formats.

Diana Stralberg has been with PRBO as GIS Specialist for one year. She holds an MS in Resource Ecology and Management from the University of Michigan, and a BS in Mathematics/Applied Science from UCLA. Her research pursuits have focused on the effects of landscape pattern and composition on the distribution and abundance of landbirds in a variety of habitats, including southern California chaparral, foothill oak woodland and San Francisco Bay tidal marsh. In addition to pursuing research interests in landscape ecology and spatial analysis, Diana provides technical GIS and GPS support to PRBO biologists and coordinates map production for the organization. She has five years of experience with ArcInfo and ArcView GIS. Her current projects include a landscape analysis of San Francisco Bay tidal marshbirds, fine-scale mapping of tidal wetlands in southern San Francisco Bay, landscape and regional analyses of oak woodland bird distribution, and habitat suitability modeling for several additional projects.

D. Cost

1. Budget submitted in Web form.

2. Cost-sharing: PRBO has received funding from the David and Lucille Packard Foundation to continue its Adaptive Conservation Planning Program for California birds. These cost-share funds will be used for additional support of Task 1 and Task 2C.

E. Local Involvement

In the past decade, PRBO has developed strong working relationships with many local land conservancies, land management agencies, and educational groups in multiple project locations in the Central Valley. Our products will help guide their future management and restoration activities. The public will have access to our results on-line and through PRBO's ongoing local education projects. We are not aware of any opposition to our proposed project, which does not involve any on-the-ground actions.

F. Compliance with Standard Terms and Conditions

PRBO will comply with the State and Federal contract terms described in Attachments D and E of the 2002 PSP.

G. Literature Cited

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Table 1. Mayfield estimates of nest survivorship (S = the proportion of nests that successfully fledge at least one young), including mean and observed 'range', for 10 (of 26) species of open-cup nesters in the Central Valley.

Species	n	Mean S	range
Mourning Dove	78	0.16	0.06-0.25
Hutton's Vireo	25	0.07	0.05 -0.10
Common Yellowthroat	80	0.36	0.13-0.59
Lazuli Bunting	103	0.12	0.07-0.17
Blue Grosbeak	57	0.26	0.06-0.41
Black-headed Grosbeak	183	0.35	0.15-0.57
Spotted Towhee	309	0.23	0.20- 0.50
Song Sparrow	221	0.14	0.05-0.24

Table 2. List of past, ongoing, and proposed bird monitoring projects/locations in the CALFED region, specifying the data-collection effort for each measure of bird population health[1]. Projects that include CALFED-supported restoration actions are marked with *.

Project	Location	Years of Study	Status	Abundance/ distribution	Breeding Success	Survival
Lower Sacramento *	Sacramento River, between Red Bluff and Colusa	1993-2001	Ongoing, extension proposed	90-230 stations	4 sites	2 sites
Cosumnes*	Cosumnes River	1995-2001	Ongoing through 2004	81 stations	3-4 sites	2 sites
McCormack-Williamson Tract*	Cosumnes River	2000-2001	Completed	40 stations	_____	_____
San Luis NWR	San Joaquin River near Los Banos	1995-1997	Completed	69 stations	6 sites	2 sites
San Joaquin NWR*	San Joaquin River between Stanislaus and Tuolumne Rivers	2000-2001	Ongoing through 2004	66 stations	3 sites	2 sites
Clear Creek *	Clear Creek near Redding	1998-2001	Extension proposed	14 stations	2 sites	1 site
Mokelumne *	Mokelumne River and Murphy Creek		Proposed	115 stations	3 sites	2 sites
Lassen Foothills	Dye, Battle, Deer, and Mill Creeks	1998-2001	Ongoing	120 stations		
East Park Reservior		1997-1999	Completed	25 stations	1 site	1 site
Upper Sacramento	Sacramento River between Lakehead and Mt. Shasta City	1991-1997	Completed	100	4 sites (1993)	12 sites
CA PIF Survey	Sacramento, San Joaquin and tributaries	1998-1999	Completed	800 stations	_____	_____

[1] Past data collection funded by the following organizations: The Nature Conservancy, US Fish and Wildlife Service, Bureau of Reclamation, Natural Resource Conservation Service, CA Department of Parks and Recreation, Sacramento River Partners, National Fish and Wildlife Foundation, David and Lucille Packard Foundation, William and Flora Hewlett Fund, Dean Witter Foundation, CALFED ERP.

Table 3: Plant species diversity correlated with bird species diversity from point count data at all sites along the lower Sacramento River (1995).

Vegetation Variables	Correlation Coefficient (All Habitats)	Significance Level[1] (All Habitats)	Correlation Coefficient (Riparian)	Significance Level[1] (Riparian)
shrub species richness	0.658	***	.301	*
tree species richness	0.711	***	.309	*
herb species richness	0.214	ns	.269	*

[1] * = P<.01, ** = P<.003, *** = P< .001, ns = not significant.

Table 4. Specific vegetation variables correlated with bird species diversity from point count data at all sites along the lower Sacramento River (1995).

Vegetation Variable	Correlation coefficient	Significance level[1]
box elder shrubs	0.3038	***
box elder trees	0.3195	***
California black walnut shrubs	0.3855	***
California black walnut trees	0.4425	***
elderberry trees	0.2820	**
Fremont cottonwood trees	0.2844	**
Gooding's willow trees	0.2584	*
Himalayan blackberry	0.2986	***
mugwort	0.4101	***
native sedge	0.2791	**
valley oak	0.3385	***
wild grasses	0.2909	**

[1] * = P<.01, ** = P<.003, *** = P< .001, ns = not significant.

Table 5. Means of vegetation variables compared with nest outcome of five riparian open-cup nesting species at the Ohm and Flynn restoration sites on the Sacramento River (1994-1995).

Species	Vegetation Variable	Successful Nests	Unsuccessful Nests	P
Western Wood-pewee	tree species richness	3.00 ± .21	2.00 ± .45	.025
	shrub cover (%)	13.3 ± 4.26	34.2 ± 7.95	.029
	total green (%)	64.2 ± 8.11	88.7 ± 4.10	.002
	litter cover (%)	23.1 ± 7.47	2.38 ± 1.56	.002
	Fremont Cottonwood (#)	3.00 ± 1.03	.17 ± .17	.008
Lazuli Bunting	canopy height (m)	20.8 ± 1.49	9.29 ± 1.97	.002
	total green (%)	44.1 ± 14.4	72.0 ± 6.34	.019
	litter cover (%)	47.8 ± 17.5	21.0 ± 6.61	.026
	elderberry shrubs (#)	1.50 ± .96	.071 ± .071	.016
	Valley oak trees (#)	4.5 ± 2.72	.43 ± .71	.011
Western Kingbird	litter depth (mm)	30.7 ± 9.14	12.2 ± 5.82	.051
	willow shrub cover (%)	132.5 ± 63.8	0.0 ± 0.0	.052
Black-headed Grosbeak	grape cover (%)	45.0 ± 11.6	23.8 ± 7.97	.003
Spotted Towhee	mugwort cover (%)	8.89 ± 8.89	136.7 ± 55.3	.047

Table 6. List of riparian habitat restoration sites for which data is available on bird population characteristics.

Restoration Site	Years of Study	Watershed	Abundance/distribution	Reproductive Success	Survival
Tall Forest (cultivated site)	1995-2001	Cosumnes	Yes	Yes	Yes
Cottonwood Grove (process-based site)	1995-2001	Cosumnes	Yes	Yes	No
Valley Oak (cultivated site)	1995-2001	Cosumnes	Yes	No	No
Fallow field (process-based site)	1995-2001	Cosumnes	Yes	Yes (1999)	No
Wilson's section (process-based site)	1997-2000	Cosumnes	Partial	Yes (1997)	Yes
Hospital Creek (process-based site)	2000-2001	San Joaquin	Yes	Yes	No
Phelan Island (cultivated site)	1996-2001	Sacramento	Yes	Yes	No
River Vista (cultivated site)	1993-2001	Sacramento	Yes	Yes	No
Flynn (cultivated site)	1993-2001	Sacramento	Yes	Yes	Yes
Ryan (cultivated site)	1993-2001	Sacramento	Yes	No	No
Stony Creek	1995-2001	Sacramento	Yes	Yes	Yes
Reading Bar	1999-2001	Clear Creek	Yes	No	No
Phase 2	2001	Clear Creek	Yes	Yes	No
Lassen foothills (6 small sites)	1998-2001	Dye and Mill Creeks	Yes	No	No

Figure 1. Conceptual model of the adaptive management process.

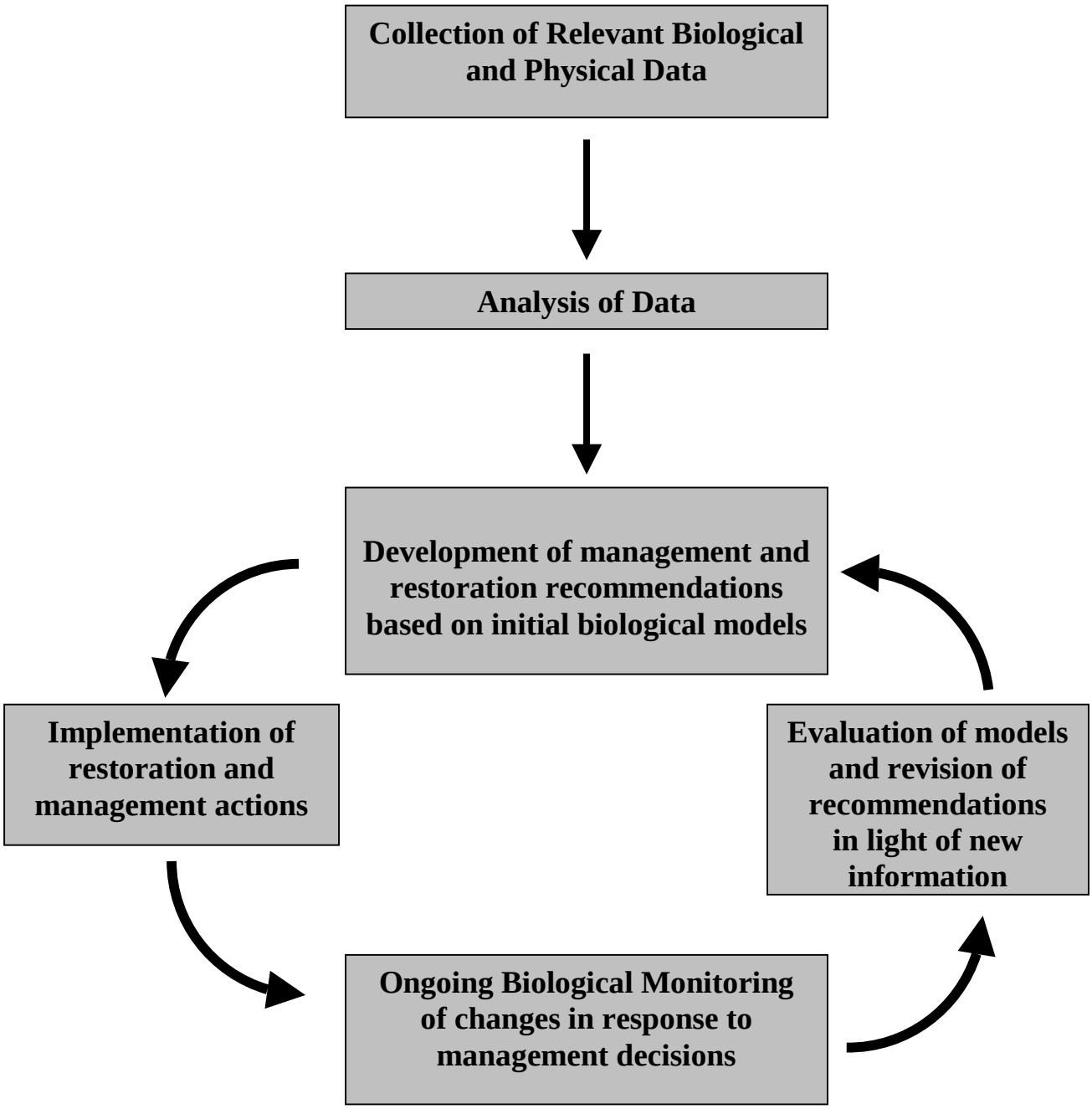

Figure 2. Conceptual model of the factors influencing bird populations in Central Valley riparian ecosystems. Adapted from Griggs and Small (2000).

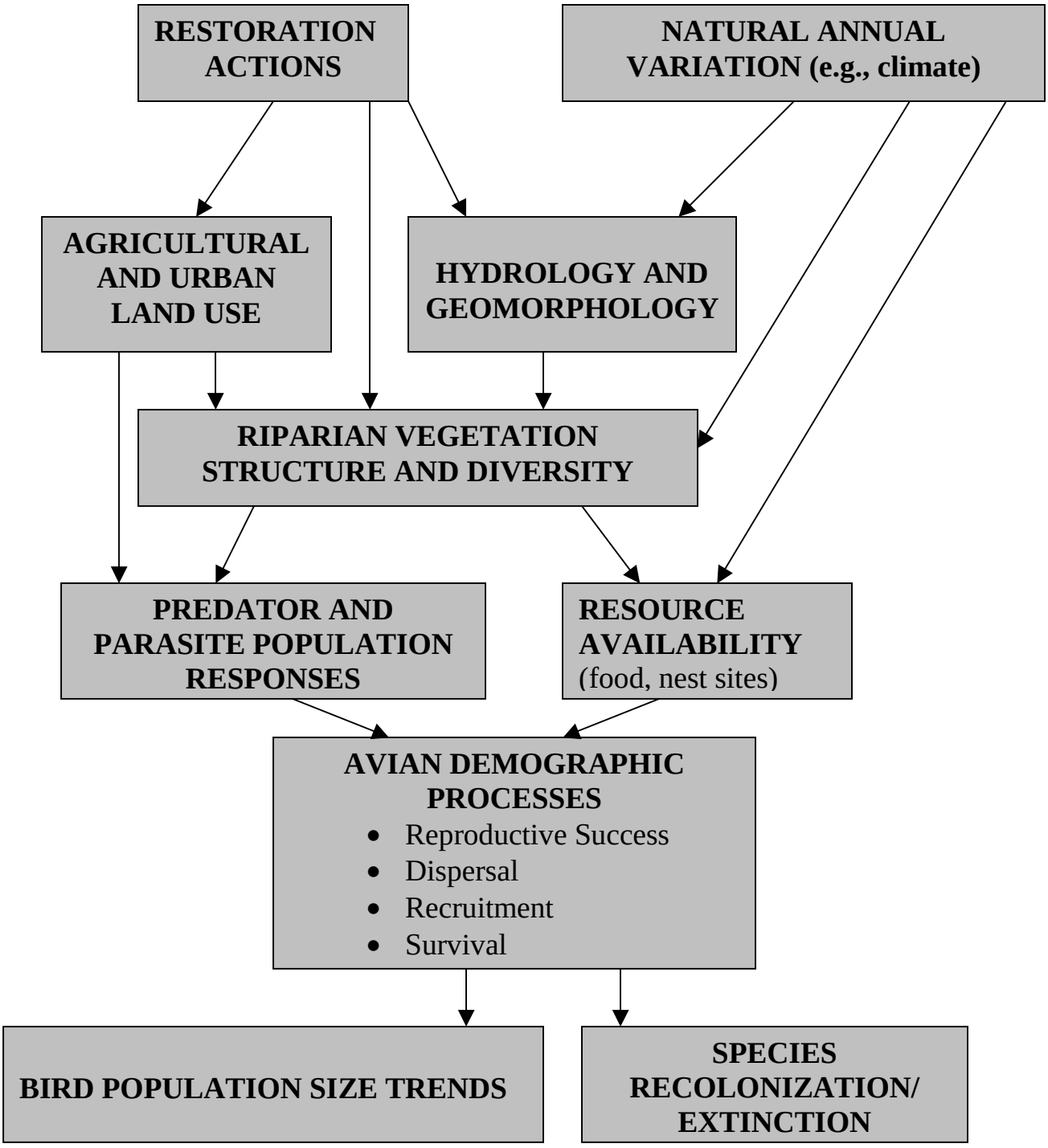

Figure 3: Overall riparian bird diversity (Shannon-Wiener index) and age (in years) on four Sacramento River restoration sites: Phelan Island, River Vista, Flynn, and Ryan (Sacramento River NWR). Data points represent mean annual diversity of individual point count stations. Data are jittered to allow individual points to be seen. Least squares line of best fit is shown. Data have been standardized to eliminate year effect. Based on point count data from 1994-1999.

Figure 4. Map of PRBO intensive monitoring projects and extensive survey sites (CA PIF Survey) in the Central Valley of California.

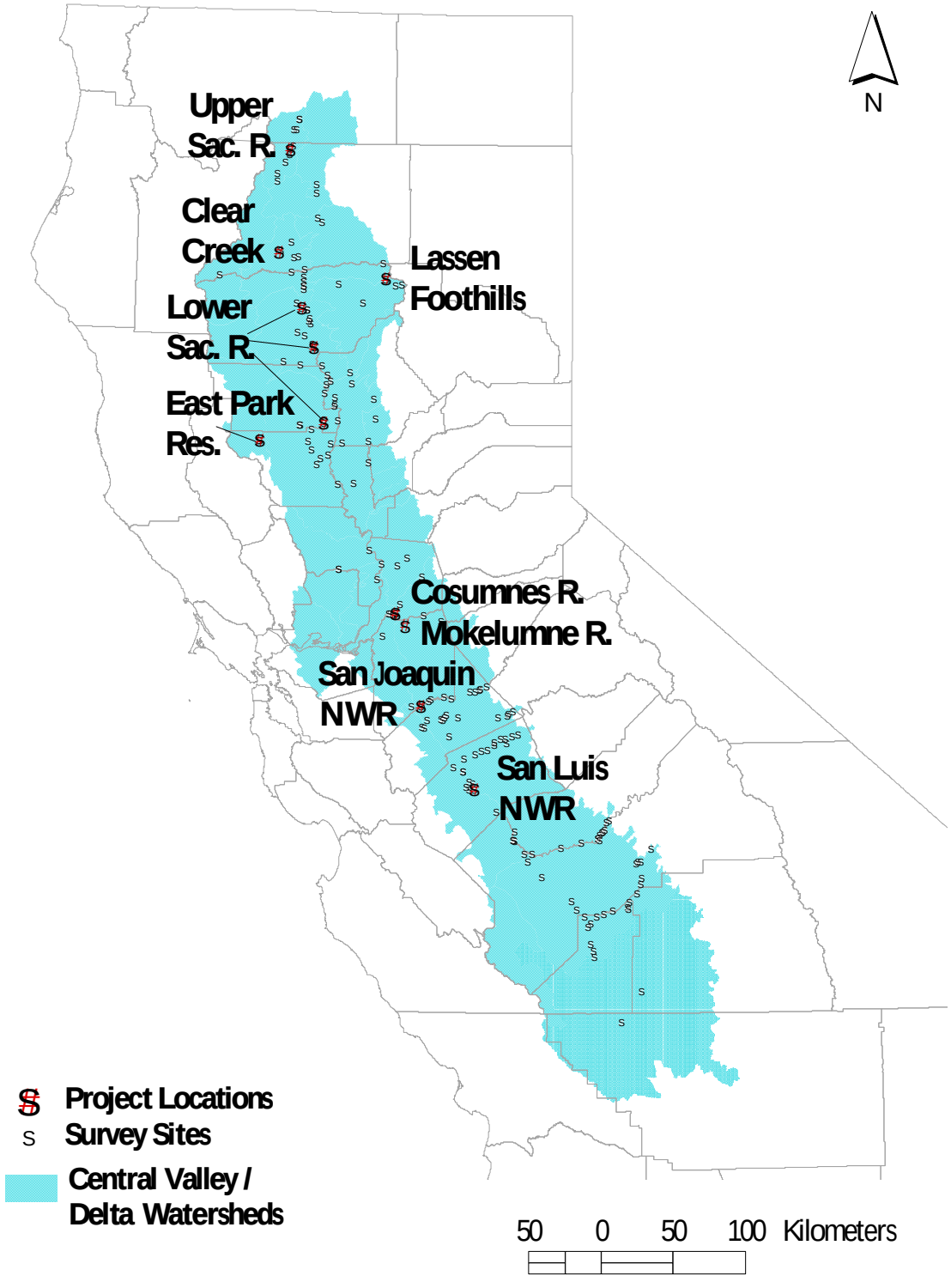

Figure 5. Relationship of maximum tree height on Spotted Towhee abundance in three study sites within the Central Valley. Slopes differ significantly, P<0.0001.