Summary Information

National Audubon Society

Monitoring ecosystem response and restoration implementation in western Sacramento Valley watersheds

Amount sought: $1,200,000

Duration: 36 months

Lead investigator: Jeanne Wirka, Audubon California

Short Description

This project will expand the monitoring efforts initiated during our Willow Slough Rangeland Stewardship Program (ERP−01−N31). We propose to monitor restoration actions carried out by Audubon−California (ERP−98−E13, ERP−01−N31), the Center for Land−Based Learning (ERP−02−P11), the Solano Land Trust's Jepson Prairie Preserve (ERP 97−N10, ERP−02−P21), and The Nature Conservancy's Lassen Foothills Project (ERP−02−P26). The monitoring program is based on a conceptual model that takes a dual approach to measure indices of ecosystem response across landscape units while at the same time assessing restoration implementation at the project level.

Executive Summary

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Audubon−California's Landowner Stewardship Program proposes to expand the monitoring efforts initiated during our Willow Slough Rangeland Stewardship Program (ERP−01−N31). We propose to monitor restoration actions carried out by Audubon−California (ERP−98−E13, ERP−01−N31), the Center for Land−Based Learning (ERP−02−P11), the Solano Land Trust's Jepson Prairie Preserve (ERP 97−N10, ERP−02−P21), and The Nature Conservancy's Lassen Foothills Project (ERP−02−P26). The monitoring program is based on a conceptual model that takes a dual approach to measure indices of ecosystem response across landscape units while at the same time assessing restoration implementation at the project level. We have assembled a team of researchers from U.C. Davis, the Institute for Ecosystem Studies, and Michigan State University to carry out six integrated research tasks across 15 different properties that encompass over 20 individual restoration projects. Our ultimate goal is to build a watershed−wide monitoring system, including a geo−referenced

data management system that integrates data at multiple scales, from different landscape units and properties to individual research sites and sampling units.

We will monitor four types of restoration activities in the Putah and Cache Creek Watersheds, Jepson Prairie Preserve, and the Lassen Foothills Project: 1) Range management, including prescribed fire and grazing; 2) Native perennial grasslands, 3) Riparian; and 4) Education and outreach aimed at increasing landowner participation and restoration success.

Goals

*Assess how well objectives for restoration actions are being attained.

*Develop indices to track ecosystem response to restoration actions.

*Better understand the invasion dynamics of weed species and how they affect ecosystem processes.

*Continue to monitor vegetation response to restoration actions.

*Identify necessary adjustments to prior restoration actions to better achieve project objectives.

*Integrate site specific data collection and analysis at a landscape scale to better understand the contributions of upland restoration actions to watershed health.

Tasks

*Utilize the recently−designed Willow Slough GIS, remote sensing tools and web−based delivery system to continue monitoring soil cover and ecosystem properties in restored and comparison sites as well as create a geo−reference data management system that integrates all proposed tasks.

*Monitor the potential of upland restoration and management sites to affect water quality and ecosystem health by investigating soil, water, and weed properties as indices of ecosystem response.

Monitor avian populations in riparian restoration sites.

*Expand monitoring of grassland sites to document “year effects,” evidence of sustained population establishment (e.g., flowering, seed production, seedling establishment),

correlates of restoration success, and response to management treatments.

*Determine the relative success rate and cost−effectiveness of establishing native trees and shrubs through direct seeding compared to the use of container stock..

*Assess the effect of education−based restoration on project success and landowner recruitment.

*Assess on−going restoration costs and continue to monitor restoration sites in cooperation with private landowners.

We expect the proposed project will demonstrate that different vegetation types, and the management practices applied to them, will vary substantially in their effect on ecosystem processes. It is also likely that the history of any given landscape patch will have strong effects on associated ecosystem properties. The proposed tasks will allow us to extend the monitoring accomplished to date to a longer timeframe and additional sites which will increase the validity of results. Finally, project−based monitoring will provide a detailed cost−benefit analysis of various restoration techniques to aid in project management decisions.

Measuring ecosystem response and restoration implementation in western Sacramento Valley watersheds

A. Project Description, Goals and Scope of Work

Audubon-California's Landowner Stewardship Program, together with the private landowners and research institutions with whom we work, proposes to continue and expand the monitoring efforts initiated during the second phase of our program (The Willow Slough Rangeland Stewardship Program, ERP-01-N31). We propose to monitor restoration actions carried out by Audubon-California (ERP-98-E13, ERP-01-N31), the Center for Land-Based Learning (ERP-02-P11), the Solano Land Trust (ERP 97-N10, ERP-02-P21), and The Nature Conservancy's Lassen Foothills Project (ERP-02-P26). Our approach combines measures of ecosystem response (effectiveness monitoring) with evaluation of restoration success (implementation monitoring) at both a landscape and a site-specific scale.

The specific ecological problems addressed by the projects we propose to monitor include: increased erosion, loss of soil cover, poor water quality, reduced infiltration rates and increased run-off, invasion by non-native species, loss of biodiversity, loss of native grassland and riparian habitat, degradation of forage quality, and low rangeland productivity. We will monitor and assess four types of restoration activities: 1) range management, including prescribed fire and managed grazing, to reduce invasion of non-native species, improve forage quality, and restore grasslands; 2) native perennial grasslands through seeding and management, 3) riparian restoration on seasonal streams in rangeland and permanent or semi-permanent waterways in farmland to increase wildlife habitat and improve water quality; and 4) education and outreach aimed at increasing landowner participation and restoration success. Each of our co-recipients of CALFED ERP funding have carried out one or more of these activities between 1999 -2004. Table 1 outlines the objectives and accomplishments to date, and status of each of these projects.

By monitoring similar restoration actions across a wide variety of landscape units and project sites, we aim to:

- assess how well the restoration actions are attaining their objectives;
- develop indices to track ecosystem response to restoration actions;
- better understand the invasion dynamics of weed species and how they effect both ecosystem processes and the outcome of restoration actions;
- continue to monitor vegetation response to restoration actions;
- identify whether adjustments to prior restoration actions are needed to better achieve their objectives; and
- integrate site specific data collection and analysis at a landscape scale to better understand the contributions of upland restoration actions to watershed health.

1. Problems, objectives, progress, and findings to date

Setting

Audubon's Willow Slough Program is located in Yolo County, Ecozone 10.4 Yolo Basin, Willow Slough, which lies in the greater Putah-Cache Creek watershed (Figure 1). The watershed includes the steep eastern slope and low-lying foothills of the inner Coast Ranges and the relatively flat alluvial plain of the southern Sacramento Valley. Audubon's Landowner Stewardship Program and the Center for Land-Based Learning (CLBL) are based in Solano County, adjacent to Putah Creek, near the town of Winters. Most of projects on which Audubon and CLBL partner through the Student and Landowner

Watershed and Environmental Stewardship Program (SLEWS) have been located in the larger Putah-Cache watershed. With its 2002 CALFED grant, however, CLBL has expanded the SLEWS program to two additional locations in the San Joaquin Valley and the Chico area, respectively. While Audubon and SLEWS do not work together on these programs, a north state SLEWS site (FVR, see Appendix 3 for complete list of project sites) has been selected to provide a north state comparison site.

The Jepson Prairie Preserve is managed by the Solano Land Trust to maintain a Central Valley vernal pool and native grassland system. The Preserve supports a wide diversity of native plants including a number of at-risk species. It is also home to a number of grassland weeds, including medusahead, perennial pepperweed and yellow star-thistle. Managers at the Preserve have been using burning and grazing to manage target vegetation and initiated a monitoring program in 1998 to document whether these activities were having the desired effect.

The Nature Conservancy's Lassen Foothills project encompasses an 830,000-acre project area in the northeastern corner of the Central Valley. The project extends eastward up 6 tributaries of the Sacramento River to the western slopes of Mount Lassen National Park. The long-term vision of the Lassen Foothills Project is to protect the viability of 11 upland and aquatic portfolio sites. The landscape is dominated by vernal pool grasslands, vast blue oak woodlands, deeply carved canyons, and clear spring-fed creeks. The upper watersheds of each creek extend up into the conifer belt and Mill Creek has the highest elevation salmon spawning in North America. The project area is remote and largely without roads, however, a week cattle market, an invasion of exotic weeds, and pressure to subdivide threatens this unique landscape (Rich Reiner, undated).

Problems

The 131,000 acre Willow Slough watershed is an important contributor to the health of the Bay-Delta ecosystem (ERPP, VII. pp. 341-353). In 1996, the Willow Slough Watershed Integrated Resources Management Plan (Willow Slough Plan) identified three major categories of resource problems: 1) lack of biodiversity and quality habitat for wildlife as a result of conventional land management practices; 2) degradation of water quality through sediment and nutrient loading; and 3) the resulting threats to agricultural sustainability in the region. At all of the sites in this study, rangeland resources have been degraded by more than 100 years of intensive sheep and cattle grazing and poor land management practices that have reduced diversity of plant species and cover, reduced infiltration and increased rainfall run-off, accelerated erosion, and degraded riparian habitats. Intensive farming practices have degraded water quality, severely reduced important riparian and wetland habitats, and increased flooding problems. The Willow Slough Plan further recognized that the upper and lower watershed resource problems are intimately tied to one another, so that only an integrated approach to managing watershed resources can improve overall ecological health (Jones and Stokes 1996).

Over 80 percent of land in Yolo County is devoted to agriculture, although the rate of loss of agricultural lands is increasing rapidly. Between 2000 and 2002, the farmland conversion rate in the County more than tripled (California Department of Conservation, 2004). As a result, farmers and ranchers recognize that land conservation is an important economic as well as ecological goal. Many agricultural landowners consider themselves to be stewards of the land and share the desire to maintain open space, habitat diversity, and water quality with conservation organizations and agencies. An area of shared concern continues to be the invasion of rangeland by grassland weeds, especially yellow star-thistle (*Centuarea solstitialis*), barbed goat grass *(Aegilops triuncialis*), and medusahead (*Taeniatherum caput-medusae*). Medusahead and yellow star-thistle have been an on-going problem at the Jepson Prairie and Lassen Foothills projects, respectively (Pollak and Kan 1996, Swiecki and Bernhardt 2002). These

species not only reduce cover and food resources for avian species and small game, but also alter ecosystem properties including rangeland productivity, soil and water dynamics, and nutrient storage (Knapp 1996). They have also proven to be an intractable problem in habitat restoration (DiTtomaso 2000, Carlson et al. 2000, Kyser and DiTomaso 2002). While there has been considerable success in controlling medusahead with prescribed fire and star-thistle with combinations of fire, herbicide, and grazing or mowing (Barrows et al. 1998; D'Antonio et. al. 2002, DiTomaso et al. 1999, Hatch et al. 1999, Menke 1980), our experience and a number of controlled studies have demonstrated weeds can reinvade within three years after eradication. Goatgrass remains a difficult weed to control, but some progress has been made using prescribed fire (DiTomaso *et al* 1999, 2001, Hopkinson et al. 1999).

Objectives and accomplishments to date of restoration actions

Restoration and/or management objectives for the Willow Slough program, Jepson Prairie and the Lassen Foothills project are listed in Table 1. While the majority of work in this proposal will be carried out at Willow Slough sites, Jepson and Lassen Foothills provide a unique opportunity not only to compare ecosystem response to restoration actions, but to begin to collaborate with other land managers and researches that are carrying out similar restoration actions in varying landscapes.

Table 1.

Restoration action	**Objectives**	**Accomplishments and status of projects to date**
Employ range management techniques such as fencing riparian areas, prescribed burning and managed grazing to reduce erosion, improve wildlife habitat, improve forage quality, reduce erosion and control non-native invasive weeds, and improve habitat in grassland and riparian areas.	Develop two whole ranch conservation plans that include prescribed fire, managed grazing. Coordinate prescribed grazing with landowners Apply prescribed fire to 1500 acres of invaded rangeland Reduce relative cover of target weeds species to 25% of former levels in one, two, or three years following prescribed fire.	AUDUBON: Two draft ranch conservation plans prepared; final plans to be completed by January 31, 2005. Grazing management programs applied at three ranches between 2001-2004. 1200 acres burned at five private ranches between 1999 –2004. Medusahead and yellow star-thistle reduced to below 25% pre-project levels, but increasing after 3 years.
Re-establish and manage native perennial grasses to restore wildlife habitat, improve forage quality, increase infiltration, reduce run-off, and filter nutrients.	Seed and manage 400 acres for perennial grass establishment Achieve 50% cover of native perennial grasses relative to other species guilds at seeded sites	AUDUBON: Seeded and managed 310 acres of perennial grasses between 1999-2004. One additional site to be seeded by December 2005. Percent cover at the more successful sites has been maintained at about 40 percent. Sites where grazing or exotic species were not managed after planting achieve much lower levels. (Continued on next page)

Restoration action	Objectives	Accomplishments and status of projects to date
Restore riparian habitat on seasonal streams in rangeland and permanent or semi-permanent waterways in farmland	Fence approximately 2 mile of riparian habitat in rangelands. Restore riparian vegetation on 2 miles of seasonal riparian habitat in rangeland. Restore 1 ½ miles of riparian habitat on permanent or semi-permanent waterways in farmland Achieve 50% survival of planted trees/shrubs by 2004	AUDUBON AND CLBL (SLEWS): Implemented 8 riparian habitat projects totally nearly 3 miles in rangeland. This included fencing 75 acres of riparian area at habitat for grazing management. AUDUBON AND CLBL have implemented nearly 1.5 mile of riparian habitat on sloughs or streams in farmland. Survival of trees and shrubs varies from approximate 30% at harsh rangeland sites to greater than 80% on farm sites.
Restore native perennial grasslands adjacent to Barker Slough and Calhoun Cut at Jepson Prairie Preserve (Solano Land Trust)	Develop an exotic weed control plan for : perennial pepperweed, yellow starthistle, medusahead, Eucalyptus, fennel, cocklebur and lippia. Implement including prescribed fire, herbicide spraying, grazing, and mechanical removal	Medusahead reduced to very small levels or eliminated from pastures treated with prescribed fire. Medusahead on the prairie as a whole probably reduced to pre-1995 levels. Yellow star-thistle successfully controlled in burn plots. Perennial pepperweed increasing. Swiecki and Bernhardt 2002

Conceptual model and hypotheses

The monitoring program is based on a series of revisions to the original conceptual model that Audubon developed for the Willow Slough Rangeland Stewardship Program. The revisions take into account the findings of previous monitoring efforts and the additional questions that have arisen during implementation phases of the work. The original model posited that 1) successful implementation of conservation and restoration practices is best achieved through a community-based watershed stewardship program; and 2) conservation and restoration practices on individual farms and ranches will increase biodiversity and quality habitat for wildlife, improve water quality, control invasive non-native plants, and sustain the economic conditions for agriculture.

Implicit in this model is a recognition that eliciting positive ecosystem response from restoration actions on private lands in the agriculture landscape requires that restoration be scaled up from site specific to landscape efforts. However, restoration and monitoring efforts often focus solely on re-establishing a certain vegetation type at the project level, rather than the properties and functioning of the overall ecosystem at a larger scale. Yet, it is difficult to measure and interpret the contributions of restoration actions in a mixed-landuse landscape to watershed health because the effect of any single land patch is lost at this large scale.

Our revised conceptual model takes a dual approach that measures indices of ecosystem response across landscape units while at the same time assessing restoration implementation at the project level. Our goal is to build a watershed-wide monitoring system through collaborative research and the creation of a geo-referenced data management system that integrates data at multiple scales, from different landscape units and properties to individual research sites and even individual sampling units (e.g. plots, quadrats, transects). The conceptual model for this integrated approach is described in Figure 1. Hypotheses to be tested are included in the individual research plans in Appendix 3.

3. Previously-funded monitoring

Audubon's Willow Slough program included six monitoring tasks. Three of these were subcontracted to researchers at U.C. Davis (Andersen, Laca, and Young), one to the Agricultural Research Service (Griffith and Steiner), one to Michigan State University (Malmstrom). The remaining task was carried out by Audubon staff. This proposal would support continuation and expansion of the Malmstrom and Young contracts, as well as continuing the Andersen and Audubon monitoring programs in house. Findings of these previous monitoring studies are summarized in Table 2.

At Jepson Prairie, the Solano Land Trust conducted a baseline inventory of weed species on the Jepson Prairie Preserve conducted in 1996 identified the following species as the highest priority for control: perennial pepperweed, yellow starthistle, medusahead, Eucalyptus, fennel, cocklebur and lippia. The Solano Land Trust prepared a control plan and has implemented a variety of prescribed fire, grazing, herbicide, and mechanical removal since then. Phytosphere Research monitored vegetation response to these treatments in 2001-2002 (Swiecki and Bernhardt 2002). The monitoring showed that the variability of the soils, annual fluctuations in weather, and the variability of management treatments between pastures make it difficult to draw a cause-effect relationship between management and species composition. However, the monitoring is very effective in defining broad trends in both native and non-native species and allows SLT to identify newly establishing weed populations.

The Lassen Foothills project has implemented a comprehensive multi-scale monitoring program to based on a 900,000 acre GIS that includes: periodic geo-referenced landscape scale remote imagery; rangeland vegetation, livestock use, and rare plant monitoring; pre- and post fire vegetation monitoring; land ownership data base including conservation status and easement terms; and periodic updates of parcel data.

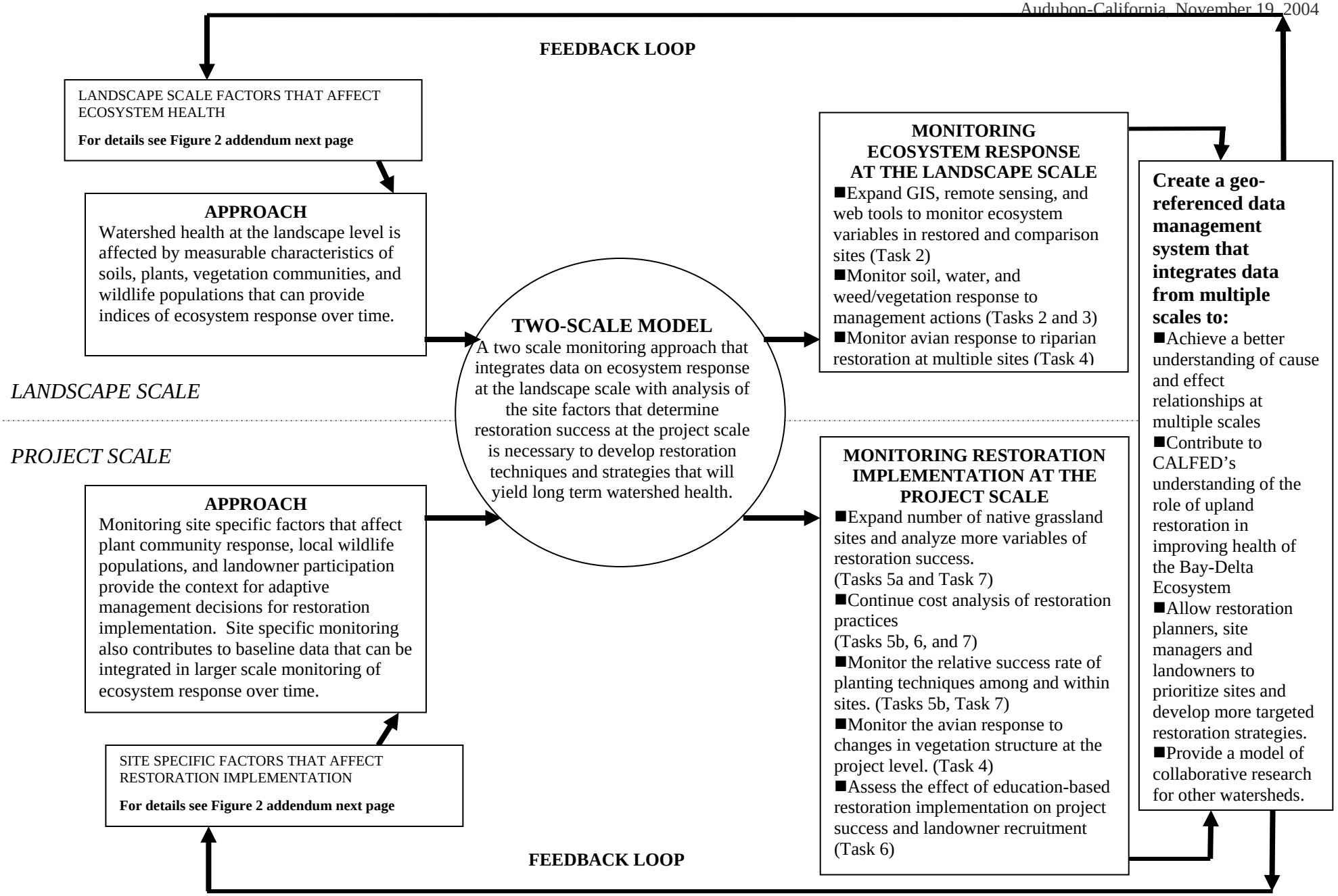

Figure 1: Conceptual model

Figure 2 addendum

LANDSCAPE SCALE FACTORS THAT AFFECT ECOSYSTEM HEALTH

- Upland sites are a major source of nutrient pollution in water bodies through leaching, runoff, and erosion (Carpenter et al. 1998, EBMUD 2001, Baron et al. 2003, Al-Kaisi et al. 2003).
- Erosion from upland sites is a major source of excess sediments in rivers (Baron et al. 2003, Al-Kaisi et al. 2003).
- Loss of riparian and grassland habitat further contributes to these problems and reduces wildlife abundance and diversity (WWF 2001).
- Invasion by non-native species reduces productivity of rangeland (Jacobson 1929, Ogle et al. 2003. Peters et al. 1996).
- Invasions may alter ecosystem properties in a manner that thwarts efforts to restore grassland and riparian habitats (Mack et al. 2000, Eviner and Chapin 2001).
- Habitat connectivity between restoration sites is constrained by the level of participation among landowners.
- Degradation of rangeland ecosystems reduces the economic viability of ranching, which may contribute to the pace of land conversion to urban uses, thereby further reducing water quality and wildlife habitat.

SITE SPECIFIC FACTORS THAT AFFECT RESTORATION IMPLEMENTATION

- Success of vegetation establishment varies among sites, much of which can be attributed to planting and management techniques (Clary et al., in revision; Lulow et al., in review).. Scaling up restoration projects will require more reliable, streamlined, and cost effective methods.
- Survival varies among species vary within sites individual sites (Lulow et al., in review). However, more information is needed to determine cause and affect relationships of biotic and abiotic factors that affect absolute and relative survival at the local scale.
- Evidence of sustained population establishment (e.g., flowering, seed production or seedling establishment) is lacking in many upland monitoring efforts (Benayo et al. 2004). . For long-lived species, recruitment failure may not express itself at the population level for many years; short-term monitoring may present an overly pessimistic (or optimistic) view of recruitment success.
- Planting order and year of planting can have significant short-term effects on the resultant plant community (Bakker et al. 2003, Lulow 2004). .
- Wildlife response to riparian restoration across sites is correlated with vegetation structure, but many restoration sites take years or decades to establish.
- High cost of restoration is a barrier to increasing landowner participation and the scale of projects.
- Landowner participation is influenced by non-economic factors such as stewardship values, public perception, and desire to educate youth.

Table 2. Research and monitoring funded through the Willow Slough Rangeland Stewardship Program (ERP-01-N31)	
	Findings
Ground-based monitoring of vegetation response to conservation and restoration activities Principle investigator: Jeanne Wirka, Audubon-California. 2003 annual monitoring report submitted November 2003. Final report pending project completion.	Tree and shrub survival at harsh rangeland sites much lower than valley sites; although much higher at sites at which the landowners participated in active management; survival was higher when metal cages were installed; rangeland survival where irrigation was unreliable averaged about 30%, compared with 70-80% at valley sites. Blue oak, live oak, and foothill pine had the highest survival rates across all the sites. Relative cover of medusahead was drastically reduced at all sites following prescribed fire, from between 23 to 36 percent relative cover to between 0 and 5 percent, meeting our objective of reducing relative cover to 25 percent of initial levels. However, that medusahead is on the increase three or four years post-fire, even at sites that have been seeded with native perennial grasses and managed with grazing. Yellow star-thistle was significantly reduced at two sites treated with prescribed fire and herbicide, from between 6 and 9 percent relative cover initially to between 0 and 1 percent. At these sites, the effect of fire alone can not be determined. Native grass seeding results varied across the sites. First year cover at two sites seeded in 2000 and 2002 was 39 and 41 percent, respectively and appears to be declining at the 2000 site. It is possible that the apparent decline is a result of sampling error and that cover values will rebound as the grasses mature. It may also be that the current management regime is not adequate to allow the native grasses to out compete annuals.
Using remote sensing to assess forage dynamics in a California rangeland restoration program Principal investigator: Dr. Carolyn Malmstrom, Michigan State University Final report submitted November 2004 Other publications: Web-based delivery system at: http://www.plantbiology.msu.edu/malmstrom/Audubon (note: all property-specific information is password protected to safe-guard landowners' privacy)	MSU conducted broad-scale monitoring in the Willow Slough watershed, using remote sensing and field surveys with high geo-precision. Monitoring data was entered into a GIS system and made directly available to watershed stakeholders through a user-friendly web site and individual trainings (see web address at left). These tools better permitted stakeholders to assess spatial and temporal patterns and make adaptive management decisions in response to environmentally-driven variability, as well as to compare the outcomes of different restoration activities. Extensive interviews with stakeholders found that this process led to an increasing interest and commitment to landscape-level analyses and data collection among the participants. We measured soil cover and the distribution of noxious weeds. Soil cover is a critical parameter in reducing erosion and improving water quality in upland systems. The amount of aboveground green biomass available in spring represents a soil cover resource that must be partitioned by land managers into forage for livestock and cover to be left standing (residual dry matter) to protect soils throughout the summer and the beginning of the

	subsequent growing season, when rains begin. The team also developed a cost-effective multi-temporal remote sensing approach for mapping medusahead and goatgrass and produced maps for the entire watershed, including restoration sites and untreated controls. In the overall evaluations of restoration sites and comparison regions, the team found that sites revegetated with perennial species (native grasses or clover) generally exhibited higher aboveground biomass levels in spring and fewer weeds than untreated sites, particularly if the revegetated sites were actively managed with fire or grazing. Sites treated with burning or rotational grazing alone showed more variable effects; short-term reductions in weed fractions were evident after prescribed burns, but the effect was not as long-lasting as revegetation
Correlates of successful native perennial grass establishment and enhancing biodiversity with native forbs in ecological restoration of annual rangelands Principal Investigator: Dr. Truman Young (with Megan Lulow and Jeffrey Clary), University of California at Davis. Final report submitted November 2004 Other publications: Lulow, M.E., T.P. Young, J. Wirka and J.H. Anderson. Effects of slope aspect and soil type on the success of seeded native grasses in a California grassland restoration project. Restoration Ecology, in review.	There are profound direct effects of the year of seeding on the relative success of grasses and forbs. Sites with richer soils can have very high rates of early restoration success. At harsh sites, establishment can appear low, but healthy stands may develop over time. Even a single follow-up management application can profoundly increase restoration success. Several native grass species have greater success on N-facing slopes than on S-facing slopes at harsh rangeland sites. *Nassella pulchra* is particularly successful in harsher sites, on S-facing slopes, and in the face of exotic annuals. This both reinforces its utility as a restoration grass, and raises questions about the validity of relict sites as reference communities for grassland restoration. Planting order can have large short-term effects on the resultant plant community. In particular, successful forb establishment only occurred in treatments where they were seeded a year before seeding with native grasses, at least in more mesic sites. There was also limited evidence for community convergence after three years, but only further monitoring will confirm its extent.
Evaluation of forage quality and selectivity by livestock of native perennial and introduced grasses. Principle investigator: Dr. Emilio Laca (with Amanda van Houtte and Lindsay Brenneke), U.C. Davis Final report submitted November 2004	There are no striking differences in chemical composition between annual forage grasses and native perennials when comparing the same plant parts, although *Lolium multiflorum* seems to be consistently better than the rest. Animal preference for *Nassella pulchra* is dramatically reduced during the flowering stage. Sheep do eat N. pulchra in the field even when at very low availability, but selectivity is variable and not at high as previously reported. Annual and perennial grasses require very different management, and management can be crucial to determine successful use of perennials.

Avian monitoring and assessment of perennial grassland and riparian restoration efforts in the Willow Slough watershed. Principle investigator: Dr. Daniel Andersen (with Jan Goerrissen), Wildlife and Fisheries Biology, U.C. Davis. Final report submitted November 2004	An avian monitoring program was established to compare the short-term (1-3 year) affects of grassland restoration on the bird community, as well as collect baseline data to monitor change over the long-term. Monitoring was conducted at project sites, as well as reference site with remnant fields of native grasslands. Due to the slow growth of native bunchgrasses in the harsh rangeland conditions, the effects of the natives, per se, could not be determined. However, monitoring at the remnant sites clearly demonstrated avian species richness and abundance to be greater in perennial grasslands than annual grasslands; with the strongest patterns observed in grassland specialist birds. Avian monitoring in riparian areas was conducted to collect baseline data to monitor long-term patterns of change within the avian community as plants become established and the sites develop a characteristic riparian structure. Greater avian species richness and abundance at comparison sites in mature riparian vegetation suggests, that given time, the restored sites will provide critical nesting habitat for resident and migratory birds. Brush piles were constructed in an open grassland to evaluate the efficacy of installing supplemental structure to provide habitat for birds until planted trees and shrubs could establish. Several bird species successfully nested in brush piles, and at least one species facilitated natural seed dispersal to the brush piles, resulting in natural recruitment of three native tree and shrub species. Establishment and growth of experimentally seeded trees was facilitated in brush piles.
Field-based research on soil and plant response to restored perennial grasslands versus non-native grasslands Principle investigator: Drs. Stephen Griffith and Jeffrey Steiner, USDA Agricultural Research Service, Corvallis, OR. Final report submitted November 2004	Although some results were inconclusive, this study yielded the following working hypotheses: Native perennial grasslands produce more above and below ground biomass per unit area and contain higher tissue N at season's end. Native perennial grasslands have higher soil N fertility. Native perennial grassland soils allow plant roots to absorb more soil bound water, especially under drier conditions and allow for more surface water infiltration which will help minimize erosion, especially on steeper hill slopes.

4. Approach and scope of work

Audubon proposes to expand the monitoring efforts initiated during the second phase of our program (The Willow Slough Rangeland Stewardship Program, ERP-01-N31). We have assembled an integrated team of research partners from the University of California at Davis, the Institute for Ecosystem Studies in Millbrook, New York, and Michigan State University in East Lansing, Michigan. The team will evaluate and assess restoration actions carried out by Audubon-California (ERP-98-E13, ERP-01-N31), the Center for Land-Based Learning (ERP-02-P11), the Solano Land Trust (ERP 97-N10), and The Nature Conservancy's Lassen Foothills Project (ERP-01-P26). A map of Audubon and CLBL sites and a full list of individual restoration project sites are given in Appendix 1. There are seven tasks in the scope of work. Tasks 1, 4 and 7 will be carried out by Audubon staff. Audubon will be responsible for subcontracting, overseeing, and coordinating all work and grant reporting, as well as serving as a liaison among individual researchers and between researchers and private landowners. Tasks 2, 3, 5, and 6 will be subcontracted to members of the research team. Our team will take a collaborative approach that measures indices of ecosystem response across landscape units while at the same time assessing restoration implementation at the project level (See conceptual model, Figure 1). We will create of a geo-referenced data management system that integrates data at multiple scales from each of the separate tasks. This integrated approach will serve as a model of how restoration and monitoring on private land might be conducted in a participatory way and replicated in other watersheds.

Task 1. Program management. Program Management includes all aspects of program oversight, such as supervision of work progress, fulfillment of contract reporting requirements, and invoicing associated with each task. It also includes coordination among researchers, landowners, partner organizations, local agencies, and other stakeholders. The program management budget includes general program expenditures (excluding service contracts), such as staff salaries, general program equipment, and travel.

Task 2. Using recently designed Willow Slough GIS and remote sensing tool and web-based delivery system to 1) to continue monitoring soil cover and ecosystem properties in restored and comparison sites in the Willow Slough Watershed and at Jepson Prairie and 2) create a geo-reference data management system that integrates tasks 2-7. During the first phase of this project from 2001-2004 (see Table 2 for results), Dr. Carolyn Malmstrom from Michigan State University led a team of field and technical experts at Michigan State University to conduct extensive broad-scale monitoring of restoration efforts across the Willow Slough watershed, using remote sensing and field surveys with high geo-precision. In addition, the team integrated the broad-scale monitoring data into a geographic information system and made that data directly available to watershed stakeholders through a user-friendly web site and individual trainings (http://www.plantbiology.msu.edu/malmstrom/Audubon). Multiple interviews with stakeholders (including private landowners) found that this process led to an increasing interest and commitment to landscape-level analyses and data collection. The information better permits stakeholders to assess spatial and temporal patterns and make adaptive management decisions in response to environmentally-driven variability, as well as to compare the outcomes of different restoration activities. The project produced a substantial amount of data indicating significant responses to restoration activities and developed in-depth working relationships with landowner participants. These data quantify short-term outcomes of restoration activities and form a valuable baseline for longer-term monitoring.

Among the most important ecological parameters monitored were components of soil cover (measured in spring as aboveground green biomass) and the distribution of noxious grassland weeds, including

medusahead and barbed goatgrass. Soil cover is a critical parameter in reducing erosion and improving water quality in upland systems. A primary aim of the project's GIS and web site was to allow land managers to evaluate the consequences of restoration efforts and other management activities on this ecosystem resource. The team also developed a cost-effective multi-temporal remote sensing approach for mapping medusahead and goatgrass and produced maps for the entire watershed, including restoration sites and untreated controls.

This task will use remote sensing techniques developed in 2001-2004 to extend monitoring from 2006-2008 to: 1) assess the longer-term effects of restoration activities on soil cover and other ecosystem properties important for water quality in the Willow Slough Watershed; 2) further integrate watershed information by assisting landowners and other scientists in making GPS-linked data acquisitions and coordinating the development of additional GIS data layers that can be used for richer analysis of watershed response; and 3) to improve the power and flexibility of the watershed webtool by incorporating new ability to simulate 3-D flights over the landscape. In addition, with the support of the Solano Land Trust, we propose to: 4) extend the remote sensing monitoring to include areas of recently-completed CALFED-supported grasslands work at Jepson Prairie.

At Willow Slough, the remote sensing measurements of soil cover and species composition that the MSU team developed will form the basis for stratified field sampling of soil properties influencing water quality (including erosion potential and nutrient loss), which will be conducted by Dr. Valerie Eviner from the Institute for Ecosystem Studies (see task 3, below). Dr. Eviner has extensive experience with these measurements in grassland systems and has previously collaborated with Dr. Malmstrom. In addition, species composition monitoring will be coordinated with Dr. Joseph DiTomaso from the U.C. Davis (task 3), who will lead efforts to monitor yellow star-thistle distribution. Extending these measurements to Jepson will be aided by the team's ability to reconstruct historical cover dynamics at that site from satellite imagery already processed for Willow Slough, because the two sites fall within the same Landsat scene (A full description of the approach, methods, and expected outcomes is given in Appendix 4A).

Task 3. Monitoring the potential of upland restoration and management sites to affect water quality and ecosystem health by investigating soil, water, and weed properties as indices of ecosystem response.

Restoration efforts often focus on reestablishing a certain vegetation type, rather than the properties and functioning of the overall ecosystem. A consideration of ecosystem processes is critical when assessing restoration projects because restoration efforts may greatly alter ecosystem processes that have large effects on water quality and quantity and may have limited success without accounting for how ecosystem processes alter vegetation dynamics. Audubon will contract with Dr. Valerie Eviner at the Institute for Ecosystem Studies and Dr. Joe DiTomaso at U.C. Davis to measure landscape patches differing in vegetation and management practices in order to assess the relative impacts of these landscape types on water quality, using soil processes as indices of impacts on water quality. We will address the following questions: How do ecosystem properties differ across vegetation types (remnant stands, restored sites, annual sites, invaded sites)?; How do ecosystem properties differ across sites within a vegetation type?; and, Are sites with certain ecosystem characteristics more amenable to successful restoration of natives, or more susceptible to invasions? This question will be determined by linking the ecosystem monitoring in long-term vs. short-term invaded and restored sites, with vegetation monitoring that is occurring at these sites by the rest of the team. We will likely only be able to get an

indication of this trend with this monitoring effort, but it could be a substantial contribution for future research aimed at maximizing the success of restoration efforts.

We will determine the present potential of sites to impact water quality using a number of measurements. Soil and plant samples will be collected seasonally from three locations within each site. To determine ecosystem characteristics in sites dominated by perennial bunchgrasses, there will be two samples taken from each of the five locations within a site- one sample directly under the bunchgrasses, and the second in between them. Percent area of bunchgrasses vs. between bunchgrasses will be estimated and combined with the ecosystem data to assess ecosystem processes in these stands on an area basis. We will monitor: nutrient content, potential for nutrient retention, and susceptibility of nutrient loss; ecosystem carbon storage, soil water dynamics, soil temperature and soil erosion potential. We will determine the present potential of sites to impact water quality and the mechanisms by which each vegetation type best protects against erosion. Negative impacts on water quality not only occur through erosion, but also through leaching of nutrients. We will quantify the amount of nutrients in each site that are highly susceptible to flow into groundwater or streams. Measures of nitrogen cycling rates will allow us to assess how tightly nitrogen is stored in the soil pool (and thus how susceptible N is to leaching during rainfall events). By measuring nutrient content in plants and soils, we will gain insights into where nutrients are stored in the ecosystems, and how susceptible they might be to loss due to every day events (e.g. gopher disturbance, grazing, rain storms), as well as occasional events (e.g. fire). A gradual buildup of soil organic matter and plant productivity might not necessarily have noticeable effects on water quality in the present, but could be indicators of trends that will have large impacts on water quality in the long-term. (A full description of the approach, methods, and expected outcomes is given in Appendix 4B).

Task 4. Avian monitoring in riparian restoration sites. Audubon will hire an avian monitoring specialist to collect baseline data on avian abundance, diversity, and breeding effort at riparian restoration sites in the Willow Slough watershed. These will be paired with nearby reference sites that represent the vegetation conditions of the project site prior to the implementation of the restoration activity. These data may then be used to monitor changes in the bird community during the establishment phase and evaluate whether the restoration project is creating new habitat for avian species. Avian monitoring will be conducted using a combination of standard methods. Relative avian abundance will be quantified using point counts and strip transects (described by Bibby et al. 1992, Ralph et al. 1993). We will use fixed radius point counts of 50m and five-minute duration for point count monitoring. The number of point count stations established within each habitat type will depend on the total area and spatial configuration of each habitat type. A minimum spacing of 250 meters between point count stations will used to attain independence of sampling points and minimize the probability of double counting individual birds. Point count stations will be positioned to sample all available habitat types, including transition zones between habitat types. Strip transects will consist of walking the distance between two adjacent point count stations during a fixed time interval and recording all birds observations within the habitat type that the transect line runs through. Point count and strip transect monitoring will be conducted during the first five hours of daylight and under favorable weather conditions (light winds, no rain or dense fog). During the breeding season, reproductive effort and success will be monitored by: 1) conducting territory spot-mapping (International Bird Census Committee 1970); 2) noting behaviors indicative of breeding such as adults carrying food or fecal sacs, or giving distraction displays (Sharrock 1976); or 3) observing recently fledged young (Vickery et al. 1992) (A full description of the approach, methods, and expected outcomes is given in Appendix 4C).

Task 5a. Expanded monitoring of grassland sites to document "year effects," evidence of sustained population establishment (flowering, seed production, seedling establishment), correlates of restoration success, and response to management treatments.

Establishing native grasses in rangeland has been the most intensively monitored restoration activity in Audubon's program. Early findings of studies carried out by Dr. Truman Young and his students at U.C. Davis (see Table 2) indicate that establishment of native grasses varies by species and is correlated with environmental variables and management techniques. Through this task, Audubon will build on our partnership with Dr. Young to continue our quantification of the relative establishment of native grass species in relation to specific environmental variables (e.g. slope, aspect, soils, and weed competition) and to build on the initial monitoring program by expanding it to additional restoration sites and addressing the following additional questions; 1) What are the effects of time since restoration on achievement of restoration objectives; 2) Are year effects (Bakker et al. 2003) evident in native grass restoration sites; 3); Do the timing and intensity of management treatments influence interactions between both native and exotic grasses and forbs; 4) Can patterns in native grass and forb coexistence be generalized to different soil types; 5) How does native grass cover respond to selected adaptive management techniques; and 6) are new individuals being recruited into planted populations.

The study will employ a random stratified design and use the pin-frame method to sample a wide range of natural and experimental variation across multiple restoration and reference sites. Plots will be stratified with respect to soil type, topographic position, and aspect. We will also monitor vegetation at three sites (each in a different soil type) that were exposed to the replicated fertilizer/herbicide treatments. Five to ten replicated plots will be sampled at each of the four treatment combinations within each of the three soil types, for a total of 60-120 plots. We will identify and permanently mark areas of infestations of weeds *(medusahead, goatgrass, filaree)* for specific monitoring. A pin frame will be used for accurate measure of aerial cover, counting first hits per pin for each species encountered. We will also record the frequency (in $0.25m^2$ quadrats) of all species. Density of planted perennial grasses will be quantified by counting plants in these quadrats. These individuals will be scored for flowering and seed production. Each plot will be searched for seedlings of planted species, and these will be measured and marked/tagged for future surveys. Surveys will be carried out four times per year. At all sites, representative soil cores will be taken for structural and elemental analysis, providing additional environmental variables for statistical analysis (A full description of the approach, methods, and expected outcomes is given in Appendix 4D).

Task 5b. Determining the relative success rate and cost-effectiveness of establishing native trees and shrubs through direct seeding on site as compared to the use of container stock

Our experience has shown that planting trees and shrubs from container stock can be prohibitively costly, time-consuming, and logistically difficult for large scale riparian restoration projects, especially those implemented by private landowners and at remote sites. In addition, there are rooting problem with container stock that may limit their efficacy in restoration settings (Halter et al. 1993; McCreary 1995, 1996; Welch 1997; see review in Young and Evans 2001). Establishing trees and shrubs directly from seed may offer a more cost effective, efficient, and ultimately more successful restoration strategy. Direct seeding has been shown to be at least as effective as container stock in the establishment of Valley Oak (*Quercus lobata*) (Young & Evans, in press). However, there is little information on the relative merits and cost-effectiveness of these techniques for the woody species frequently used in Central Valley and foothill riparian projects.

As an adaptive management technique, Audubon and the Center for Land-based Learning (CLBL) implemented an experiment at four riparian restoration sites beginning in the Fall of 2004 to monitor the

relative survival and cost effectiveness of planting seven tree and shrub species (not including oaks) from containers versus seed. We will contract with Dr. Truman Young at U.C. Davis to continue to monitor and assess the outcome of those planting experiments in the coming three years.

The experimental design pairs multiple replicates of container plants with directly seeded plants within a pre-existing restoration plan (i.e. these were not separate plantings). All seed was collected on site and scarified or stratified as necessary. Both the container and direct seeded plants in each pairing were planted on the same day into pre-augured holes and protected with a plastic tube (Tubex). Weeds are chemically controlled within a three-foot diameter areas around the tubes. Each pair receives the same amount of water via the same drip irrigation system and is under the same relative environmental conditions (such as aspect, shade, etc). In addition to the field experiments, we propagated container stock of each species from each site in the native plant nursery managed by the CLBL and Audubon. These plantings are testing the viability of the seed as well as providing a source for container plants from the same seed year to be planted in year 2. This second stage planting will allow us to determine whether the first round container plants benefited from the "head start" provided in the nursery. Data will be collected for three years and analyzed using two-way MANOVA for inter-correlated measures of plant success (height, diameter, growth rate) and LOGIT for categorical variables, such as mortality. Using project records, we will calculate the propagation, planting, and management costs of each species and stock type on a per plant basis, and compare these with field success, producing an estimate of cost-effectiveness for each (A full description of the approach, methods, and expected outcomes is given in Appendix 4D).

Task 6. Assessing the effect of education-based restoration implementation on project success and landowner recruitment

Audubon and the Center for Land-Based Learning developed a joint program in the fall of 2001 to engage high school students in habitat restoration projects that enhance classroom learning, develop leadership and make a positive difference for wildlife on the land. The Student and Landowner Education and Watershed Stewardship (SLEWS), with generous support of CALFED, has since expanded to two additional regions in Northern California, and conducts 100 field days a year, involving 18 schools, 25 teachers, and over 3000 students a year. In 2003, SLEWS received the Governors Environmental Leadership Award for excellence in pioneering effective new educational strategies. The benefits of involving students in restoration projects go far beyond education, however. With the exception of native grass and range management projects, Audubon partners with SLEWS to implement every restoration project we do with private landowners. It has been our observation that adding a SLEWS component to restoration projects has raised public awareness of restoration and increased landowners' involvement in their own projects. Not only do SLEWS landowners participate in field days with the students, but it appears that they take a much more proactive approach to stewardship of the site. In addition, SLEWS reduces implementation costs by substituting student volunteers for paid labor and it attracts funding sources outside the traditional restoration arena. We believe that this directly affects restoration success on private lands.

Audubon will contract with the Center for Land Based Learning and Dr. Cary Trexler with the U.C. Davis Department of Agricultural Education to assess the extent to which SLEWS (or other efforts that mesh education and restoration) favorably impact(s) landowner implementation and management strategies in a cost effective manner, and, the extent to which these types of efforts attract non-traditional sources of funding. Dr. Trexler will use a case study approach, which is characterized by the collection and presentation of detailed information about a particular participant or small group, and frequently include accounts of the subjects themselves (Merriam, 1998; Stake, 1995). The design requires an

interesting collaboration between those researching the benefits of the SLEWS program and those assessing the economic impact of restoration efforts. Data will be collected through surveys, interviews, and newspaper content analysis. In the tables below are the general area of research, the population to be studied, the specific data to be focused on, the data collection strategies and types of instruments, and method of data analysis. (A full description of the approach, methods, and expected outcomes is given in Appendix 4E).

Task 7. Cost assessment and post-implementation monitoring of vegetation response to conservation and restoration activities.

Audubon staff will continue to monitor restoration sites implemented throughout the six years of our program in cooperation with the landowners. We will continue to use methods outlined in our current Quality Assurance Project Plan (Wirka 2002), although we will work with our subcontractors to modify methods as necessary to maximize consistency among the monitoring efforts. Monitoring methods include: 1) photo monitoring at seasonal intervals, oriented from witness posts that have been established at all the sites listed in Table 2; 2) step-point or pin-frame monitoring of rangeland species composition and cover at sites treated with prescribed fire or seeded with native grasses treatments, and 3) census and assessment of woody shrubs and trees in riparian areas. Program staff will also assist our subcontractors with data collection as needed. Data will be into the GIS-referenced data management system described in Task 2. Data will be entered the same day as collected into an Excel data file backed up regularly. These data will later be imported into statistical packages (SAS, JMP, CANOCO) for formal analysis. Both the original data and the analyses will be archived in a form available to other researchers. In addition, we will continue the restoration cost assessment initiated during our previous grant (Subtask 3.8). Current cost assessments look primarily at implementation costs and the first 1-3 years of management costs. With some of the projects entering their sixth year, we will be able to get a more realistic picture of long term costs. This task will be coordinated with task 5b and task 6. We will also continue to cooperate with the Yolo County Resource Conservation District to disseminate cost information to landowners, agencies and the public.

5. Feasibility

Audubon has developed mutually-beneficial relationships among the landowners with whom we work, both on implementation and monitoring. Appendix 3 includes letters of support from landowners from whom we have asked permission to access their respective properties. The proposed work will require no permits nor be affected by any local ordinances or land-use restrictions. Individual research workplans contained in Appendix 2 address the feasibility of these components of the program.

6. Expected outcomes and products

We expect that this monitoring project will demonstrate that different vegetation types, and the management practices responsible for them, will vary substantially in their effects on ecosystem processes. It is also likely that the history of a given landscape patch will have strong effects on its ecosystem properties. The ground-based monitoring grassland, riparian, and project monitoring will allow us to extend the quantification accomplished to date to longer timeframes and additional comparison sites. The woody plant monitoring will not only provide a detailed cost-benefit analysis of the relative advantages of direct seeding versus container stock for several woody species, but will provide additional useful information about the restoration techniques that can maximized success of both kinds of plantings.

Specific outcomes of Task 2 include a enhanced geographic information system for the Willow Slough Watershed incorporating extended monitoring of ecosystem properties and the development of remote sensing layers to contribute to existing Jepson Natural Reserve GIS resources; 2) an enhanced, streamlined web-delivery of spring cover estimates; 3) an annual grasslands vegetation classification based on spectral imagery for Willow Slough and Jepson Reserve; 4) enhanced ability to predict potential soil cover provided from senescent vegetation in summer based on spring cover estimates; and 5) broad area estimates of ecosystem properties and response to restoration activities, derived from integrating landscape cover analysis and stratified measures of soil properties.

7. Data handling and storage

Our subcontract with Michigan State will yield a data management system into which all of the research data will be integrated in a form that facilitates data sharing among our team and eventually other researchers. Data handling and storage by our research subcontractors will be the responsibility of the subcontractor. Individual data handling and storage procedures are provided in the Appendix 2 workplan. Data collected by Audubon staff will be entered on the day it is collected into an Excel data file to be imported into statistical packages (SAS, JMP, CANOCO) for formal analysis. Audubon and the Center for Land-Based Learning recently adopted an office-wide data back-up system in which all hard drives are fully backed up every two weeks.

8. Public involvement and outreach

Audubon's Landowner Stewardship Program is well-rooted in the agricultural communities in Yolo and Solano County. We have built relationships with landowners for six years and frequently host landowner meetings, workshops, and field tours. In addition, Audubon and the Center for Land-Based Learning have established a regional "Farm and Nature Center" at the farm at which our offices are located. The Center hosts over 3000 visits a year, through classroom visits, workshops, and demonstration projects. We also have an excellent working relationship with several other local agencies and organizations, including NRCS, the Yolo and Solano Resource Conservation Districts, the Solano Land Trust, the Yolo Land Trust, and The Nature Conservancy. Because the bulk of our restoration work is carried out on private lands, the public is generally not able to visit the sites. However, the demonstration projects at the Farm and Nature Center provide an excellent opportunity for the public to learn about habitat conservation on farms and ranches.

9. Work schedule: The annual work schedule and list of deliverables is provided on the on-line forms and provided in Table 4, Appendix 2

B. Applicability to ERP Goals

The Willow Slough Watershed Rangeland Stewardship Program supports the "habitat vision" for agricultural lands presented in the ERPP (Vol. I p. 177) by encouraging agricultural management practices that improve wildlife habitat and support special-status wildlife populations and other wildlife dependent on the Bay-Delta. It also supports the major focus of the Yolo Basin Ecological Management Zone expressed in the ERPP (Vol. II. pp. 311-327) by increasing the health of its important ecological processes, habitats, and fish, wildlife species, and plant populations and makes substantial contributions to the health of the Delta. The program embraces the concept presented in the ERPP (Vol. II. p. 318) that "a change in land stewardship practices can correct the negative impacts while maintaining, and in some cases, improving the agricultural economic base." It also applies to the vision for the Willow Slough Ecological Management Unit by "integrating agriculture and natural habitats in a manner to

support ecological health." The ERPP (Vol. II. p. 321) states that the health of the Ecological Management Units of the Yolo Basin Ecological Management Zone "can be maintained and restored only with the active participation of local watershed groups, which include local landowners and concerned individuals".

The Willow Slough Watershed Rangeland Stewardship Program is applicable to these ERPP Goals:
Goal 1. At-Risk Species: The grassland, riparian and oak woodland habitats in the Willow Slough area provide important habitat for at-risk species. The activities implemented with private ranchers are intended to improve forage quality and availability throughout the year and increase habitat values for grassland and riparian wildlife species. Protection and enhancement of riparian habitats, and restoration of native perennial grassland habitats is expected to benefit the neotropical bird guild (Group IV) (Vol. I. p. 373), by increasing quality breeding and migratory habitats. Restoration of native perennial grassland is expected to improve forage diversity, and plantings of large overstory riparian trees species is also expected to provide nesting sites for California Swainson's hawks and other raptors (Group III) (Vol. I. p. 278). Fencing and revegetation of riparian corridors and habitat enhancement of stockwater ponds will include planting of Mexican elderberry (*Sambucus mexicana*), the host plant of the Valley Elderberry Longhorn Beetle (Group III) (Vol. I. p. 256).
Goal 3. Harvestable Species: Restoration activities of the Willow Slough Program will help to maintain and enhance populations of Central Valley upland game species (Group IV) (ERPP Vol. I. p. 424), and migratory waterfowl (Group IV) (ERPP Vol. I. p. 366) by improving habitat values for these species. Riparian enhancement and restoration of native perennial grasslands are expected to improve forage diversity and availability, and nesting habitat for migratory waterfowl (Group IV) (Vol. I. p. 366). Enhancement of waterfowl habitat is of high interest to recreational hunters in the area, and provides strong incentives for participation of private landowners in conservation and restoration activities. The ring-necked pheasant, wild turkey, dove, cottontail rabbit, which are also popular game for hunting in the region, would benefit from activities under the program.
Goal 4. Habitats: The program restores functional habitat types, especially riparian (ERPP Vol. I. p. 151 and Vol. II. p. 324) and perennial grassland habitats (ERPP Vol. I. pp. 36, 87, 172) on rangelands for public values. The proposed program establishes incentive programs to encourage landowners to establish and maintain perennial grasslands on their properties (ERPP Vol. I. p. 174); and implement intensive management programs to control non-native vegetation (ERPP Vol. I. p 174). The program improves rangeland management (ERPP Vol. II. p. 312), reducing livestock grazing in riparian zones (ERPP Vol. I. p. 156), and improving associated wildlife habitat values on agricultural land to support special-status and other wildlife (ERPP Vol. I. p. 177).
Goal 5. Non-native Invasive Species: Proposed restoration and conservation activities are designed to reduce the negative biological and economic impacts of non-native invasive species. We intend to demonstrate that range management techniques, including prescribed burning and livestock grazing can be used as large-scale restoration tools to control populations of non-native invasive range species and support habitat enhancements.
Goal 6. Sediment and Water Quality: The proposed activities are intended to improve water quality and reduce sediment flowing to waterways within the upper Willow Slough watershed and ultimately into the Bay-Delta system. Riparian fencing and revegetation of riparian corridors is expected to reduce nutrient and sediment loading by minimizing trampling of stream banks and defecation into streams by livestock. Sediment loading into upper watershed waterways will also be reduced through targeted experiments with biotechnical materials to control gully and streambank erosion.

C. Qualifications

Vance Russell, M.S. Landowner Stewardship Program Director. Vance has 17 years of experience in the conservation and natural resource management fields. Vance is one of the founding members of the Wild Farm Alliance and currently serves on the organization's board of directors. He also serves on the Management Board of the Central Valley Habitat Joint Venture. He co-authored "Wild Harvest – Farming for Wildlife and Profitability" which details the importance of conservation incentives for landowners. Vance received his M.S. degree in Forest Science and Natural Resources Management from Cornell University in 1996 and B.A. in Biology from the College of Wooster in 1987.

Jeanne Wirka, M.S. As the Restoration Ecologist for the Landowner Stewardship Program, Ms. Wirka has conducted extensive monitoring of grassland and riparian restoration projects and is responsible for submitting annual monitoring reports to CALFED. She seven years of experience in riparian and grassland restoration using native California species. She has an undergraduate degree from Harvard University and an M.S. in Ecology from the University of California at Davis, with an emphasis on plant community ecology.

Joseph DiTomaso, Ph.D. Extension specialist, Department of Vegetable Crops, UC Davis. Dr. DiTomaso received both his undergraduate degree in Wildlife and Fisheries Biology (1977), and his Ph.D. in Botany (1986) from UC Davis, where he has been a faculty member for 9 years. His primary focus is on the biology, ecology and control of weeds in non-crop environments, with emphasis on California. Dr. DiTomaso has been was named "Outstanding Weed Scientist – Public Sector" at the Western Society of Weed Science's (WSWS) annual meeting March 2004. The award is among the most prestigious awarded by the society and reflects the respect of DiTomaso's peers and colleagues. The award was based on DiTomaso's impact and contributions to weed science, weed management practices, and services to the Western Society of Weed Science and the people of California.

Valerie Eviner, Ph.D. Dr. Eviner holds a position as Assistant Scientist at the Institute of Ecosystem Studies in Millbrook, NY. She has a Ph.D. in Integrative Biology from UC Berkeley and a BA in biology from Rutgers. Among her primary research interests are the effects of plant species and communities on ecosystems, the ecology of invasive plants, sustainable agroecology, and grassland ecology. She is a recipient of The Nature Conservancy's Oren Pollak Grassland Research Award.

Mary Kimball, M.A. Director, Center for Land Based Learning. Ms. Kimball has been involved in agricultural education for 11 years. She was recently recognized by the College of Agricultural Science for outstanding leadership in her field. Ms. Kimball earned a B.S. degree in Agricultural Science and Management, with an emphasis in Plant Science, from the University of California at Davis, and a Master's Degree in Human and Community Resource Development from Ohio State University. She has 11 years of experience in project management, ranging from habitat restoration to agricultural and environmental education.

Carolyn Malstrom, Ph.D. Dr. Malmstrom has spearheaded work to assess forage dynamics with remote sensing in the Willow Slough watershed since 2001. Dr. Malmstrom will be the principal investigator for the on-going remote sensing and GIS work described in Task 2. She received an A. B. in Biology, magna cum laude, from Harvard College in 1987, and a Ph.D. in Biological Sciences from Stanford University in 1997. She has been an Assistant Professor at Michigan State University, Dept. of Plant Biology (formerly Botany and Plant Pathology) since 1999

Cary Trexler, Ph.D. Dr. Trexler is a faculty member in the UC Davis School of Education and holds a joint appointment in the College of Agricultural and Environmental Science. He has developed, assessed, published research on innovative educational programs and is skilled in social science research techniques. Professor Trexler is interested in the intersection of science, technology, and society in relation to the agri-food system. Specifically his research is focused on studying how people construct an understanding of the agri-food system and their understanding of the environmental trade-offs

involved in producing food. He has a PhD from Michigan State University and MS and BS degrees from Cal Poly San Luis Obispo.

Truman Young, Ph.D. Dr. Young is Assistant Professor Restoration Ecology, Department of Plant Sciences at UC Davis. He has been involved in Audubon's work in Yolo County since 1999 when the program started and continues to be involved in our grassland monitoring. He holds a B.A. from the University of Chicago and a Ph.D from University of Pennsylvania. His research interests include a broad range of plant population and community ecology. Current research emphasizes human dominated landscapes, rangeland management and habitat restoration.

D. Cost

1. Budget

This project was designed to integrate research at multiple scales, using a geo-referenced data management system to be designed by our subcontractor for Task 2 (Dr. Carolyn Malmstrom). Task 2 is therefore integral to the success of the project. Tasks 2 and 3 are also inextricably link as the three principle investigators (Dr. Malmstrom, Dr. Valerie Eviner, and Dr. Joe DiTomaso) have designed an integrated study. Tasks 1, 4, and 7 will be carried out by Audubon staff. If staff hours are not fully funded, tasks 4 and 7 will have to be eliminated or scaled back. Task 5 is a continuation of work initiated by Dr. Truman Young during our last CALFED contract and provides a unique opportunity to continue to monitor grasslands and riparian systems in a manner that yields important adaptive management decisions. Tasks 5 and 6, although integral to our conceptual model, do not have direct linkages with the other tasks.

2. Cost sharing

Cost sharing for this proposal comes primarily in the form of in-kind contributions from our research subcontractors and agencies with whom we partner locally. For task 4 (avian monitoring) we have received a pledge from an agricultural producer to fund a portion of a full-time position. Twenty-five percent of the position would be funded through this grant; up to 75% is very likely to be funded through the producer. A tabulation of in-kind cost share is supplied in the budget forms.

3. Long-term funding strategy

Audubon California is actively seeking funds from the Wildlife Conservation Board, the National Fish and Wildlife Foundation, the U.S. Fish and Wildlife Foundation, the Bureau of Reclamation, and a number of private foundations to continue our restoration work. We fully intend to incorporate on-going monitoring for every project funded.

E. Compliance with Standard Terms and Conditions

Audubon will comply with the state and federal standard terms contained in Exhibits C and D of the PSP.

G. Literature cited

A full reference list is given in Appendix 3. Additional references specific to each subcontract proposal are given in the research descriptions in Appendix 4.

H. Nonprofit status

A copy of a letter from the Internal Revenue Service confirming Audubon's non-profit status is supplied in Appendix 4.

APPENDIX 1.

MAP OF AUDUBON AND SLEWS SITES IN YOLO COUNTY (Figure 2)

List of project type by landowner (Table 3, next page)

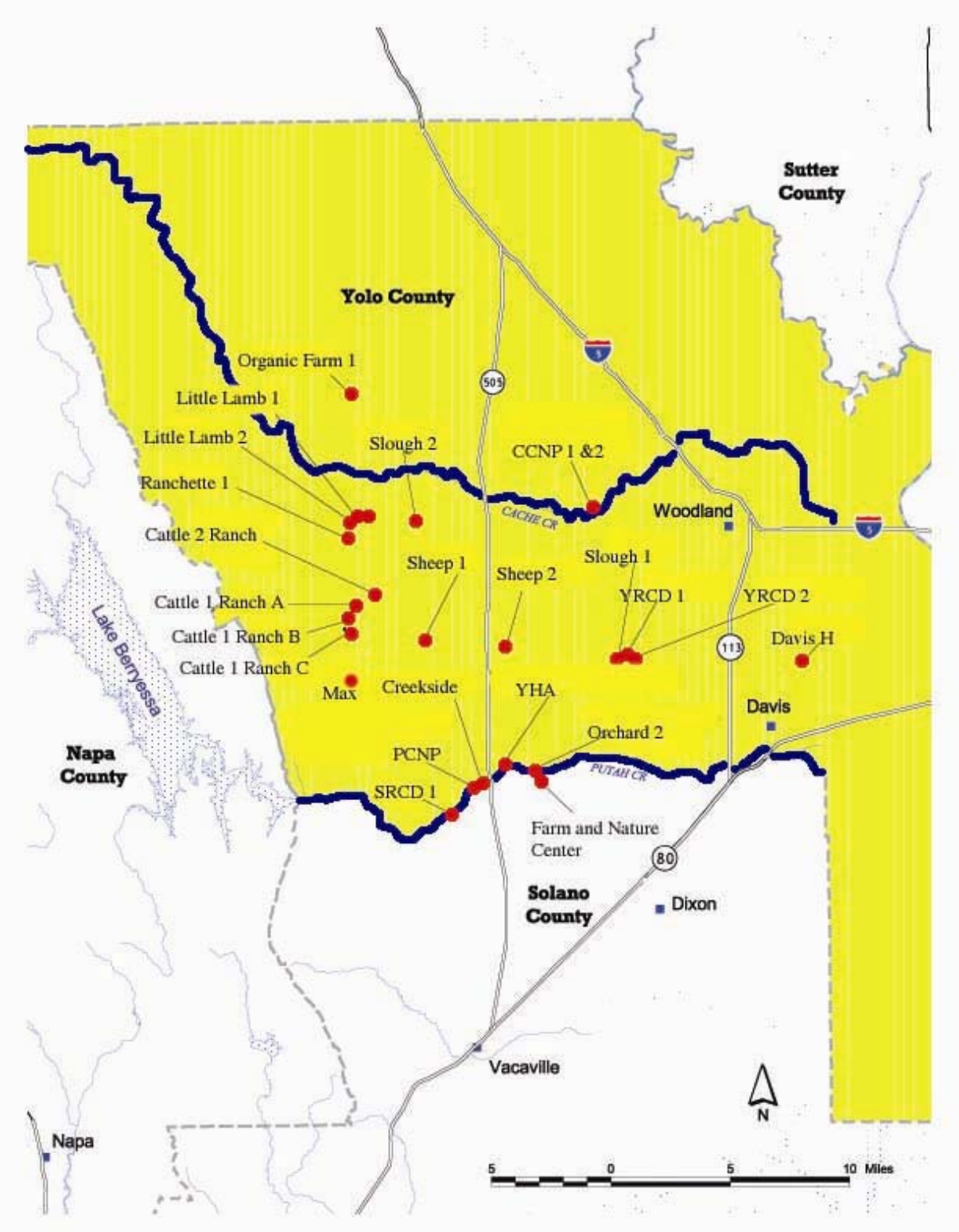

Table 3. Restoration sites included in the proposed monitoring program

Site*	Habitat type of restoration or management actions and year first implemented	Calfed-funded implementing organization(s)
Cattle 1 Ranch	annual grassland (n/a) restored perennial grassland (2000, 2004) seasonal riparian (2001, 2002) impounded riparian (2004)	Audubon-California (98-E13, 01-N31) Center for Land Based Learning (02-P11)
Cattle 2 Ranch	annual grassland (n/a) restored perennial grassland (2000) seasonal riparian (2000)	Audubon-California (98-E13, 01-N31) Center for Land Based Learning (participated but not through CALFED)
Farm and Nature Center	permanent riparian (2003)	Center for Land Based Learning (02-P11)
FVR	Seasonal riparian	Center for Land-Based Learning (02-P11)
Hedgerow	semi-permanent riparian (1991) Perennial grassland (various)	Reference site, no CALFED funding
Jepson Prairie	annual grassland perennial grassland	Solano Land Trust (97-N10)
Lassen Foothills	annual grassland restored perennial grassland	The Nature Conservancy
Little Lamb 1	seasonal riparian (2003)	Audubon-California (01-N31) Center for Land Based Learning (02-P11)
Little Lamb 2	seasonal riparian (2003)	Audubon-California (01-N31) Center for Land Based Learning (02-P11)
Max	seasonal riparian (2004)	Center for Land Based Learning (02-P11) (Audubon participating but not through CALFED)
Orchard 1	annual grassland restored perennial grassland (1992, 2003) seasonal riparian (1999, 2000)	Audubon-California (98-E13, 01-N31)
Ranchette 1	annual grassland restored perennial grassland (2002, 2003) seasonal riparian (2002)	Audubon-California (01-N31) Center for Land Based Learning (02-P11)
Sheep 1	annual grassland restored perennial grassland (1997) seasonal riparian (1999, 2002)	Audubon-California (98-E13, 01-N31) Center for Land Based Learning (participated but not through CALFED)
Slough 1	semi-permanent riparian (2000)	Audubon-California (98-E13) Center for Land Based Learning (participated but not through CALFED)
Slough 2	semi-permanent riparian (2003, 2004)	Audubon-California (01-N31) Center for Land Based Learning (02-P11)

*Private properties have been given pseudonyms at the request of the landowners

Appendix 2. Work Schedule and Deliverables

Table 4. Work schedule and deliverables

TASK	YEAR ONE	YEAR TWO	YEAR THREE
Task 1. Program management	WORK SCHEDULE ▪ Establish subcontractor agreements (first year), coordinate subcontract progress with Principal Investigators ▪ Review subcontractor quarterly, annual and final reports ▪ Hire and supervise field technicians/monitoring specialists as needed ▪ Conduct quarterly coordination and information dissemination meetings between Audubon, researchers, local agencies, funders, landowners, and other stakeholders ▪ Prepare and submit monthly invoices and quarterly reports to CALFED (or Contracting Agency) ▪ Attend professional meetings to disseminate research findings DELIVERABLES ❖ Quarterly reports		
Task 2. Monitoring Soil Cover and Ecosystem Properties in Restored and Comparison Sites in the Willow Slough Watershed and at Jepson Prairie - Malmstrom.	WORK SCHEDULE ▪ Stratify the Willow Slough and Jepson landscapes for sampling, based on historical remote sensing imagery and ground data sets already developed ▪ Field measurements and remote sensing data acquisition synchronized for the three project years ▪ Conduct field measurements to coordinate with satellite imagery ▪ Acquire aerial photography for vegetation mapping and description of the within-pixel heterogeneity of Landsat	WORK SCHEDULE ▪ Continue field measurements ▪ Continue to acquire aerial photography for vegetation mapping and description ▪ Continue data integration DELIVERABLES ❖ Interim report ❖ Stakeholder meetings	WORK SCHEDULE ▪ Landscape-scale analysis of relationships between ecosystem properties, soil cover, and restoration techniques in collaboration with task 3 ▪ Utilize the broad area cover analysis, as appropriate, for scaling up estimates of ecosystem properties to the landscape-scale ▪ Meet with participating users for user evaluation of products, and discuss future development DELIVERABLES ❖ Final report

TASK	YEAR ONE	YEAR TWO	YEAR THREE
	imagery (March, May, June) ▪ Begin data integration ▪ Streamline web tool ▪ Meet with landowners to answer questions, hear concerns DELIVERABLES ❖ Interim report ❖ Stakeholder meetings ❖ Streamlined web tool		❖ Stakeholder meetings ❖ Presentations at professional meetings ❖ Peer-reviewed publication of results
Task 3. Monitoring ecosystem functions following restoration or invasions in California grasslands – Eviner and DiTomaso	WORK SCHEDULE ▪ Selection of sites and establishment of control sites ▪ Sampling and sample processing-Spring ▪ Sample and data analysis, summary of first season's data ▪ Sampling and sample processing-Fall DELIVERABLES ❖ Interim report	WORK SCHEDULE ▪ Selection of sites and establishment of control sites ▪ Sampling and sample processing-Spring ▪ Sample and data analysis, summary of first season's data. ▪ Sampling and sample processing-Fall DELIVERABLES ❖ Interim report	WORK SCHEDULE ▪ Sampling and sample processing-Spring ▪ Sample and data analysis, summary of first season's data ▪ *S*ampling and sample processing-Fall DELIVERABLES ❖ Final report ❖ Presentations at professional meetings ❖ Peer-reviewed publication of results
Task 4. Avian Monitoring - TDB	WORK SCHEDULE • Establish study sites • Measure structural characteristics of vegetation • Conduct weekly point-count surveys	WORK SCHEDULE • Measure structural characteristics of vegetation • Conduct weekly point-count surveys DELIVERABLES	WORK SCHEDULE • Measure structural characteristics of vegetation • Conduct weekly point-count surveys DELIVERABLES

TASK	YEAR ONE	YEAR TWO	YEAR THREE
	DELIVERABLES ❖ Submit annual report on findings	❖ Submit annual report on findings	❖ Final report ❖ Presentations at professional meetings ❖ Peer-reviewed publication of results.
Tasks 5a and 5b. 5a. Expanded monitoring of grassland sites to document "year effects," evidence of sustained population establishment (flowering, seed production, seedling establishment), correlates of restoration success, and response to management treatments. **Task 5b. Determining the relative success rate and cost-effectiveness of establishing native trees and shrubs through direct seeding on site as compared to the use of container stock- Young and Palmerlee**	WORK SCHEDULE • Literature survey • Site selection • Field data collection • Continuation of propagation experiment in field and nursery • Record cost data • Data analysis DELIVERABLES ❖ Submit annual report on findings	WORK SCHEDULE • Continue field data collection • Continuation of propagation experiment in field and nursery • Continue to record cost data • Data analysis • Begin writing for publication DELIVERABLES ❖ Submit annual report on findings	WORK SCHEDULE • Finish field data collection • Finish of propagation experiment in field and nursery • Final cost analysis Final data analysis • Begin writing for publication DELIVERABLES ❖ Final report ❖ Presentations at professional meetings ❖ Peer-reviewed publication of results
Task 6. Assessing the effect of education-based restoration implementation on project success and landowner recruitment - Trexler	WORK SCHEDULE • Likert-type surveys of interviews 20 landowners participating in SLEWS and 20 non-participants. focusing on landowners' desire to and degree of participation,	WORK SCHEDULE • Interviews with educational and environmental funders to determine level of interest in combining restoration and education • Cost analysis to determine	WORK SCHEDULE • Finish data collection and analysis DELIVERABLES ❖ Final report on participation ❖ Final report on sustainability

TASK	YEAR ONE	YEAR TWO	YEAR THREE
	attitudes towards sustaining projects, leadership, and cost effectiveness DELIVERABLES ❖ Preliminary report of baseline landowner data	relative funding advantage or disadvantage of SLEWS-type programs DELIVERABLES ❖ Cost analysis (June 2007) ❖ Funding report (December 2007) ❖ Interim reports on other analyses	❖ Final report on leadership ❖ Final report on cost effectiveness DELIVERABLES ❖ Final report
Task 7. Cost assessment and post-implementation monitoring of vegetation response to conservation and restoration activities – Audubon staff	WORK SCHEDULE • Prepare monitoring plan • Continue photo monitoring of all projects in ERP-01-N31 • Step-point monitoring of prescribed burning and native perennial grassland restoration • Census and assessment of woody shrubs/trees for riparian sites • Continue to collect and analyze costs data from grassland and riparian restoration projects • Work with subcontractors in tasks 5 and 6 to integrate cost information • Continue to prepare unit-cost reports for landowners, agencies, and the general public (e.g., cost per acre, per mile) • Integrate long term	WORK SCHEDULE • Prepare monitoring plan • Continue photo monitoring of all projects in ERP-01-N31 • Step-point monitoring of prescribed burning and native perennial grassland restoration • Census and assessment of woody shrubs/trees for riparian sites • Continue to collect and analyze costs data from grassland and riparian restoration projects • Work with subcontractors in tasks 5 and 6 to integrate cost information • Continue to prepare unit-cost reports for landowners, agencies, and the general public (e.g., cost per acre, per mile)	WORK SCHEDULE • Prepare monitoring plan • Continue photo monitoring of all projects in ERP-01-N31 • Step-point monitoring of prescribed burning and native perennial grassland restoration • Census and assessment of woody shrubs/trees for riparian sites • Continue to collect and analyze costs data from grassland and riparian restoration projects • Work with subcontractors in tasks 5 and 6 to integrate cost information • Finish unit-cost reports for landowners, agencies, and the general public (e.g., cost per acre, per mile) DELIVERABLES ❖ Final monitoring report

TASK	YEAR ONE	YEAR TWO	YEAR THREE
	management costs based on actual management activities DELIVERABLES ❖ Prepare and submit first year monitoring report	• Integrate long term management costs based on actual management activities DELIVERABLES ❖ Second year monitoring report	❖ Final cost assessment ❖ Presentations at professional meetings ❖ Collaborative publication with research subcontractors submitted to peer reviewed journal(s)

Appendix 3. Literature Cited

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Note: Additional references providing scientific background and justification, research protocols, and data collection and analytical methods are provided in individual research subcontract proposals included in Appendix 2.

Appendix 4. Plans for research subcontracts for Tasks 2-7.

Appendix 4A: Task 2.

PROPOSED RESEARCH SUBCONTRACT WITH AUDUBON-CALIFORNIA
Ecosystem Restoration Program Monitoring Proposal Solicitation (November 19, 2004)

Monitoring Soil Cover and Ecosystem Properties in Restored and Comparison Sites in the Willow Slough Watershed and at Jepson Prairie.

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Previous CALFED restoration work

CALFED-supported restoration of upland habitat has been recently completed in the Willow Slough Watershed (*ERP-01-N31 Audubon-California's Rangeland Stewardship Program*). As part of this multi-investigator project, a Michigan State University (MSU) team led by Dr. Malmstrom used remote sensing and geographic information systems technology to monitor and analyze the effects of restoration activities on soil cover dynamics and the distribution of noxious grassland weeds throughout 2001-2004. In addition, the team developed a web-based tool that allowed land managers to evaluate the consequences of restoration efforts and other management activities (Malmstrom et al., 2004, Using Remote Sensing to Assess Forage Dynamics in a California Rangeland Restoration Program, ERP-01-N31, Final Report). A detailed description of this work is provided in the *Scope of Work, Task 2*, in the main body of the proposal, and the findings are summarized in *Table 2*.

Proposed work

In this proposal, we seek funding 1) to use remote sensing techniques developed in 2001-2004 to extend monitoring from 2006 through 2008 to assess the longer-term effects of restoration activities on soil cover and other ecosystem properties important for water quality in the Willow Slough Watershed; 2) to further integrate watershed information by assisting landowners and other scientists in making GPS-linked data acquisitions and coordinating the development of additional GIS data layers that can be used for richer analysis of watershed response; and 3) to improve the power and flexibility of the watershed webtool by incorporating new ability to simulate 3-D flights over the landscape. In addition, with the support of the Solano Land Trust, we propose 4) to extend the remote sensing monitoring to include areas of recently-completed CALFED-supported grasslands work at the Jepson Natural Reserve (*ERP-97-N10*).

At Willow Slough, the remote sensing measurements of soil cover and species composition that the MSU team developed in 2001-2004 will form the basis for the development of a stratified field sampling

of soil properties influencing water quality (including erosion potential and nutrient loss), which will be conducted by Dr. Valerie Eviner from the Institute for Ecosystem Studies. Dr. Eviner has extensive experience with these measurements in grassland systems and has previously collaborated with Dr. Malmstrom. In addition, species composition monitoring will be coordinated with Dr. Joseph DiTomaso from the University of California, Davis, who will lead efforts to monitor yellow star thistle distribution. Extending these measurements to Jepson will be aided by the team's ability to reconstruct historical cover dynamics at that site from satellite imagery already processed for Willow Slough, because the two sites fall within the same Landsat scene. Including the Jepson reserve will provide valuable information about the longer-term results of restoration at that site and extend the landscape-scale of our analysis. The broader-scale view adds value in several ways, among them by extending our ability to monitor the relationship between weather patterns and soil cover response and by increasing the sample size for analyses of long-term response to restoration activities. Taken together, this work will significantly enhance understanding of the long-term effects of upland rangeland restoration on critical ecosystem properties and the dynamics of invasive vegetation. In addition, the project's approaches to integrating and exchanging of data among scientists and land mangers can serve as a valuable model for other watershed efforts.

Questions to be addressed by extended monitoring and data integration

1. What are the relationships between soil cover dynamics, grassland species composition (noxious weed fraction, native fraction), and soil properties important for water quality (erosion potential, nutrient and moisture retention)?

2. What are the long-term consequences of restoration activities on these properties?

3. How can landscape-level data best be integrated and streamlined to enhance adaptive management decision-making and evaluation of restoration outcomes by stakeholders?

Approach

A. Monitoring long-term response of ecosystem properties in restored sites and comparison areas, in the Willow Slough Watershed and at Jepson Prairie. A critical aspect of restoration work is monitoring the effect of revegetation and other restorative techniques on ecosystem properties and conversely determining the effects of ecosystem properties on restoration success. In coordination with field measurements to be conducted by Dr. Eviner and Dr. DiTomaso, the extended monitoring we propose here will allow us to address both Question 1: *What are the relationships between soil cover dynamics, grassland species composition (noxious weed fraction, native fraction), and soil properties important for water quality (erosion potential, nutrient and moisture retention)?* and Question 2: *What are the long-term consequences of restoration activities on these properties?* The MSU team will quantify soil cover properties using remote sensing and related field measurements and coordinate the linkage of these with Dr. Eviner's and Dr. DiTomaso's measurements of nutrients, water, and erosion potential.

Soil cover measures. The remote sensing-based estimates of spring green soil cover and weed distribution developed by the MSU team in the 2001-2004 project were highly successful. We were able to develop a time series of cover estimates from 1985 through 2004, which allowed for rich contextual analysis of restoration efforts and facilitated the choice of *post hoc* comparison sites for restoration efforts without matched *a priori* control sites. In addition, we developed a cost-effective,

multi-temporal approach for assessing the distribution of medusahead and goatgrass, two dominant noxious weeds in the rangeland. Our mapping approach involved using a time series of aerial photography which allowed us to achieve a fine spatial resolution (1 ft to 1 m) that permits clear delineation of vegetation patches. We propose to continue to use these remote sensing tools to monitor soil cover measures throughout the Willow Slough Watershed and to extend monitoring to Jepson Prairie as well. To increase the value of the Jepson monitoring, we will also conduct a retrospective analysis of the site's response to earlier treatments, by analyzing historical Landsat data already purchased. The main foci of the soil cover work would be to continue remote-sensing analysis of the quantity of spring standing green biomass, build additional data sets on end-of-season senescent soil cover, and monitor the distribution of weed patches.

Spring green biomass. In 2001-2004, we developed an unparalleled time series of spring standing green biomass estimates for the Willow Slough watershed, which are valuable both as direct measures and as baseline values from which to estimate potential summer values of senesced vegetation available for soil protection (residual dry matter - RDM). We propose to continue to use the same approach with March/April Landsat imagery (or cross-calibrated alternative imagery if Landsat is decommissioned) to quantify peak spring biomass levels in restoration sites and comparison areas. In addition, we will extend this analysis to Jepson Prairie.

Senescent components of soil cover. We also propose to conduct additional monitoring of the senescent vegetation component of soil cover, which is particularly valuable in controlling soil erosion. We would propose to monitor senescent vegetation in three complementary ways: 1) By direct stratified field sampling; 2) by developing predictive relationships between satellite-based estimates of spring green biomass values and quantities of end-of-season senescent vegetation; and 3) by employing trial senescent vegetation indices now under development. In September/October (the beginning of the season), March/April (peak spring) and June (end-of-season), we would conduct stratified quadrat sampling of green and senesced fractions of soil cover across the landscape to directly quantify these variables in restored and comparison areas. We would also acquire field spectroradiometric measurements (VIS-NIR, Unispec DC, PP Systems) at the same sites to confirm calibration of previously-developed remote sensing algorithms and test the trial senescent indices. In addition, to enhance our ability to predict potential summer soil cover from measured spring values and weather patterns, we would establish small (2-3 m x 2-3m) temporary grazing exclosures at select sites each spring to quantify end-of-season biomass accumulation in the absence of grazing. In June, the biomass would be harvested and exclosures removed. Finally, we would test the efficacy of trial indices of the senescent components of soil cover using dry-season Landsat imagery from Sept/October (beginning of season) and June (end-of-season).

Weed fraction. The fraction of weeds represented in vegetation canopies can substantially alter ecosystem properties, including patterns of soil cover and soil and water dynamics. Both high-input restoration activities and less-intensive efforts, such as prescribed burns, have reduced weeds in project sites in the Willow Slough Watershed. The effects of burns, however, appear to persist for only one to two years, whereas high-input strategies involving revegetation may exert longer-term control. In the 2001-2004 project period, we developed a cost-effective approach for mapping the fraction of late-season weeds and developed a baseline vegetation map along with a set of geo-registered 1000 ground control points at which we collected vegetation information. In this project, we propose to continue monitoring weed species distribution using the remote sensing techniques developed in 2001-2004**.** The repeated monitoring will permit us to quantify the long-term effects of restoration efforts on weed spread. In addition, we will be able to identify sets of emergent weed patches across the landscape and

follow their trajectories in detail to determine under what conditions new patches emerge or current patches expand or decline.

Linking soil cover types to soil and water dynamics. To address Questions 1 and 2, we propose to integrate our ecosystem-level understanding of the response of grassland soil and water dynamics to restoration activities, by linking the soil cover measures (above) with field measures of soil and water properties taken by Dr. Eviner and Dr. DiTomaso. We will work together to stratify the watershed landscape appropriately using our previously developed GIS, vegetation maps, and time series of cover dynamics to identify appropriate sampling points for both soil cover and soil property measurements. As part of the stratification process, we will identify matched sets of different vegetation patches (e.g., highly weedy, less weedy, native grasses) to be sampled in each monitoring unit. We will conduct a similar analysis at Jepson Prairie, in consultation with the Solano Land Trust. At the end of the project, we propose to use the field measurements and information about the distribution of vegetation patch types on the landscape to make broader estimates of watershed properties.

B. Enhancing integration of watershed geospatial data and further streamlining its delivery to land managers. One of the particularly novel and exciting aspects of the 2001-2004 work was the development of technology to support adaptive management decision-making by landowners participating in restoration efforts. This technology was generally well-received and found to be a valuable integrator for the entire project. Based on our initial experience, we have determined several areas in which the potential of these tools can be substantially enhanced. We envision further integrating watershed data from additional sources, solidifying the GIS and web tool as long-term resources available for the stakeholder community, and streamlining the tools to enhance their flexibility and ease of use.

Integrating watershed data. We propose to organize and incorporate all geo-referenced project data into the GIS and supervise the development of geospatial data protocols that would enhance coordination of data acquired in the future. We propose working with stakeholders to develop easy data collection methods to enhance the development of grazing records, such as using handheld units that can be downloaded to the project website.

Enhancing the webtool. In its current configuration, the web site provides spatial information for each property and each field on each property in the watershed. Based on stakeholder evaluation of 3-D simulations in 2004, we propose to adopt an new ArcIMS technology approach to allow more fluid maneuvering through spatial data, including simulation of flights over the landscape. This technology has been tested by MSU colleagues and is in current use for Arctic mapping projects.

Data handling and storage

Michigan State University is strongly committed to the highest standards in computing technology. Dr. Malmstrom's lab is well equipped with computers and data storage devices appropriate for protecting remote sensing and GIS data. Computers in Dr. Malmstrom's laboratory and in the Department of Plant Biology will be used to store data and provide web-based access to information for stakeholders in the project. As part of the data integration effort, Dr. Malmstrom's lab will develop protocols for acquisition of ground-based data to be acquired by other researchers in the project, train personnel in their use, and facilitate integration of those data into the project GIS. All data will be backed up in Michigan on CDs, DVDs, and portable hard drives.

Expected products and outcomes

The aim of the project is to address the three questions described earlier. Specific products to be produced include: 1. An enhanced geographic information system for the Willow Slough Watershed incorporating extended monitoring of ecosystem properties and the development of remote sensing layers to contribute to existing Jepson Natural Reserve GIS resources. 2. Enhanced, streamlined web-delivery of spring cover estimates. 3. Annual grasslands vegetation classification based on spectral imagery for Willow Slough and Jepson Reserve. 4. Enhanced ability to predict potential soil cover provided from senescent vegetation in summer based on spring cover estimates. 5. Broad area estimates of ecosystem properties and response to restoration activities, derived from integrating landscape cover analysis and stratified measures of soil properties.

Work schedule

In the first year, Dr. Malmstrom's team will work closely with Dr. Eviner and Dr. DiTomaso, as well as other watershed researchers, to stratify the Willow Slough and Jepson landscapes for sampling, based on historical remote sensing imagery and ground data sets already developed. After the initial stratification, field measurements and remote sensing data acquisition will be appropriately synchronized for the three project years. Dr. Malmstrom's team will focus on three critical time periods for cover analysis: just prior to fall rains (October), mid-spring (March/April), and end-of-growing season (May/June). Field measurements will coordinate with satellite imagery acquisition at these time periods. Aerial photography for vegetation mapping and description of the within-pixel heterogeneity of Landsat imagery will be acquired three times each year (March, May, June).
Data integration efforts will begin the first year with the development of shared protocols and training in GPS for field researchers. Each year's data will then be incorporated into the GIS system as received. Webtool streamlining will be conducted primarily in the first-year, to maximize its usefulness. ArcIMS will be incorporated, using protocols developed by Dr. Craig Tweedie at Michigan State University for arctic data integration. In the third year, landscape-scale analysis of relationships between ecosystem properties, soil cover, and restoration techniques will be conducted by Dr. Malmstrom's team in collaboration with Dr. Eviner, Dr. DiTomaso, and Audubon-California. As appropriate, the broad area cover analysis will be used as a basis for scaling up estimates of ecosystem properties to the landscape-scale.

Feasibility

The remote sensing techniques the MSU team will use for quantifying spring green biomass and mapping noxious rangeland weeds were developed, tested, and successfully implemented in the 2001-2004 phase of the watershed work. The GPS and GIS technology for integrating additional data sets into the watershed data management system are established and available, and MSU personnel are experienced in training other researchers to use them. Through the course of extensive personal interviews in 2001-2004, the MSU team has developed good working relations with all participating land owners and land managers. The MSU team has separate, on-going work at Jepson Natural Reserve, and so is already familiar with this site and its history. Coordination of soil property measurements and remote sensing analysis will be facilitated by prior collaborative experience between Dr. Malmstrom and Dr. Eviner. Webtool enhancements incorporating ArcIMS will draw on protocols already developed and implemented by Dr. Craig Tweedie at MSU for arctic data set integration.

	2005-2006	2006-2007	2007-2008	total
Faculty summer salary		15,850.55	16,643.08	32,493.63
Faculty fringe		1,212.57	1,273.20	2,485.76
Postdoctoral assistant	34,000.00	35,020.00	36,071.00	105,091.00
Postdoctoral assistant fringe	11,201.00	12,091.00	16,581.00	39,873.00
Field help: 40 hrs x 3 times per year x $15	1,800.00	1,890.00	1,984.50	5,674.50
Field help fringe	137.70	144.59	151.81	434.10
Lab help: sorting and weighing biomass 80 hrs x 3 times x $12	2,880.00	3,024.00	3,175.20	9,079.20
Lab help fringe	220.32	231.336	242.9028	694.56
ArcIMS setup	3,000.00			3,000.00
Travel (4 trips per year): postdoc March, June, Oct field campaigns + 1 PI	6,500.00	6,500.00	6,500.00	19,500.00
Landsat TM 5 imagery (3x year)	1,800.00	1,800.00	1,800.00	5,400.00
Aerial photography Pacific Aerial Surveys (3x year): Willow Slough & Jepson	7,200.00	7,920.00	8,712.00	23,832.00
Aerial photography digital scans: 2 sites x 3 times x 2 image types *$175	2,100.00	2,100.00	2,100.00	6,300.00
Supplies: computing, office, field	3,500.00	3,500.00	3,500.00	10,500.00
Software licenses: 1 ERDAS and 1 GIS; others covered by MSU	350.00	350.00	350.00	1,050.00
Large image production: 6 sets x 3 images x $60	1,080.00	1,080.00	1,080.00	3,240.00
Exclosures: 40 x 4 tposts ($4) x 40 ft chickenwire? ($12)	1,120.00	480.00	480.00	2,080.00
Total	76,889.02	93,194.04	100,644.69	270,727.75
B Indirect costs @ 25%	19,222.26	23,298.51	25,161.17	67,681.94
Grand total B	96,111.28	116,492.55	125,805.86	338,409.69
				338,409.69
Notes:				
MSU provides use of computing resources, Unispec DC spectroradiometer, GPS				

The MSU team foresees only one potential logistical issue. Landsat 7 suffered mechanical failure in 2003 so current Landsat imagery is being obtained from the older Landsat 5, which is nearing the end of its planned use cycle. Plans to replace Landsat 5 are of urgent importance to the broad remote sensing community, but have not been finalized. If Landsat 5 is decommissioned during the course of this project, the MSU team (along with other Landsat researchers) will switch instruments, either to SPOT and MODIS or to other "gap-filler" instruments being considered by NASA. Since a termination of Landsat would represent such a substantial event for the remote sensing community, energies would be focused community-wide on cross-calibrating imagery to maintain data continuity. Such a switch might engender a delay in product processing, but the MSU team can reasonably expect to draw on algorithm developments produced by NASA and the remote sensing community to overcome this issue.

Cost-sharing by Michigan State University

- Use of hyperspectral field radiometer (PP Systems Unispec DC, $25K)
- Use of high-precision global positioning system (Trimble PRO XRS with real-time differential correction, $10K)
- Use of MSU computers for webserver for product access by stakeholders
- Use of MSU software licenses for remote sensing and GIS work (including ERDAS, ArcGIS, ENVI)
- Technology transfer of remote sensing indices and website interface, developed with non-CALFED funding

Qualifications

Dr. Carolyn Malmstrom, Michigan State University. Dr Malmstrom will be the principal investigator for the subcontract work using remote sensing and GIS to monitor soil cover and ecosystem properties in restored and comparison sites in the Willow Slough Watershed and at Jepson Prairie. Dr.

Malmstrom received an A. B. in Biology, magna cum laude, from Harvard College in 1987, and a Ph.D. in Biological Sciences from Stanford University in 1997. She has been an Assistant Professor at Michigan State University, Dept. of Plant Biology (formerly Botany and Plant Pathology) since 1999. Dr. Malmstrom is a grasslands and forest ecologist who works with ecosystem dynamics and remote sensing at a variety of scales across landscapes. Her experience includes coordinating international development of remote sensing resources for global change research as a Programme Officer with the International Geosphere-Biosphere Programme in Stockholm, evaluating the effects of satellite orbital drift on early NASA-produced NDVI time series, and most recently leading the remote sensing and GIS components of the 2001-2004 Willow Slough Watershed Rangeland Stewardship Program. Her current research focuses on California grasslands, where she is funded for several projects investigating the response of grassland dynamics to changes in disturbance regimes.

Budget

	2005-2006	2006-2007	2007-2008	total
Faculty summer salary		15,850.55	16,643.08	32,493.63
Faculty fringe		1,212.57	1,273.20	2,485.76
Postdoctoral assistant	34,000.00	35,020.00	36,071.00	105,091.00
Postdoctoral assistant fringe	11,201.00	12,091.00	16,581.00	39,873.00
Field help: 40 hrs x 3 times per year x $15	1,800.00	1,890.00	1,984.50	5,674.50
Field help fringe	137.70	144.59	151.81	434.10
Lab help: sorting and weighing biomass 80 hrs x 3 times x $12	2,880.00	3,024.00	3,175.20	9,079.20
Lab help fringe	220.32	231.336	242.9028	694.56
ArcIMS setup	3,000.00			3,000.00
Travel (4 trips per year): postdoc March, June, Oct field campaigns + 1 PI	6,500.00	6,500.00	6,500.00	19,500.00
Landsat TM 5 imagery (3x year)	1,800.00	1,800.00	1,800.00	5,400.00
Aerial photography Pacific Aerial Surveys (3x year): Willow Slough & Jepson	7,200.00	7,920.00	8,712.00	23,832.00
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Large image production: 6 sets x 3 images x $60	1,080.00	1,080.00	1,080.00	3,240.00
Exclosures: 40 x 4 tposts ($4) x 40 ft chickenwire? ($12)	1,120.00	480.00	480.00	2,080.00
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Grand total B	96,111.28	116,492.55	125,805.86	338,409.69
				338,409.69
Notes:				
MSU provides use of computing resources, Unispec DC spectroradiometer, GPS				

Appendix 4B: Task 3.

PROPOSED RESEARCH SUBCONTRACT WITH AUDUBON-CALIFORNIA
Ecosystem Restoration Program Monitoring Proposal Solicitation (November 19, 2004)

Monitoring ecosystem functions following restoration or invasions in California grasslands

Principle Investigators:
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Conceptual Background:
Restoration efforts often focus on reestablishing a certain vegetation type, rather than the properties and functioning of the overall ecosystem. A consideration of ecosystem processes is critical when assessing restoration projects because restoration efforts may:

- greatly alter ecosystem processes that have large effects on water quality and quantity
- have limited success without accounting for how ecosystem processes alter vegetation dynamics.

In the latter case, the effects of restoration practices on ecosystem processes may have unintended effects on which plants are most successful (e.g. planting of a legume or fertilization of a site may promote the invasion of weedy species in the long-term). Similarly, if the native plant species we are trying to restore rely on specific ecosystem characteristics, we may not be able to successfully reestablish these species without restoring the ecosystem.

Project Background:
Audubon-California's Willow Slough Rangeland Stewardship Program (ERP-98-E13 and ERP-01-N31) has been working with private landowners in Yolo County to restore habitat, including native perennial grassland, on farms and ranches since 1999. Other grassland restoration projects in this watershed have been on-going since the early 1990's. Audubon launched a monitoring program at these sites in 2001, and this proposals builds on this work by:

- Expanding monitoring to multiple sites, including other CALFED-funded grassland and range management projects at the Jepson Prairie and the Nature Conservancy's Lassen Foothills Project
- Monitoring the potential of these restoration and management sites to affect water quality.

Audubon and the landowners with whom they work recognize that upland sites are the major source of nutrient pollution in water bodies through leaching, runoff, and erosion. Erosion from upland sites is also a major source of excess sediments in rivers. It is challenging to measure and interpret the contributions of a mixed-landuse watershed to water quality—the effect of any single land patch on water quality becomes lost at this large scale. We propose to measure landscape patches differing in vegetation and management practices, which will allow us to assess the relative impacts of these landscape types on water quality, using soil processes as indices of impacts on water quality. For example, our results might indicate that in the short-term, restoration to native grasses increases early season leaching by 30% over annual grasslands (e.g. Corbin and D'Antonio).

Goals:

- We will monitor a number of sites to determine how efforts at restoration and rangeland management affect ecosystem processes.
- This work will be linked to that of other researchers working at the same sites to assess if site-dependent ecosystem processes or management effects on ecosystem processes pre-dispose a site to successful restoration of native plant species, or invasion by medusahead, goatgrass or yellow starthistle.
- Data from this project will be integrated into a GIS-referenced data management system that includes multiple researchers and sites.

Research overview:

We will monitor four different vegetation types in California rangelands:

- Sites restored to native perennial grasses
- Annual grassland sites
- Invaded sites- annual grasslands that have been invaded by goatgrass, medusahead or yellow starthistle
- Remnant stands of native grasses

Four to six sites of each vegetation type will be monitored. Sampling sites will be selected based on the GIS data from Malmstrom's work on the previous CalFed project. Sites will be chosen based on the following criteria:

- sites are representative of the desired patch type (native restored, relict native, annual, weedy) on the landscape
- sites to be compared will be carefully controlled in order to maximize our ability to detect the effects of vegetation class on ecosystems, rather than just measuring variability in environmental conditions and management across the landscape
    - to the extent possible, sites will be similar in management practices (e.g. fertilization, grazing), soil type, and microenvironment.

Integration from patch to landscape scales can be achieved by linking Eviner's and DiTomaso's ecosystem work with Malmstrom's GIS and on-the-ground studies at these sites (Task 2, Appendix 2A).

In these sites, we will monitor:

- Nutrient content, potential for nutrient retention, and susceptibility of nutrient loss
    - nitrogen and phosphorus stocks in plants and soils
    - nitrogen cycling rates (potential of nitrogen to leach from soils)
- Ecosystem carbon storage
    - plant productivity, residual dry matter (RDM)
    - soil carbon content, organic matter content
- Soil water dynamics
    - soil moisture content at different depths
    - soil water holding capacity
    - water infiltration rates
- Soil temperature
- Soil erosion potential
    - soil cohesion measurements
    - soil compaction measurements

- percent plant cover

We will determine the present potential of sites to impact water quality using a number of measurements. Soil erosion is largely determined by how well soil holds together (cohesion), by the potential impact of water droplets on disrupting soil (strongly decreased by plant cover), and by water flow into soil (water infiltration rates, influenced by soil compaction). These measurements will help us to determine the relative potential of sites to harm water quality through erosion, and also the mechanisms by which each vegetation type best protects against erosion. Negative impacts on water quality not only occur through erosion, but also through leaching of nutrients. Our proposed measurements will quantify the amount of nutrients in each site that are highly susceptible to flow into groundwater or streams. Measures of nitrogen cycling rates will allow us to assess how tightly nitrogen is stored in the soil pool (and thus how susceptible N is to leaching during rainfall events). By measuring nutrient content in plants and soils, we will gain insights into where nutrients are stored in the ecosystems, and how susceptible they might be to loss due to every day events (e.g. gopher disturbance, grazing, rain storms), as well as occasional events (e.g. fire). More importantly, monitoring where nutrients are stored in the ecosystem allows us to assess the developing potential of restored sites to protect water quality. Many changes in nutrient dynamics in ecosystems are longer-term. A gradual buildup of soil organic matter and plant productivity might not necessarily have noticeable effects on water quality in the present, but could be indicators of trends that will have large impacts on water quality in the long-term.

Research questions:

1. How do ecosystem properties differ across vegetation types (remnant stands, restored sites, annual sites, invaded sites)?
    a. How do these differences vary seasonally?
    b. How do they vary across landscapes due to differences in site conditions (soil type, hydrology, etc.)?
2. How do ecosystem properties differ across sites within a vegetation type?
    a. How do these vary with time since restoration/invasion? (short-term vs. long-term effects of vegetation change)
    b. How do these vary due to different management practices?
    c. How do these vary due to differences in site conditions?
3. Are sites with certain ecosystem characteristics more amenable to successful restoration of natives, or more susceptible to invasions?

    This question will be determined by linking the ecosystem monitoring in long-term vs. short-term invaded and restored sites, with vegetation monitoring that is occurring at these sites by the rest of the team. We will likely only be able to get an indication of this trend with this monitoring effort, but it could be a substantial contribution for future research aimed at maximizing the success of restoration efforts.

Research methods:

Sampling

Soil will be collected using soil cores 4 cm in diameter and 15 cm in depth. Aboveground plant tissue will be clipped from a 10 cm diameter ring, and will be separated by species. Root tissue will be sampled using a core 4 cm in diameter and 15 cm deep. In order to account for variations within a site, soil and plant samples will be collected from three different locations within each site. To determine ecosystem characteristics in sites dominated by perennial bunchgrasses, there will be two samples taken

from each of the five locations within a site- one sample directly under the bunchgrasses, and the second in between them. Percent area of bunchgrasses vs. between bunchgrasses will be estimated and combined with the ecosystem data to assess ecosystem processes in these stands on an area basis.

Samples will be collected seasonally:

- early in the growing season (November)
- mid-growing season (February)
- peak biomass/ late season for most annuals (late April)
- late season for invaders and native perennials (June)

Measurement Details

Plant biomass, C and N content- Aboveground material will be clipped, while roots will be harvested from soil cores by a floatation method. Both shoot and root material will be dried at 60^{o} C for 48 hours, weighed to determine biomass, ground in a ball mill, and run on a Carlo Erba to determine % C, and % N.

Plant P content- Plant material will be collected and prepared, as described above. Phosphorus content will be determined through microwave digestion, followed by ICP analysis.

Total soil C and N - Soil will be harvested, passed through a 2 mm sieve, then air-dried, ground in a Wiley Mill, and run on a Carlo Erba for % C and % N.

Total soil P- Soil will be collected and prepared, as described above. Phosphorus content will be determined through microwave digestion, followed by ICP analysis.

Inorganic soil N- Soil cores will be passed through a 2 mm sieve, and 20 g of soil will be extracted into 100 ml of 2M KCl. These samples will be run on a Lachat autoanalyzer to determine NH_4 and NO_3 concentrations.

Inorganic soil P- Soil cores will be passed through a 2 mm sieve, extracted in Bray's #1 solution, and run on a Lachat autoanalyzer to determine PO_4 concentrations.

Net mineralization and nitrification rates- will be determined using a one-week and one-month aerobic incubation, and processed as described for inorganic soil N. Incubations will occur in the lab under constant temperature and moisture conditions.

Soil organic matter- Soil will be harvested, passed through a 2 mm sieve, then air-dried and combusted in a muffle furnace to determine soil organic matter content.

Soil temperature- will be determined with a Barnant hand-held thermometer using a K-type thermocouple (Barnant Company, Barrington, Illinois, USA) placed at a depth of 5 cm.

Soil moisture- will be determined gravimetrically (dried for 24 hours in a 105^{o}C oven).

Water infiltration- will be determined using an infiltrometer (Forestry Suppliers, Inc., Jackson, Mississippi, USA).

Water holding capacity- field capacity of soil will be determined by measuring the water content of soil after placing soil in a funnel, saturating it with water, and allowing it to drain for 24 hours.

Soil cohesion- will be determined using a torsional vane shear tester (mid-sized vane, 1 rotation = 1 kg/cm^2) (Forestry Suppliers, Inc., Jackson, Mississippi, USA).

Soil compaction- will be determined using a penetrometer (Forestry Suppliers, Inc., Jackson, Mississippi, USA).

Percent plant cover- each species will be assessed visually using several randomly placed 1 m^2 sampling quadrats at each of the sampling sites.

Data handling and storage:

Each year, data from the growing season will be compiled into multiple databases:

- individual site reports for each land manager, containing their site data, as well as the median, average, minimum and maximum values of ecosystem measures for the entire study
- an ecosystem project report that integrates and interprets Eviner's and DiTomaso's plant and soil data
- an overall Audubon project summary- the ecosystem data will be put into Malmstrom's GIS database, allowing us to integrate all of the measures compiled in the Audubon monitoring effort
- an overall database containing the raw data and interpreted data from this project, which will be made available to CALFED, Audubon, and TNC.
- data will be archived at Audubon, UC Davis, IES, Michigan, and on the web

Expected outcomes and products:

Outcomes

We hypothesize that this monitoring project will demonstrate that different vegetation types, and the management practices responsible for them, will vary substantially in their effects on ecosystem processes. The impact of a vegetation type on any one index of water quality (e.g. erosion) will likely differ from its impacts on other water quality indices (e.g. potential leaching loss of nitrogen or phosphorus). These differences are likely to change seasonally.

It is also likely that the history of a given landscape patch will have strong effects on its ecosystem properties. For example, a site that has been recently restored to native perennial grasses will likely behave more like an annual grassland, than a site that has been restored for a longer period of time.

We also expect that in many aspects, grasslands invaded by late-season annuals will likely behave similarly to the native perennial sites (e.g. in the timing of plant nutrient storage).

Products

Each year, data reports will be compiled and distributed, as described in the *Data handling and storage* section (see above). In addition, an overall report containing the data and interpretations will be compiled for CALFED and Audubon at the end of the project. These results will also be published in manuscripts in scientific journals, and presented at conferences. There are three main subjects that these reports will address:

- the effects of management/vegetation type on multiple soil properties, and the implications for water quality
- Integrated estimates of the current impacts of upland management practices on water quality within this watershed (in collaboration with Malmstrom's GIS data, which includes the area distribution of these different land patches across the watershed)
- how ecosystem properties pre-dispose a site to successful/unsuccessful restoration or control of invasives

PI responsibilities:

Dr. Valerie Eviner will be responsible for all soil measures, except for soil moisture and water holding capacity. This includes: nutrient and carbon analyses, net mineralization and nitrification rates, organic matter content, soil temperature, water infiltration rates, cohesion and compaction. Dr. Joseph DiTomaso will be responsible for plant nutrient analyses, as well as soil moisture and water holding capacity. In conjunction with these analyses, his team will carry out biomass and species distribution measurements at the plot-scale, with a particular focus on yellow star thistle, which will assist Dr.

Carolyn Malmstrom in a more comprehensive monitoring of plant biomass and species distribution. Much of this work will be conducted by a graduate student working towards his MS degree.

Timeline:

2006
January- selection of sites and establishment of control sites
February, April, June- sampling and sample processing
July-October- sample and data analysis, summary of first season's data
November- sampling and sample processing

2007
February, April, June- sampling and sample processing
July-October- sample and data analysis, summary of second season's data
November- sampling and sample processing

2008
February, April, June- sampling and sample processing
July-October- sample and data analysis, summary of second season's data
November- sampling and sample processing
November-December- project summary, wrap-up

Appendix 4C: Task 4.

PROPOSED RESEARCH DESIGN FOR AUDUBON-CALIFORNIA
Ecosystem Restoration Program Monitoring Proposal Solicitation (November 19, 2004)

Avian Monitoring at the riparian restoration sites in the Willow Slough Watershed

Lead investigator: TBD
Oversight and training to be provided by: Jan Goerrissen, Ph.D. Granite Mountain Research Station, U.C. Natural Reserve System (see qualifications, below)

Introduction
The goal of many wildland restoration projects is to reestablish native vegetation communities in sites that have been severely degraded. Because the focus of many restorations is on plant establishment, restoration success is often measured in terms of plant survival and establishment. Success could also be measured in terms of the habitat benefits realized by wildlife species as a result of the restoration activity. Restoration projects can provide valuable habitat for wildlife species that rely on indigenous vegetation for part or all of their habitat needs. In order to fully appreciate the potential benefits a restoration project can have on local wildlife, a wildlife monitoring program should be included as part of the restoration activity. The proposed restoration project along the Dry Creek watershed, with its diverse plantings of grasslands, oak woodlands, riparian woodlands, and pond complexes will provide ample opportunity to monitor the response of wildlife to restoration of a variety of vegetation communities and habitat types. I am proposing to develop an avian monitoring protocol, establish survey points and routes, and conduct monitoring at the Dry Creek restoration site during the implementation and early establishment phase of the project.

Objective
The objective of the wildlife-monitoring program is to collect baseline data on avian abundance, diversity, and breeding effort at riparian restoration in the Willow Slough watershed. These data may then be used to monitor changes in the bird community during the establishment phase and evaluate whether the restoration project is creating new habitat for avian species

Monitoring protocol
Avian monitoring will be conducted using a combination of standard methods. Relative avian abundance will be quantified using point counts and strip transects (described by Bibby et al. 1992, Ralph et al. 1993). We will use fixed radius point counts of 50m and five-minute duration for point count monitoring. The number of point count stations established within each habitat type will depend on the total area and spatial configuration of each habitat type. A minimum spacing of 250 meters between point count stations will used to attain independence of sampling points and minimize the probability of double counting individual birds. Point count stations will be positioned to sample all available habitat types, including transition zones between habitat types. Strip transects will consist of walking the distance between two adjacent point count stations during a fixed time interval and recording all birds observations within the habitat type that the transect line runs through. Point count and strip transect monitoring will be conducted during the first five hours of daylight and under favorable weather conditions (light winds, no rain or dense fog). In addition to monitoring relative abundance through the standard methods of point counts and strip transects, I will follow-up each

morning's monitoring by birding in each habitat type for 30 minutes to search for any species that may have been missed during the monitoring period. Although any new sightings will not be included in formal analyses, such opportunistic sightings can be informative on overall avian use of a site. During the breeding season, reproductive effort and success will be monitored by: 1) conducting territory spot-mapping (International Bird Census Committee 1970); 2) noting behaviors indicative of breeding such as adults carrying food or fecal sacs, or giving distraction displays (Sharrock 1976); or 3) observing recently fledged young (Vickery et al. 1992).

Reference Sites

In order to determine whether any observed changes in species composition or relative abundance throughout the contract period is due to the restoration activity or other factors, avian monitoring will also be conducted at nearby reference sites that represent the vegetation conditions of the project site prior to the implementation of the restoration activity. The same number and, if possible, configuration, of monitoring stations will be established as a comparison for each restored vegetation community within the project site. Avian monitoring at the reference sites will be conducted in conjunction with the restoration sites, with each vegetative comparison being conducted on the same day. This will facilitate paired comparisons and enable me to make the distinction between seasonal variation in the bird community and a response to the restoration activity.

Timeline

In order to determine seasonal variation in avian use of the restoration and comparison sites, I propose monitoring the sites for nine months of the year. Based on monitoring I have conducted in the area, avian diversity and relative abundance fluctuates greatly throughout the fall, winter, and spring, but remains consistently low during the late summer. I propose conducting monthly monitoring from October through June, and territory spot-mapping and observations of breeding activity during the breeding season (April through June). Monthly monitoring during the fall and winter is sufficient to document most avian species that utilize the habitat types during these months, while bimonthly monitoring in the spring would be necessary to accurately document breeding activity.

Annual timeline for avian monitoring:

Task	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Point counts &Transects	X	X	X	X	X	X				X	X	X
Spot-Mapping				X	X	X						
Reporting								X				

Qualifications

Audubon will hire an in-house avian monitoring specialist to carry out the field research. Oversight for this project will be provided by Jan Goerrissen Ph.D, who is currently the Assistant Director of the Granite Mountain Research Center in the U.C. Natural Reserve System. Dr. Goerrissen conducted all of the avian research for the Willow Slough Rangeland Improvement Program (ERP-01-N31). He received his Ph.D. in the Ecology Graduate Group at the University of California, Davis in 2004. Jan has been an avid birder since 1989, and has conducted a number of research and monitoring projects on wild birds during the past nine years. Jan has over four years of local experience in conducting point count and transect monitoring throughout portions of Yolo County. In addition to his field skills, Jan is also passionate about teaching and has worked both as a teaching assistant and course instructor for a number

of field biology and ornithology courses offered by the Department of Wildlife, Fish, and Conservation Biology at U. C. Davis.

Reporting

The PI will submit annual reports to Audubon California in August of each year. Reports will summarize field research activities, data analysis, and monitoring results for each habitat type. Reports will also include a summary sheet of all bird species recorded at the restoration project site for each month, as well as an indication of which species may breed at the site. A final report summarizing observed patterns of avian use of the restoration site during the implementation and early establishment phase will be submitted during the last year of the contract period.

Budget

Field work		Hours/month	Number of months	Total hrs	
per year	Site establishment	1	12	12	$300.00
Per site	Monitoring	1.5	9	13	$325.00
Riparian	Opportunistic sightings	0.5	9	4	$100.00
6 + 6 ref	Spot-mapping	2.5	3	7	$175.00
	Data entry/analysis	1	9	9	$225.00
Total 12 sites				396	$9,900.00
Oversight and reporting				34	$1,020.00
Subtotal/year				463	$12,045.00
TOTAL 3 YEARS				1,389.00	$ 36,135.00

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Appendix 4D: Task5

PROPOSED RESEARCH DESIGN FOR AUDUBON-CALIFORNIA
Ecosystem Restoration Program Monitoring Proposal Solicitation (November 19, 2004)

Tasks 5a. Expanded monitoring of upland sites to continue to document correlates of restoration success, document evidence of "year effects," evidence of sustained population establishment, and response to management treatments"

Task 5b. Determining the relative success rate and cost-effectiveness of establishing native trees and shrubs through direct seeding on site as compared to the use of container stock

Principle Investigator:

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Part 5a: Cross-site, cross-year monitoring of multiple CALFED grassland restoration sites

Background
Restoration of native species offers the potential to increase the diversity, productivity and ecosystem function of plant communities in California rangelands. Native perennial grasses may enhance forage quality, improve ecosystem services, and increase wildlife values over the exotic annual grasses currently dominating rangelands. Although much has been learned over the last ten years about aspects important to the establishment of native grass species, too much of this success has not been rigorously documented (Young 2000). This leaves the restoration methods open to question, reduces the effectiveness of knowledge dissemination, stymies granting agencies that rightfully need documentation of the relative success of their funded projects. In addition, detailed quantitative monitoring often reveals patterns that might otherwise be missed, allowing more rapid refinement of management techniques. We do know that perhaps the greatest impediment to the restoration of native perennial grasses and forbs is the pernicious presence of exotic invasive annuals (Brown and Rice 2000, DiTomaso 2000, Carlson et al. 2000, Kyser and Ditomaso 2002, Corbin and D'Antonio 2004). Herbicides and burning have proven useful in controlling these invasive plants, and in preparing restoration sites (e.g., Anderson and Anderson 1996, Ditomaso et al. 1999; Hatch et al. 1999, Ditomaso 2000, Anderson 1999, Corbin et al., in press 2004).

In our previous CALFED grant, we began to address the monitoring shortfall by successfully designing and implementing a monitoring program for some early CALFED grassland restoration sites (especially the Dieter Ranch). This initial monitoring program was very useful in revealing the environmental and management correlates of successful restoration at that site. It also made clear that longer-term monitoring may be critical for revealing not only long-term patterns, but also for revealing year effects, and post-restoration management effects. Some of the results of this previous research (Lulow et al., in review; Clary et al., in revision) include:

1. There are profound and divergent direct effects of the year of seeding on the relative success of grasses and forbs. Previous research had suggested such "grass years" and "forb years" (Pitt and Heady 1978), but could not tease apart direct effects from indirect effects related to grass-forb competition.
2. Sites with richer soils (ex-agricultural sites) can have very high rates of early restoration success.
3. In harsh sites, initial establishment and growth of planted native grasses can appear discouragingly low with short-term monitoring, but often within a few years these grasses do develop healthy productive stands.
4. Even single follow-up management applications (such as the 2003 burn of the south half of the Dieter site) can profoundly increase restoration success.
5. In harsher rangeland sites, many native grass species have far greater success on N-facing slopes than on S-facing slopes.
6. The native perennial bunchgrass *Nassella pulchra* is particularly successful in harsher sites, on S-facing slopes, and in the face of exotic annuals. This both reinforces its utility as a restoration grass, and raises questions about the value of relic sites as reference communities for grassland restoration.
7. Planting order can have large short-term effects on the resultant plant community. In particular, successful forb establishment only occurred in treatments where they were seeded a year before seeding with native grasses, at least in more mesic sties.
8. There was also limited evidence for community convergence after three years, but only further monitoring will confirm its extent.

These initial results have already begun to have an impact on restoration practice (and success), but also emphasize the need for continued and more extensive monitoring.

Most upland restoration projects emphasize monitoring of the planted individuals (the initial generation) at the expense of monitoring for evidence of sustainable population establishment (flowering, seed production, seedling establishment). Because both perennial bunchgrasses and woody species can have long life spans, recruitment failure in many restoration projects may not express itself at the population level for many years (Benayas and Camacho-Cruz 2004). And because recruitment can be episodic, short-term monitoring may present an overly pessimistic (or optimistic) view of recruitment success.

Objectives and Benefits of Project

We are proposing taking the monitoring of CalFed restoration sites to the next level, with more extensive monitoring of more sites, attention to the long-term aspects of monitoring, analysis that integrates the various facets of our monitoring to each other and the other sub-projects of this proposal.

Specific objectives of the studies are to:

1. Document the effects of time since restoration on achievement of restoration objectives, using both chronosequence data within sites, and comparisons of restoration sites of differing ages.
2. Further document the evidence of "year effects", in terms of the year of restoration, and individual years after restoration (Pitt and Heady 1978, Bakker et al. 2003).
3. Continue our quantification of the establishment of native perennial grass species in relation to specific environmental variables (e.g. slope, aspect, soils, and weed competition).
4. Determine the extent to which the timing and amounts of grazing and broadleaf herbicide influence the productivity and interactions between native grasses and forbs vs. exotic grasses and forbs in established restoration sites.

5. Determine the extent to which patterns in native perennial grass and native forb coexistence can be generalized to different soil types.
6. Quantify changes in the cover of native perennial grasses in response to selected adaptive management techniques using sampling methods that are conducive to making comparisons with other restoration sites.
7. Carry out detailed monitoring of the recruitment of new individuals into planted populations. This will be partitioned into flowering rates, seed production, __and the establishments of seedlings and later stage juveniles.

Approach

We propose to extend both in space and in time our monitoring program for CalFed upland restoration sites. For Yolo County alone, there are over a dozen CalFed restoration sites that have been (or soon will be) "completed" and for which there is currently no funding for continued monitoring. In addition, there are several restoration and reference sites nearby that we would like to use as additional "anchor points" for landscape-scale monitoring.

We will establish 100-200 sampling plots throughout each grassland restoration site. The plots will be located in a random stratified design that samples a wide range of natural and experimental variation. Plots will be stratified with respect to soil type, topographic position, and aspect. We will place plots such that we cover the full range of restoration management techniques that have been applied. We will also monitor vegetation at three sites (each in a different soil type) that were exposed to the replicated fertilizer/herbicide treatments. Five to ten replicated plots will be sampled at each of the four treatment combinations within each of the three soil types, for a total of 60-120 plots. We will also identify and permanently mark areas of particular infestations of intractable weeds *(medusahead, goatgrass, filaree)* for specific monitoring.

Within each plot, we will sample plant cover. A pin frame will be used for accurate measure of aerial cover, counting first hits per pin for each species encountered. We will also record the frequency (in $0.25m^2$ quadrats) of all species. Density of planted perennial grasses will be quantified by counting plants in these quadrats. These individuals will be scored for flowering and seed production. Each plot will be searched for seedlings of planted species, and these will be measured and marked/tagged for future surveys. Surveys will be carried out four times per year.

At all sites, representative soil cores will be taken for structural and elemental analysis, providing additional environmental variables for statistical analysis.

Data Handling, Storage and Analysis

Data will be entered daily into an Excel data file, backed up regularly. These data will later be imported into statistical packages (SAS, JMP, CANOCO) for formal analysis. Both the original data and the analyses will be archived in a form available to other CalFed researchers.

For management aspects that were designed as replicated controlled studies (e.g., some of the pesticide, grazing, and planting order studies from the previous CalFed grant), we will carry out multi-way MANOVAS with interaction terms on the dependent variables of cover by planted native perennial grasses, non-native invasive plants, and non-planted native plants (e.g., *Brodelia*, *Amsinckia*). We will analyze the broad vegetation surveys using Canonical Correspondence Analysis (CCA), which simultaneously integrates data for species and for sample plots, with environmental and experimental

factors as correlated drivers of community structure and species success (Young and Peacock 1992, Ter Braak 1996, Huhta and Rautio 1998, Einarsson and Milberg 1999).

Part 5b. Determining the relative success rate and cost-effectiveness of establishing native trees and shrubs through direct seeding on site as compared to the use of container stock.

Background

Planting trees and shrubs from container stock can be prohibitively costly, time-consuming, and logistically difficult for large-scale restoration projects, especially those implemented by private landowners (Benayas and Camacho-Cruz 2004). In addition, there are rooting problem with container stock that may limit their efficacy in restoration settings (Halter et al. 1993; McCreary 1995, 1996; Welch 1997; see review in Young and Evans 2001). Establishing trees and shrubs directly from seed may offer a more cost effective, efficient, and ultimately more successful restoration strategy. Direct seeding has been shown to be at least as effective as container stock in the establishment of Valley Oak (*Quercus lobata*) (Young and Evans, in press). However, there is no information available on the relative merits and cost-effectiveness of these techniques for other woody species frequently used in Central Valley and foothill riparian projects.

The difficulty of establishing trees from nursery-grown plants is especially evident in harsh or remote rangeland sites where irrigation may be unreliable and adequate site preparation (digging or auguring holes) may not be possible. In addition, the logistical difficulty in ensuring that container stock is planted correctly by hired crews or volunteers in remote and large scale projects can lead to low survival rates. Survival rates when using container stock at Audubon's rangeland sites are typically half that of the valley sites and the investment per plant is much higher. We believe that the development of direct seeding techniques can reduce costs and produce more effective restoration protocols.

Staff of Audubon-California's Landowner Stewardship Program and the Center for Land-based Learning implemented a number of experiments to test this question beginning in the Fall of 2004. This proposal seeks to monitor and assess the outcome of those planting experiments in the coming three years.

Questions/Hypotheses:

1. What is the relative growth and survival rate of both container and direct seeded plants in foothill and valley riparian ecosystems?

H1. Initial survival rates of direct-seeded trees and shrubs will be equal to, or slightly lower than, container stock of the same species.

H2. Of those that survive, the size and vigor of plants established via direct seeding will equal or surpass that of container stock over the same period of time (acknowledging the time that the container stock spent in the nursery).

H3. Establishment and growth rate will vary by species and will be correlated with potential abiotic factors (shade, aspect, etc.).

2. Can the direct seeding of trees and shrubs be more cost effective than container plantings or are the lower capital and labor costs offset by higher expected mortality rates?

H1. The cost of acquiring, treating, and planting seeds will be less than the cost of buying and planting the same number of container stock.

H2. The cost of higher mortality rates in direct seeded plants will be offset by the lower costs in acquiring and planting seeds.

H3. The cost-effectiveness of establishment will vary by species due to variable survival rates. There will be a threshold associated with the survival rate of each species at which it becomes cost-effective.

3. Will direct seeded plants need special care, beyond what is common practice for the implementation of restoration, and will that lessen the cost-effectiveness?

H1. The amount to which direct seeded plants need special care will vary by species.

H2. Simple techniques that provide special care will not make direct seeded plants less cost-effective than the container stock.

Experimental design

The experimental design pairs container plants with direct seeded plants at 4 riparian restoration sites implemented by Audubon and CLBL. Species include 7 native woody plants: California Buckeye (*Aesculus californica*), Coyote Brush (*Baccharis pilularis*), Foothill Pine (*Pinus sabiniana*), Mexican Elderberry (*Sambucus mexicana*), Mountain Mahogany (*Cercocarpus betuloides*), Toyon (*Heteromeles arbutifolia*), and Western Redbud (*Cercis occidentalis*). All seed was collected on site and scarified or stratified as necessary. Both container and direct seeded plants in each pairing were planted 5 feet apart into pre-augured holes and protected with a plastic tube (Tubex). Weeds are controlled within a three-foot diameter around the tubes. Each pair receives the same amount of water via the same drip irrigation system and is under the same environmental conditions (such as aspect, shade, etc).

In addition to the field experiments, we propagated container stock of each species from each site in the native plant nursery managed by CLBL and Audubon. These plantings are testing the viability of the seed as well as providing a source for container plants from the same seed year to be planted in Year 2. This second stage planting will allow us to determine whether the first round container plants benefited from the "head start" provided in the nursery.

Monitoring and Assessment Plan

The monitoring component of this project will provide a quantitative assessment of the cost-effectiveness and efficacy of direct seeding. Monitoring procedures will be standardized throughout all of the experiment sites so that all data are comparable. Every three months, all planted individuals will be surveyed for growth and mortality. We will measure height, stem number, and stem diameters at 30 cm and 150cm (dbh). We will score plants for herbivore damage and reproduction. Site factors will be recorded as well (slope, aspect, shade).

Data Handling, Storage and Analysis

Data will be entered the same day as collected into an Excel data file backed up regularly. These data will later be imported into statistical packages (SAS, JMP, CANOCO) for formal analysis. Both the original data and the analyses will be archived in a form available to other CalFed researchers. Data will be collected for three years and analyzed using two-way MANOVA for inter-correlated measures of plant success (height, diameter, growth rate and LOGIT for categorical variables, such as mortality.

Using project records, we will calculate the propagation, planting, and management costs of each species and stock type (seed vs. container) on a per plant basis, and compare these with field success, producing an estimate of cost-effectiveness for each.

For both Part I and Part II:

Expected Products/Outcomes

Part A of this project will extend our detailed quantification of the success of current restoration practices in California upland grasslands. Part B will not only provide a detailed cost-benefit analysis of the relative advantages of direct seeding versus container stock for several woody species, but will provide additional useful information about the restoration techniques that can maximize success of both kinds of plantings. This approach is part of an integrated adaptive management strategy, in which we take ongoing results of monitoring, and incorporate them into our protocols for perennial grassland and riparian restoration, which we share with all interested parties. We will produce yearly interim reports, and a final project report to Audubon and CALFED within six months of the end of the contract period. We will also continue to submit our results for publication in the major peer reviewed journals in the field *(Restoration Ecology, Environmental Management, Ecological Applications, Journal of Range Management)*. We will also participate in landowner training workshops and field days, and assist in the development of protocols and guidelines for local land owners and livestock managers, and natural resource agencies and organizations. We will support the dissertation research of one masters and one doctoral student in restoration ecology.

Budget and timeline attached

Responsibilities of Each Party

Dr. Truman Young, principle investigator, will oversee all work, assist in analysis and writing of reports, and participate in watershed field days, scientific meetings, and watershed team meetings. The final report will be reviewed and signed by the principle investigator. Two ***graduate student research assistants*** will carry out the majority of the field work, report writing, and participation in meetings and field days. For the woody plant monitoring, this student will be ***Alex Palmerlee***, who designed the direct seeding experiment and supervised its implementation at both Audubon and CLBL sites. The other student will be chosen from the 2004/5 applicant pool to the Ecology Graduate Group.

Cost-Sharing.

The University of California is paying the salary of Truman Young, and additional salary support of graduate research assistants, if needed above that funded by CalFed. Considerable equipment is already on hand in Dr. Young's lab, including computer stations, soil corers, reference materials, and miscellaneous supplies.

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Budget

Item	Year 1	Year 2	Year 3	Total
Personnel				
Research assistant support (UC Davis graduate student)	$21,942	$23,038	$24,190	$69,170
Graduate student fees (not subject to overhead)	$11,212	$12,333	$13,566	$37,111
Benefits	$2,926	$3,072	$3,225	$9,223
Other				
Laptop computers (2)	$4,000	$0	$0	$4,000
Miscellaneous supplies, soils analysis	$1,000	$1,000	$1,000	$3,000
Travel to professional meetings	$800	$800	$800	$2,400
Publication costs (page charges)	$0	$500	$500	$1,000
Transportation to and from Field sites (6000@ $0.375/mi)	$2,250	$2,250	$2,250	$6,750
Total direct costs	$44,130	$42,993	$45,531	$132,654
Indirect costs (25%**, not applied to equipment or fees)	$8,229.50	$7,665.00	$7,991.25	$23,885.75
Total costs	**$52,360**	**$50,658**	**$53,522**	**$156,540**

Timeline

	Year 1 (2005-2006)											
Task	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Literature search	■					■						
Field monitoring		■	■		■	■		■	■		■	■
Data analysis			■	■			■			■		
Writing for publication				■	■						■	
Reports to CalFed											■	
Field days/workshops				■						■		
Professional meetings	■			■								
	Year 2 (2006-2007)											
Task	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Literature search						■						
Field monitoring		■	■		■	■		■	■		■	■
Data analysis	■			■			■			■		
Writing for publication				■	■					■	■	
Reports to CalFed											■	
Field days/workshops				■						■		
Professional meetings	■			■								
	Year 3 (2007-2008)											
Task	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Literature search						■						■
Field monitoring		■	■		■	■		■	■		■	■
Data analysis	■			■			■			■	■	■
Writing for publication									■	■	■	■
Reports to CalFed											■	■
Field days/workshops				■						■		
Professional meetings	■				■							

Appendix 4E: Task 6.

PROPOSED RESEARCH SUBCONTRACT WITH AUDUBON-CALIFORNIA
Ecosystem Restoration Program Monitoring Proposal Solicitation (November 19, 2004)

Assessing the Ecological and Economic Impact of Meshing Education and Restoration Efforts

Principle Investigator:
Dr. Cary J. Trexler
Assistant Professor
California Agricultural Experiment Station
School of Education, University of California at Davis
2031 Academic Surge Building
Davis, CA 95616-8610
(530) 752.2623

Purpose:
The purpose of the research section is to determine if SLEWS (or other efforts that mesh education and restoration) favorably impact(s) landowner implementation and management strategies in a cost effective manner and are these types of efforts attractive to funding agencies.

Method:
This proposal's design primarily calls on case study research methodologies. Case studies are often characterized by the collection and presentation of detailed information about a particular participant or small group, and frequently include accounts of the subjects themselves (Merriam, 1998; Stake, 1995). The design requires an interesting collaboration between those researching the benefits of the SLEWS program and those assessing the economic impact of restoration efforts. Data will be collected through surveys, interviews, and newspaper content analysis. In the tables below are the general area of research, the population to be studied, the specific data to be focused **on, the data collection strategies and types of instruments, and method of data analysis.**

Research Questions:

1. Does SLEWS affect landowners' willingness to participate in, sustain over time, and lead expansion of ecosystem restoration efforts?

Area	Population	Specific Data Focus	Collection Strategies/ Instruments	Type of Analysis	Deliverables and Date
Participation	Participants (20)	Focus on landowners' desire to and degree of participation	• Likert-type surveys • Interviews	• Quantitative analysis of survey data. • Discourse analysis of interviews	Preliminary report on baseline data (December 05) Final Report (June 08)
	Non-participants (20)	Focus on landowners' degree of participation	• Likert-type surveys • Interviews	• Quantitative analysis of survey data. • Discourse analysis of interviews	
Area	**Population**	**Specific Data Focus**	**Collection Strategies/ Instruments**	**Type of Analysis**	**Deliverables and Date**
Sustain	Participants (20)	Management measured by: • Knowledge of site • Knowledge of site's effects on wildlife • # of times working on site (hours) Attitude measured by: • Willingness to continue, improve, & expand • Overall excitement	• Interviews	• Discourse analysis of interviews	Preliminary report on baseline data (December 05) Final Report (June 08)

	Non-participants (20)	Management measured by: • Knowledge of site • Knowledge of site's effects on wildlife • # of times working on site (hours) Attitude measured by: • Willingness to continue, improve, & expand • Overall excitement	• Interviews	• Discourse analysis of interviews	
Leadership	Participants (20) CLBL Staff	• Willingness to share with others • Who has been to? • Interviews with CLBL staff • Diagram of contiguousness of ecosystem habitat under restoration	• Likert-type surveys • Interviews • audio tapes	• Quantitative analysis of survey data. • Discourse analysis of interviews • Mapping	Preliminary Report (March 05) Mid-evaluation Report (March 07) Final Report (June 08)

2. What are the differences between cost/benefits associated with SLEWS and other comparable restoration efforts.

Area	Population	Specific Data Focus	Collection Strategies/ Instruments	Type of Analysis	Deliverables and Date
Cost Effectiveness	Participants (20)	• Labor - installation • Program costs • Landowner investment vs. someone else's • Supplies and materials	• Interviews and project data • audio tapes	• Discourse analysis of interviews • Review of expenditures	Comparative Report on Existing Efforts (March 06) Comparative Report on New Efforts, from beginning of this grant (March 08)
	Non-participants (20)	• Labor - installation • Program costs • Landowner investment vs. someone else's • Supplies and materials	• Interviews and project data • audio tapes	• Discourse analysis of interviews • Review of expenditures	

3. Does adding an education component affect a restoration efforts likelihood of receiving and or increasing the overall amount of funding from agencies, foundations, and grantors? More specifically:
    a. Do environmental funders grant at a higher rate if there is an educational component?
    b. Do educational funders grant at a higher rate if there is an "outdoor, hands-on," or community based component?
    c. If funders do both kinds of funding, does funding levels change for projects?
    d. Are newspapers more likely to publish articles about restoration if there is an education effort attached?
    e. Are newspaper articles more favorable about restoration efforts if education is connected in some way?

Area	Population	Specific Data Focus	Collection Strategies/ Instruments	Type of Analysis	Deliverables and Date
Comparison of Project Funding	Funders who fund primarily environmental projects Funders who fund primarily education project	• Historical data on funding of Audubon project • Expand to other demonstration (STRAW, Adopt-a-Watershed, Etc.)	• Interviews and online resources • audio tapes	• Discourse analysis of interviews and comparison between groups • Content analysis of funders focus from internet	Comparison Report on Project Funding with Education Components (June 07)
Funders Impressions of Meshing Education and Restoration	Funders who fund primarily environmental projects Funders who fund primarily education project	Motivating factor for: • real work • community focus • education focus • youth development	• Interviews • audio tapes	Discourse analysis of interviews and comparison between groups	Funders Impressions (December 07)

Qualifications

Dr. Trexler is a faculty member in the UCD School of Education and holds a joint appointment in the College of Agricultural and Environmental Science. He has developed, assessed, published research on innovative educational programs and is skilled in social science research techniques. Professor Trexler is interested in the intersection of science, technology, and society in relation to the agri-food system. Specifically his research is focused on studying how people construct an understanding of the agri-food system and their understanding of the environmental trade-offs involved in producing food. He has a PhD from Michigan State University and MS and BS degrees from Cal Poly San Luis Obispo.

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Budget

A. SENIOR PERSONNEL: PI/PD, Co-PIs, Other Senior Associates.				Funded Person-month		
Name	Title	FTE	CAL	ACAD	SUMR	Amount($)
Cary Trexler	**PI**	0.015				$ 5,025
Other seniors:						$ -
6. OTHERS						
7. TOTAL SENIOR PERSONNEL (1-6)						$ 5,025

B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. POSTDOCTORAL ASSOCIATES						$ -
2. OTHER PROFESSIONALS						$ -
3. GRADUATE STUDENTS	**1 @step III**	0.5		27		$ 39,326
				0		0
4. UNDERGRAD STUDENTS						$ -
5. SECRETARIAL-CLERICAL (IF CHARGED AS DIRECT costs)						$ -
6. OTHER						$ -
TOTAL SALARIES AND WAGES (A+B)						$ 44,351

C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)						$ 1,953
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)						$ 46,304

D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5000.)						
						$ -
TOTAL EQUIPMENT						$ -

E. TRAVEL	1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSESSION					$ 3,500
	2. FOREIGN:					$ -

G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLI	**Printing and computer**					$ 2,750
2. PUBLICATION/DOCUMENTATION/DISSEMINATION						$ -
3. CONSULTANT SERVICES						$ -
4. COMPUTER SERVICES						$ -
5. SUBAWARDS						$ -
6. OTHER (GRADUATE STUDENT FEES)						$ 26,763
TOTAL OTHER DIRECT COSTS						$ 29,513

H. TOTAL DIRECT COSTS (A THROUGH G)						$ 79,317

I. INDIRECT COSTS (F&A) (SPECIFY RATE AND BASE)						
TOTAL INDIRECT COSTS (F&A)						$ 13,139

J. TOTAL DIRECT AND INDIRECT COSTS(H+I)						$ 92,456

APPENDIX 4: Proof of non-profit status for Audubon

Department of the Treasury

Internal Revenue Service
Washington, DC 20224

Date: 11-27-70 | In reply refer to:

NATIONAL AUDUBON SOCIETY
1130 FIFTH AVENUE
NEW YORK, N Y 10028

Gentlemen:

Based on the information you recently submitted, we have classified you as an organization that is not a private foundation as defined in section 509(a) of the Internal Revenue Code.

Your classification is based on the assumption that your operations will be as stated in your notification. Any changes in your purposes, character, or method of operation must be reported to your District Director so he may consider the effect on your status.

Sincerely yours,

J. A. Peters

Chief, Rulings Section
Exempt Organizations Branch

Form 4-0714 (9-70) (CONTINUED)

APPENDIX 5. Letters of support and landowner authorizations

November 16, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

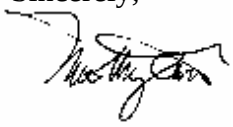
Dear Mr. Wright,

Bobcat Ranch is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. The Bobcat Ranch and its neighbors have been working with on a collaborative restoration project with Audubon whereby we are increasing wildlife habitat for birds and other wildlife species. The ranch will be happy to allow access to the Bobcat ranch to Audubon personnel and researchers to conduct monitoring and evaluation activities related to this proposal.

Sincerely,



Tim Caro

Manger, Bobcat Ranch

November 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

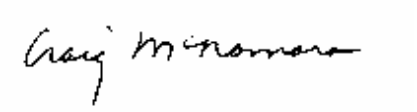
Dear Mr. Wright,

I am pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. I have worked closely with Audubon on projects at my Orchards for the past five years and feel they are well qualified to carry out the activities described in the proposal.

Sincerely,



Craig McNamara

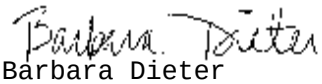
Sierra Orchards

November 15, 2004

Dear Mr. Wright,

I am a landowner who has been involved with the Audubon Landowner Stewardship Program . I urge you to fund their grant proposal to CALFED. I have been particularly impressed with the SLEWS program and the GIS systems program administered by Michigan State. We are facing a growing threat to the rangelands from rapidly spreading invasive species. I believe restoration programs are vital to healthy rangelands and wildlife habitats. Monitoring by the proposed program is crucial to these efforts and I will allow Audubon and associated researchers access to my land to complete the tasks as outlined in the proposal.

Sincerely yours,



Barbara Dieter

November 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

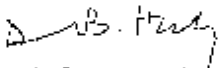
Dear Mr. Wright,

I am pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP. I will allow access to Audubon and associated research partners to carry out the tasks for the project as described in their proposal.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. The program has been very useful in supporting habitat restoration on our farm in the Union School Slough watershed.

Sincerely,



Daniel B. Hrdy
Landowner

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
Woodland Service Center
221 W. Court St., Suite 1
Woodland, CA 95695

America's Conservation Agency

PHIL HOGAN
District Conservationist
(530) 662-2037 x111
phil.hogan@ca.usda.gov

November 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright:

The USDA Natural Resources Conservation Service is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, the Yolo County Resource Conservation District and Center for Land-Based Learning. While the USDA Natural Resources Conservation Service implements natural resources conservation projects, we do not have the staffing or authority to perform the type of work that this proposal contains. Knowledge gained from this work will provide for much needed documentation on the efficacy of the projects NRCS installs out in the rural landscape of Yolo County.

Sincerely,
PHIL HOGAN
PHIL HOGAN
District Conservationist

Yolo County Resource Conservation District
221 West Court Street, Suite 1. Woodland, CA 95695
Phone: 530-662-2037 Fax: 530-662-4876
Email: yolorcd@yolorcd.org Website: www.yolorcd.org

November 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

The Yolo County Resource Conservation District (RCD) is pleased to support the Audubon California's Landowner Stewardship Program (LSP) in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's LSP works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The LSP collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, the RCD and Center for Land-Based Learning. We have worked closely with Audubon and have valued the LSP as a key partner in implementing the *Willow Slough Watershed Integrated Resources Management Plan* (1996). The monitoring work included in this proposal will provide critical information regarding the effectiveness of our partnered watershed conservation activities so far, and even extend that knowledge through region-wide comparisons and parallel efforts.

Please give this proposal your highest consideration.

Sincerely,

Paul Robins
Executive Director

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

The UC Davis Natural Reserve System is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. As the manager of the UC Natural Reserve System reserves administered by UC Davis, the information gained through this grant will be very useful to me. All land managers in this part of the state face exactly the challenges that the grant examines, and I look forward to improving our stewardship techniques as a result of the outcome.

Sincerely,

November 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

Pete's Valley Cattle is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning.

Pete's Valley Cattle has supported and worked with Audubon California since 1997 and believe their projects provide practical projects for landowners. We encourage Audubon's continued efforts and we will continue to offer access to our property for future projects.

Sincerely,

Kim Timothy
Landowner and Partner

HEDGEROW FARMS
Winters, Calif.

November 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

Hedgerow Farms, is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP. Additionally, on Hedgerow Farms property existing restoration sites, we give formal permission for any activities such as monitoring by researchers that are part of the Audubon program.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. I have been closely associated with the program since it's inception in 1998. The success and expansion of the program has progressed well beyond our initial vision due in part to the continued support of CALFED and most importantly, the quality, expertise, and dedication of the personnel running the program. Please do not hesitate to contact me for any additional information.

Sincerely,

John Anderson

21740 COUNTY ROAD 88 WINTERS, CA 95694 (530) 662-4570

November 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

John Stephens Farms is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. It is our hope that the restoration will cause wildlife to return to our property.

Sincerely,

John Stephens
Owner

November 14, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

Yolo Land and Cattle Company, is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. We have worked with the staff at Michigan State for the last three years on a pilot project on our Ranch and have been encouraged by the information that has been generated by the Research, and would like to see this valuable work continue. Your support of the program is greatly appreciated.

Sincerely,

Scott A. Stone, Partner
Yolo Land & Cattle Company
37874 County Road 28
Woodland, Ca. 95695

The Nature Conservancy

Northern Central Valley Office
500 Main Street
Chico, CA 95928-5914

tel [530] 893-5370
fax [530] 343-0437

Nov. 15, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP and approval to use TNC owned or managed lands.

Dear Mr. Wright,

The Nature Conservancy is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP. We also would like to cooperate with Audubon by offering the use of TNC owned or managed lands for this research.

Audubon's proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. Combining this proposed work with ongoing research being conducted by TNC at Vina Plains, Dye Creek and the Lassen Foothills will strengthen this effort and make the results applicable to a larger area.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. TNC is please to cooperate with Audubon in learning how to effectively manage working landscapes for conservation goals.

Sincerely,

Rich Reiner

Rich Reiner, Ph.D.
Senior Ecologist
The Nature Conservancy
Chico, CA

Rreiner@tnc.org

SOLANO LAND TRUST

1001 Texas Street Suite C • Fairfield, California 94533
Phone: (707) 432-0150 • Fax. (707) 432-0151
www.solanolandtrust.org

November 17, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

Solano land Trust is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the California Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. This has great relevance to restoration actions carried out at Jepson Prairie Preserve under ERP-97-N10 in which prescribed burning and grazing were used to control invasive species and restore ecosystem function to the vernal pool grasslands. The data generated from this proposal may also help inform current research at Jepson Prairie (ERP-02-P21) on the effects of different grazing regimes on vegetation.

Audubon's Landowner Stewardship Program works with the local farming community in implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. Because Solano Land Trust is actively engaged in both agricultural activities and restoration projects, we view the proposed research and monitoring as essential to assessing the success of restoration on agricultural lands. We are happy to be one of the many collaborators involved with the Landowner Stewardship Program.

Sincerely,

Julian A. Meisler
Conservation Planner

November 17, 2004

Patrick Wright
CALFED Bay-Delta Authority
650 Capitol Mall, 5th Floor
Sacramento, CA 95814

RE: Support letter for CALFED Ecosystem Restoration Program Monitoring and Evaluation PSP

Dear Mr. Wright,

Stephen Black, et al, is pleased to support the Audubon California's Landowner Stewardship Program in their grant proposal to the CALFED Bay Delta Authority Ecosystem Restoration Program Monitoring and Evaluation PSP. As a landowner participant in the project we will allow Audubon and the project researchers access to our land to carry out the tasks as described in the project proposal.

Audubon's new proposal to continue and expand monitoring and evaluation efforts will assist landowners and restoration professionals in assessing the effectiveness of restoration actions completed through the CALFED Ecosystem Restoration Program since 1999. The program integrates a landscape-scale study of ecosystem response to restoration and management actions with site-specific measurements of the response of vegetation, invasive species (especially medusahead and goatgrass), and wildlife to individual restoration projects. The project is also unique in assessing the ecological and economic effectiveness of integrating restoration and education efforts through its partnership with the highly acclaimed SLEWS Program.

Audubon's Landowner Stewardship Program works with the local farming community for implementing wildlife habitat restoration projects in a manner compatible with existing agricultural operations. The Program collaborates with farmers, ranchers and local partners such as the Natural Resources Conservation Service, Yolo County Resource Conservation District and Center for Land-Based Learning. As a previous landowner participant, I have had the privilege of enjoying the many benefits of this program and eagerly look forward to participating in the future.

Sincerely,

Stephen Black
24499 County Road 23A
Esparto, Ca 95627
(530) 787-3328

Tasks And Deliverables

Monitoring ecosystem response and restoration implementation in western Sacramento Valley watersheds

Task ID	Task Name	Start Month	End Month	Deliverables
1	Project Management	1	36	Quarterly and final reports Periodic invoices
2	Monitor soil cover, ecosystem properties and create georeferenced database	1	36	Interim and final reports Stakeholder meetings Streamlined web tool Presentations at professional meetings Peer−reviewed publication of results
3	Monitoring the potential of upland restoration and management sites to affect water quality and ecosystem healt	1	36	Interim and final reports Presentations at professional meetings Peer−reviewed publication of results
4	Avian monitoring in riparian restoration sites	1	36	Interim and final reports Presentations at professional meetings Peer−reviewed publication of results
5	Monitoring of grassland sites and determining the relative success rate and cost−effectiveness of	1	36	Interim and final reports Presentations at professional

	establishing native trees and shrubs through direct seeding			meetings Peer−reviewed publication of results
6	Assessing the effect of education−based restoration implementation on project success and landowner recruitment	1	36	Interim and final reports Preliminary report of baseline landowner data Cost analysis Funding report
7	Cost assessment and post−implementation monitoring of vegetation response to conservation and restoration activities	1	36	Interim and final reports Presentations at professional meetings Final cost assessment Collaborative publication with research subcontractors for peer−reviewed journal

Comments

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

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
$135,779	$73,112	$8,461	$6,748	$894,678	$10,763	$0	$0	$1,129,541	$70,459	$1,200,000

Do you have cost share partners already identified?
Yes.

If yes, list partners and amount contributed by each:

Landowners: $15,000 Wildlife Conservation Board: $38,000 Natural Resources Conservation Service: $50,000 Yolo County RCD: $25,000 CDF: $20,000 U.C. Cooperative Extension: $2,000 Center for Land−Based Learning: $15,000 Michigan State University: $45,000 U.C. Davis: Dr. Truman Young salary, additional graduate students, if needed and laboratory equipment ~$40,000 Total: $250,000

Do you have potential cost share partners?
Yes.

If yes, list partners and amount contributed by each:

Landowners: $30,000 Wildlife Conservation Board: $20,000 Natural Resources Conservation Service: $75,000 Yolo County RCD: $25,000 USFWS: $40,000 CDF: $25,000 U.C. Cooperative Extension: $6,000 Center for Land−Based Learning: $15,000 National Fish and Wildlife Foundation: $50,000 Unilever Corporation: remaining costs of the bird monitoring program Total: $286,000 plus remaining costs of bird monitoring program

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

Monitoring ecosystem response and restoration implementation in western Sacramento Valley watersheds

Year 1 (Months 1 To 12)

Task	Labor	Benefits	Travel	Supplies And Expendables	Services And Consultants	Equipment	Lands And Rights Of Way	Other Direct Costs	Direct Total	Indirect Costs	Total
1: project management (12 months)	**26170**	**14091**	**2181**	**2948**	**0**	**9763**	**0**	**0**	$55,153	**24933**	$80,086
2: Monitor soil cover, ecosystem properties and create georeferenced database (12 months)	**0**	**0**	**0**	**0**	**96111**	**0**	**0**	**0**	$96,111	**0**	$96,111
3: Monitoring the potential of upland restoration and management sites to affect water quality and ecosystem healt (12 months)	**0**	**0**	**0**	**0**	**100204**	**0**	**0**	**0**	$100,204	**0**	$100,204
4: Avian monitoring in riparian restoration sites (12 months)	**7453**	**4013**	**500**	**0**	**0**	**1000**	**0**	**0**	$12,966	**0**	$12,966
5: Monitoring of grassland sites and determining the relative success rate and cost−effectiveness of establishing native trees	**0**	**0**	**0**	**0**	**52360**	**0**	**0**	**0**	$52,360	**0**	$52,360

and shrubs through direct seeding (12 months)											
6: Assessing the effect of education−based restoration implementation on project success and landowner recruitment (12 months)	0	0	0	0	31064	0	0	0	$31,064	0	$31,064
7: Cost assessment and post−implementation monitoring of vegetation response to conservation and restoration activities (12 months)	9744	5247	0	0	0	0	0	0	$14,991	0	$14,991
Totals	**$43,367**	**$23,351**	**$2,681**	**$2,948**	**$279,739**	**$10,763**	**$0**	**$0**	**$362,849**	**$24,933**	**$387,782**

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
1: project management (12 months)	27500	14808	2180	1900	0	0	0	0	$46,388	22251	$68,639
2: Monitor soil cover, ecosystem properties and create georeferenced database (12 months)	0	0	0	0	116493	0	0	0	$116,493	0	$116,493
	0	0	0	0	102406	0	0	0	$102,406	0	$102,406

3: Monitoring the potential of upland restoration and management sites to affect water quality and ecosystem healt (12 months)											
4: Avian monitoring in riparian restoration sites (12 months)	**7826**	**4214**	**500**	**0**	**0**	**0**	**0**	**0**	$12,540	**0**	$12,540
5: Monitoring of grassland sites and determining the relative success rate and cost−effectiveness of establishing native trees and shrubs through direct seeding (12 months)	**0**	**0**	**0**	**0**	**50658**	**0**	**0**	**0**	$50,658	**0**	$50,658
6: Assessing the effect of education−based restoration implementation on project success and landowner recruitment (12 months)	**0**	**0**	**0**	**0**	**30293**	**0**	**0**	**0**	$30,293	**0**	$30,293
7: Cost assessment and post−implementation monitoring of vegetation response to conservation and restoration activities (12 months)	**9907**	**5335**	**0**	**0**	**0**	**0**	**0**	**0**	$15,242	**0**	$15,242
Totals	**$45,233**	**$24,357**	**$2,680**	**$1,900**	**$299,850**	**$0**	**$0**	**$0**	**$374,020**	**$22,251**	**$396,271**

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
1: project management (12 months)	**28235**	**15204**	**2600**	**1900**	**0**	**0**	**0**	**0**	$47,939	**23275**	$71,214
2: Monitor soil cover, ecosystem properties and create georeferenced database (12 months)	**0**	**0**	**0**	**0**	**125806**	**0**	**0**	**0**	$125,806	**0**	$125,806
3: Monitoring the potential of upland restoration and management sites to affect water quality and ecosystem healt (12 months)	**0**	**0**	**0**	**0**	**104662**	**0**	**0**	**0**	$104,662	**0**	$104,662
4: Avian monitoring in riparian restoration sites (12 months)	**8217**	**4424**	**500**	**0**	**0**	**0**	**0**	**0**	$13,141	**0**	$13,141
5: Monitoring of grassland sites and determining the relative success rate and cost−effectiveness of establishing native trees and shrubs through direct seeding (12 months)	**0**	**0**	**0**	**0**	**53522**	**0**	**0**	**0**	$53,522	**0**	$53,522

6: Assessing the effect of education−based restoration implementation on project success and landowner recruitment (12 months)	**0**	**0**	**0**	**0**	**31099**	**0**	**0**	**0**	$31,099	**0**	$31,099
7: Cost assessment and post−implementation monitoring of vegetation response to conservation and restoration activities (12 months)	**10727**	**5776**	**0**	**0**	**0**	**0**	**0**	**0**	$16,503	**0**	$16,503
Totals	**$47,179**	**$25,404**	**$3,100**	**$1,900**	**$315,089**	**$0**	**$0**	**$0**	**$392,672**	**$23,275**	**$415,947**

Budget Justification

Monitoring ecosystem response and restoration implementation in western Sacramento Valley watersheds

Labor

20% of the project managers full time salary is included in task 1 for three years at $26/hour Approximately 30% of the fulltime salary of the ecologist is included in task 1 at $25/hour for three years. 8 percent time of a bookkeeper is included at 20/hour Task 4 includes 25% time of a field tech at 16/hour Task 7 includes 10% time of the ecologist and field tech at rates above. Field technician: $25.22/hr Bird monitoring technician: $23.17

Research subcontractors are all affiliated with research institutions and will be compensated according to their respecive rates. Each university subcontractor has included at least one graduate student or post−doctorate researcher at half time.

Benefits

Audubon full time staff receive benefits at 35%hourly salary.

Travel

Travel costs are included in the proposal and attached budget. Travel will be reimbursed according to rates approved by State of California. Non−local travel included in the budget is only for travel to professional conferences.

Supplies And Expendables

The types of supplies required for the program generally include field materials for implementing and managing conservation and restoration projects, expendable office materials, photocopies, and postage. Total = $1,500/yr

Services And Consultants

Audubon will subcontract tasks 2, 3,5, and 6. Because this is a complex project, details of the individual tasks are included in Appendix 4.

Equipment

Computer $1,500 All terrain vehicle (cost−share) $6,000 Binoculars $1,000 GPS Unit $2,263

Lands And Rights Of Way

n/a

Other Direct Costs

n/a

Indirect Costs/Overhead

Indirect costs/Overhead will be applied to costs associated with Task 1 at a rate of 30%. Audubon negotiated a 25% indirect cost rate for each research subcontract but will not add an additional Audubon indirect cost to the total research subcontract costs.

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	**–**	**–**	
permission To Access Federal Land Agency Name	**–**	**–**	
permission To Access Private Land Landowner Name	**–**	**–**	

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

Land Use

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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.

Is there an existing plan describing how the land and water will be managed?
– No.
X Yes. **JSA, Willow Slough Watershed Integrated Resources Management Plan**

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.

Previous permission from all private landowners has been secured. See letters of support from landowners that include signed permission for access to their properties.

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?
X No.
– 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?
X No.
– Yes.

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

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

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

No land use changes will occur under the tasks of the proposal. Therefore the land use is consistent with Williamson Act contract terms.