Chapter 7

Monitoring and Adaptive Management Program

7.1 Introduction

This chapter provides a framework, guidelines, and specific recommendations that will help the PCA develop a detailed monitoring program during the initial years of implementation. It is beyond the scope of this Plan to develop a comprehensive monitoring program at this time. Rather, the goal of this chapter is to provide sufficient guidance to ensure that the monitoring program designed during implementation will meet regulatory standards.

The purposes of this program are to ensure compliance with the Plan; to assess the status of covered and other native species, natural communities, and ecosystem processes within the Reserve System[1] and in certain streams outside of the Reserve System; and to evaluate the effectiveness of management actions in helping the Placer County Authority (PCA) achieve the biological goals and objectives of the PCCP. Adaptive management and monitoring will be integrated into one cohesive program where monitoring will inform and change management actions to continually improve outcomes for covered and other native species and natural communities.

7.1.1 Regulatory Context

An HCP must incorporate monitoring of conservation measures and the response of covered species to these measures according to the Endangered Species Act regulations (50 CFR 17.22[b][1][iii] and 50 CFR 222.22[b][5][iii]). It also must include an adaptive management program. The USFWS and NMFS Five-Point Policy (65 FR 35241-35257) describes adaptive management as an integrated method for addressing uncertainty in natural resource management and states that management must be linked to measurable biological goals and monitoring. Tables 5-1

[1] In general, conservation actions and monitoring will take place within the Reserve System (i.e., lands acquired, managed, and monitored by the PCA to benefit covered species under this Plan). Because of the unique nature of streams relative to other land-cover types, in some cases, streams will be managed to benefit covered fish even if such streams are not part of the Reserve System acquired under this Plan.

and 5-2 integrate biological goals and objectives, conservation actions, and monitoring actions to ensure that the program evaluates the conservation measures and assesses the implementation of the biological goals and objectives. Any of the conservation actions proposed in Tables 5-1 and 5-2 can be modified in response to new information within an adaptive management framework.

An NCCP must include a monitoring program and an adaptive management program (California Fish and Game Code Section 2820[7] and [8]). An NCCP also must integrate adaptive management strategies that are periodically reviewed and modified on the basis of the results of monitoring efforts and other sources of new information (California Fish and Game Code Section 2820[a][2]).

The monitoring and adaptive management program described in this chapter is intended to fulfill HCP and NCCP requirements to monitor covered species, natural communities, and the response of species to management activities. This program incorporates recommendations for monitoring and adaptive management based on recent guidelines provided by the U.S. Geological Survey Biological Resources Division (USGS), CDFG, and USFWS for regional HCPs and NCCPs (Atkinson et al. 2004).

7.1.2 Adaptive Management

For the purposes of this Plan, adaptive management is a decision making process used to examine alternative strategies (e.g., conservation actions) for meeting the biological goals and objectives, and, if necessary, adjusting future management actions based on what is learned (USFWS 2000). Adaptive management allows flexible management such that actions can be adjusted as uncertainties become better understood or as conditions change. Monitoring the outcomes of management is the foundation of an adaptive approach, and thoughtful monitoring can advance scientific understanding and modify management actions iteratively (Williams et al. 2007).

The PCCP, like other regional HCP/NCCPs, has been developed despite many uncertainties about the behavior of the ecosystems in the Plan area, the distribution and abundance of many covered species in the Plan area, the response of complex ecosystems and covered species to management actions, and unknown changes to ecological systems (e.g., that may occur due to climate change) that the PCCP is intended to conserve and manage (Christensen et al. 1996; Noss et al. 1996; Atkinson et al 2004). As the PCCP is based on the best scientific information currently available, it is expected that the Plan's conservation actions will effectively achieve the biological goals and objectives. However, there are varying degrees of uncertainty associated with the management techniques and conditions within and outside the Plan area. In addition, the status of covered species and natural communities may

change in unexpected ways during Plan implementation. It is possible that additional and different management measures not identified in the Plan will be identified in the future and proven to be more effective in achieving the biological goals and objectives than those currently implemented. Results of effectiveness monitoring may also indicate that some management measures are less effective than anticipated. To address these uncertainties, the monitoring program will be designed to track progress towards achieving the Plan's biological goals and objectives and to maximize the ability of the PCA to meet the PCCP's goals and objectives in a scientifically defensible and cost effective way (Atkinson et al. 2004). Data collected through monitoring will be used to inform and improve management within an adaptive management framework.

Information collected through monitoring and targeted studies (see Section 7.2.1, Types of Monitoring) will be used to manage reserve lands and protect covered and other native species' habitat and natural and semi-natural communities. The adaptive management process will be administered by the PCA. The PCA will also coordinate and share the results of monitoring and targeted studies, as appropriate, with other HCP/NCCPs, and regional conservation and restoration programs. A well-coordinated and scalable monitoring program will enable the PCA and others to measure and evaluate changes in resources and threats in individual reserves, across the entire Plan area, and within the ecoregion. Such coordination requires standardization of protocols, sampling design, and training of personnel, as well as integrative data analysis.

Another important component of the adaptive management process is outside review by scientists. An Independent Science Advisory Group (ISAG), consisting of policy, resource management, and science advisors will evaluate the effectiveness of existing or proposed management actions. The ISAG will periodically evaluate data from the various monitoring programs and formulate recommendations for the PCA to improve or update management actions. The PCA will incorporate such recommendations, where appropriate, into Plan implementation. It is also intended that the adaptive management program will provide the basis for budget and funding decisions throughout the term of the Plan and in accordance with active adaptive management principles.
Integrating adaptive management and monitoring is critical to the successful implementation of the conservation strategy. Monitoring is the foundation of an adaptive approach, and adaptive management actions are developed, in part, from the results of monitoring. In this Plan, the two components are integrated into a single program.

The monitoring and adaptive management program will inform reserve managers and other decision makers of the status of covered and other native species, natural communities, and essential ecological processes such that management actions can be revised when necessary to meet the biological goals of the Plan.

The effectiveness of conservation efforts will be evaluated following the model outlined in Figure 7-1. This figure illustrates how indicators and success criteria will be developed and how monitoring will be used to ensure the effectiveness of the Plan. The use of conceptual ecological models will also guide monitoring and adaptive management (see Figure 7-2). Conceptual models will help frame questions for monitoring, and data will help guide future management and monitoring efforts while simultaneously updating the models. Using monitoring to provide information for adaptive management actions will require a framework for measuring responses. In its simplest form, monitoring that happens immediately after management actions occur will inform future efforts. However, as Figure 7-3 illustrates management actions must be developed in concert with monitoring objectives such that increased certainty regarding the significance of the results can be obtained. Pilot projects will be carried out (see Section 7.2.1, Types of Monitoring), whereby management actions will be treated as experiments, and monitoring will be used to evaluate each action. This will allow management to proceed without complete knowledge of the needs of the species or ecological processes. All of these components are described more fully in the following sections.

7.1.3 Program Objectives

The overarching objective of the monitoring and adaptive management program is to ensure that the biological goals and objectives are being achieved. This chapter presents a foundation and guidelines for developing the monitoring and adaptive management program. It is anticipated that the monitoring and adaptive management program will be established during the early phases of Plan implementation (see Section 7.2.2, Program Phases below). Additional objectives of the monitoring and adaptive management program are listed below.

- Provide an organizational framework and decision-making process for evaluating monitoring, targeted studies, and other data to adjust management actions.
- Document the baseline condition of biological resources in the Reserve System and other habitat outside of the Reserve System, such as streams managed for covered fish species, using existing data, modeling, and the results of ongoing field surveys.
- Develop management-oriented conceptual models (Atkinson et al. 2004) that summarize our understanding of and hypotheses about the structure and function of natural communities and factors that limit populations of covered species. Management-oriented conceptual models will be used to identify critical uncertainties, hypotheses, and assumptions, clarify likely responses to management actions (e.g., grazing, controlled burns) and environmental stressors (e.g. invasive competitors, nitrogen deposition), identify variables to monitor and hypotheses to test, and to design and change management practices.

- Incorporate hypothesis testing and experimental management, including targeted studies, to address key uncertainties and to improve management and monitoring efforts.
- Develop and implement accurate, reliable, feasible and cost-effective monitoring protocols that produce data that can inform management efforts at multiple scales and that integrate with other monitoring efforts.
- Ensure that the monitoring data are collected, analyzed, stored, and organized so the data are accessible to the PCA, the Permittees, regulatory agencies, scientists, and, as appropriate, the public.

7.1.4 Program Scope

Designing a biological monitoring and adaptive management program that is logistically feasible and scientifically sound is a complicated task that will take many years. This chapter provides a framework, guidelines, and specific recommendations that will help the PCA develop a detailed monitoring program during the initial years of implementation. It is beyond the scope of this Plan to develop a comprehensive monitoring program at this time. Rather, the goal of this chapter is to provide sufficient guidance to ensure that the monitoring program designed during implementation will meet regulatory standards. Because the location and condition of the Reserve System, as well as target areas for monitoring outside the Reserve System, are not known at this time, it is difficult or impossible to develop detailed monitoring requirements including protocols, thresholds, triggers, and other key variables. Furthermore, some of the components of this monitoring program will be new and will therefore require extensive field testing (see Section 7.2.1 Types of Monitoring, *Targeted Studies* below) before they can be implemented on a large scale.

This approach of providing a framework, guidelines, and specific recommendations in the PCCP is consistent with the monitoring and adaptive management plans for recent, approved regional HCPs and NCCPs including the Western Riverside County Multi-Species Conservation Plan (an HCP/NCCP), Coachella Valley HCP/NCCP, East Contra Costa County HCP/NCCP, and the Santa Clara Valley HCP/NCCP (public draft currently under review).

The scope of the monitoring and adaptive management program is limited by the assurances provided by the Wildlife Agencies to the Permittees and described in Chapter 10. These assurances include the commitment by the Wildlife Agencies that if unforeseen circumstances arise (as defined in Chapter 10), the Permittees will not be required to provide additional land, water, or financial compensation beyond the obligations of the HCP/NCCP.

Despite the assurances provided by the Wildlife Agencies, the monitoring program is designed to be flexible. Because the Plan seeks to balance the requirements of management with the need to learn more about the ecological system through monitoring, the amount of funding allocated to monitoring can vary during the permit term. Funding can be shifted within the Plan at the discretion of the PCA to respond to the changing needs of the monitoring and adaptive management program. The scope of the monitoring and adaptive management program is further defined below.

Geography

The geographic scope of the monitoring and adaptive management program will be determined by the lands acquired and/or managed for the Reserve System and the streams managed for the conservation benefit of covered species as described in Chapter 5. The exact configuration of the Reserve System is unknown because lands for the Reserve System will be assembled over the course of the permit and within the constraints of a willing seller program; however, most of the Reserve System will occur in the Reserve Acquisition Area (Figure 5-3), As the Reserve System grows, the monitoring program will also grow.

Scale

Because the conservation strategy functions at multiple scales, the monitoring and adaptive management program must collect information at these multiple scales. The program described in this chapter details the framework for a three-tiered approach that consists of landscape-, natural community–, and species-level monitoring.

Landscape-level monitoring is designed to detect large-scale changes, such as changes in ecosystem processes and shifts in natural community distribution. Community-level monitoring is designed to detect changes in the composition and function of natural communities, invasive species, and other important habitat factors for covered species. Species-level monitoring measures the effects of management actions on covered species and tracks the distribution, status, and other aspects of covered species in the Reserve System and the Plan area.

Coordination with Other Programs

Monitoring already occurs in western Placer County to varying degrees on public and private lands. For example, the Dry Creek Conservancy monitors and assesses aquatic insect populations, aquatic habitat, water quality and flow, geomorphology, and fish populations in the watersheds of Dry Creek, Pleasant Grove Creek, Auburn Ravine Creek, Coon Creek and surrounding areas in Placer, Sutter, and Sacramento Counties. These monitoring efforts inform conservation and restoration of aquatic systems through associated adaptive management and monitoring plans (e.g., Dry Creek Coordinated Resource Management Plan, Secret Ravine

Adaptive Management Plan). Other programs administered in part by USFWS and CDFG and other organizations and institutions, such as the statewide Swainson's hawk survey and the statewide tricolored blackbird survey, periodically survey within the Plan area and surrounding region for nesting Swainson's hawks and tricolored blackbirds, respectively. The PCCP's monitoring program will borrow from these and other existing programs where appropriate. During the inventory phase, the PCA will consult with the proponents of these monitoring programs to learn the latest protocols and determine what aspects of their monitoring overlap with the Plan's requirements. Where appropriate, the PCA will coordinate monitoring efforts with other existing programs and share data. There may also be opportunities to conduct joint monitoring efforts to meet the needs of both projects.

The PCA will also coordinate and share monitoring and other experimental results, as appropriate, with other regional restoration and management programs (e.g., South Sacramento HCP, Yuba-Sutter HCP/NCCP). A well-coordinated and scalable monitoring program will enable the PCA and others to measure and evaluate change in resources and threats in individual reserves, across the entire Plan area, and within the ecoregion. Such coordination requires standardization of protocols, sampling design, and training of personnel, as well as integrative data analyses. Programs and organizations with which the PCA should coordinate include those listed below.

- Placer Land Trust
- Dry Creek Conservancy
- Roseville Open Space Program
- Central Valley Joint Venture - American Basin Working Group
- Spenceville Conceptual Area Protection Plan (CAPP)
- Consume American Bear Yuba (CABY) Integrated Regional Watershed Management Plan Group
- American River Basin (ARB) Integrated Regional Watershed Management Plan Group
- American Basin Council of Watershed Groups

7.2 Overview

7.2.1 Types of Monitoring

Recent guidance for regional conservation planning defines monitoring as the "systematic and usually repetitive collection of information typically used to track the status of a variable or system" (Atkinson et al. 2004). The monitoring program will provide the information necessary to assess compliance and project impacts, verify progress towards achieving the biological goals and objectives, and provide the scientific data necessary to evaluate the success of the PCCP's conservation program. The PCA will monitor resources at the landscape, community, and species-levels. In addition to these levels of scale, the PCA will conduct three main types of monitoring: compliance monitoring, effectiveness monitoring, and targeted studies. A description of each of these types is provided below.

Compliance Monitoring

Compliance monitoring (also known as implementation monitoring) tracks the status of Plan implementation and documents that the requirements of the Plan are being met. Compliance monitoring verifies that the Permittees are carrying out the terms of the HCP/NCCP, permits, and Implementation Agreement. The PCA will track compliance monitoring internally to ensure that the PCCP is working as planned and will provide results to the Resource Agencies who will ensure that the Plan remains in compliance. As defined by the PCCP, compliance monitoring will be comprised of the following components:

- Tracking the location, extent, and timing of impacts on land-cover types to determine the stay-ahead requirements for land-cover acquisition, restoration, and creation;
- Tracking the location, extent, and timing of incidental take of covered species to insure that incidental take of covered species not exceed the level authorized under the incidental take permits;
- Tracking habitat enhancement, restoration, and creation actions;
- Tracking the location, extent, and timing of land acquisition and PCCP reserve establishment;
- Tracking implementation of avoidance and minimization requirements (see Chapter 6);
- Tracking and reporting of management (e.g., proportion of reserves fenced) and monitoring activities (e.g., what monitoring activities were implemented and resulting reports produced) (Atkinson et al. 2004); and
- Tracking the location, extent, and timing of implementation of other conservation measures (e.g., preparation of reserve specific management plans).

Effectiveness Monitoring

Effectiveness monitoring assesses the biological success of the Plan – specifically, it evaluates the implementation and success of the conservation strategy described in Chapter 5. Effectiveness monitoring typically measures the effects of management activities on targeted natural and semi-natural communities (e.g., cover of invasive plants in vernal pools before and after grazing treatment) and covered species (e.g., status of overwintering and breeding western burrowing owl on the Reserve System), status and trends in resources (e.g., percent cover of covered plant species in vernal pools), and status and trends of stressors to the biological resources (e.g., distribution of invasive species) (Atkinson et al. 2004). To conduct effectiveness monitoring, it is necessary to first develop criteria defining thresholds of success for management actions. These may include quantitative measures such as percent cover of invasive plants, area of habitat suitable for covered species, etc. Quantifying these conditions before and after management is the basis for judging success. In most cases, success will not be immediately apparent and monitoring must be conducted over a sufficiently long period for results to manifest.

Effectiveness monitoring will generally occur within the Reserve System, though monitoring of populations of covered fish and other ecological indicators (e.g., aquatic invertebrate populations, water quality) may occur in stream systems outside the Reserve System. The PCA will design, conduct and report on the results of effectiveness monitoring. Wildlife Agencies and the Independent Science Advisory Group will have an opportunity to provide input on and evaluate the proposed effectiveness monitoring and its results. Both status and trends monitoring and effects monitoring are described below.

Status and Trends

Effectiveness monitoring includes the monitoring of indicators (e.g., percent cover of land-cover types, areal extent of vernal pools, numbers of nesting pairs of Swainson's hawks) of biological resources to provide baseline data to assess the status and trends (i.e., increasing or decreasing) of these resources in the Plan area. Status and trends monitoring will include quantitative data on covered species (i.e., estimates of population size of some covered species, distribution, presence/absence in habitats and reserves), acres of land-cover on reserves and in the Plan area, acres of modeled habitat for covered species, occurrences of invasive species and other known threats, and incidences of natural disturbances (e.g., fire, flood).

Baseline data provides a temporal snapshot of the status of natural resources at the first year of monitoring and is a metric against which to compare future data. However, population sizes vary annually, for some species annual variation can be substantial, so long-term monitoring is

necessary to distinguish trends from natural fluctuations. Qualitative assessments of vegetation structure and/or habitat quality will also be a component of status and trends monitoring.

Effects of Management

Understanding the effects of management actions is a critical component of the monitoring and adaptive management program. The purpose of effects monitoring is to ascertain the success of management in achieving desired outcomes, to provide information and mechanisms for altering management if necessary, and to evaluate whether the biological goals and objectives have been achieved. Information collected through effects monitoring will be used to evaluate the efficacy of enhancement, restoration, and creation methods and techniques in achieving the PCCP biological goals and objectives.

Success criteria for management actions, such as vernal pool restoration and control of invasive species, will be developed in the early stages of effects monitoring. Once success criteria are developed, effects monitoring will include monitoring these criteria as well as assessing the effects of management on covered species. Management actions will be conducted using an experimental approach when feasible to produce scientifically defensible results (Figure 7-3).

Targeted Studies

Targeted studies fulfill three major objectives: they identify the best methodologies for monitoring, they provide information about the efficacy of management techniques, and they resolve critical uncertainties allowing for improved management of systems and species. For the purposes of this Plan, targeted studies that provide information regarding monitoring protocols are called methods testing. Targeted studies that provide information regarding the effects of management actions are called pilot projects. Targeted studies that address critical uncertainties are called directed studies. Methods testing and pilot projects may be conducted by the PCA. Directed studies may be funded by outside sources or in part by the PCA and may utilize graduate students, University researchers, or other scientists whose project goals inform critical uncertainties and further the biological goals and objectives of the Plan.

Methods Testing

Methods testing is designed to evaluate alternative monitoring protocols and sampling designs and to select cost-effective protocols and sampling designs with sufficient statistical power to detect biologically-relevant and management-relevant changes (Atkinson et al. 2004). For example, if the objective is to estimate the use of upland habitats by nesting northwestern pond turtles, methods testing might compare the use of

radio-tracking female turtles with other methods to estimate reproductive effort, such as surveying populations to assess relative abundance of juveniles and adults. The results of methods testing would then be used to develop a long-term monitoring protocol.

Pilot Projects

Pilot projects may be used during implementation to ascertain, on a small scale, which management actions may ultimately yield the desired conservation gains prior to initiating a long-term project. Pilot projects are also a cost-effective way to test management actions. Pilot projects can and should be used during the early phases of Plan implementation to field test different management actions (see Figure 7-3 for a continuum of experimental management).

Directed Studies

Because natural systems are extremely complex and dynamic, varying degrees of uncertainty are associated with conserving and managing these systems. Typically, management proceeds absent a full understanding of the components that affect a natural community or a species. The outcome of these management actions are carefully monitored and refined in acknowledgement of the high level of uncertainty. Directed studies are used to reduce levels of uncertainty related to achieving biological goals and objectives and to refine conceptual models (see Section 7.2.2, Program Phases, *Develop Ecological Models*). These uncertainties are generally related to the factors listed below:

- Understanding the ecological requirements of covered species,
- Identifying and understanding the threats to covered species and factors that have caused their decline, and
- The likely response of covered species and natural communities to implementation of conservation actions within the Reserve System.

Directed studies can be costly and resource intensive; therefore, the PCCP proposes few specific directed studies. Directed studies will be implemented on an as-needed basis, when resources (e.g., financial) permit, and when uncertainties limit the ability of the PCA to achieve the biological goals and objectives of the Plan. Directed studies may be carried out to gain insights into key questions identified in the conservation strategy and during Plan implementation. Potential directed studies will be identified and prioritized during implementation and will be carried out in based on their priority ranking as funding permits. Results of directed studies conducted under the Plan will inform management and ensure attainment of the biological goals and objectives. Directed studies may be conducted by the PCA and/or consulting scientists. Additional long-term directed studies, identified during Plan implementation, may be conducted by or in partnership with outside scientists from academic

institutions, consulting firms, and nonprofit organizations. It is anticipated that funding provided by the PCA for directed studies could be matched or supplemented by other entities to increase the level of investigation and to achieve results that integrate with broader issues in the scientific community. As mentioned above, the amount of directed studies will be limited by funding available to the PCA (see Chapter 9, *Funding*).

In addition to the directed studies undertaken to answer critical uncertainties, it is expected that the PCA will develop partnerships with academic institutions (e.g., undergraduate student projects, Masters theses, Ph.D. dissertations) to help address broader scientific interests within the Reserve System that will nonetheless inform and improve management and monitoring techniques. Funding for this and other programs is described in more detail in Chapter 9, *Funding*.

7.2.2 Program Phases

The essential elements of the monitoring and adaptive management program have been organized into three main phases: inventory, targeted studies, and long-term monitoring and adaptive management.

Key tasks in each phase are described in below. In general, activities in the inventory phase will occur during the first five years of Plan implementation and thereafter on new parcels as parcels are added to the Reserve System. For individual sites, the inventory phase will begin immediately after land acquisition. Most targeted studies will be concentrated in the first 10 years of Plan implementation, but they will likely continue throughout implementation as management uncertainties are identified and resolved. Activities in the long-term monitoring phase will begin on each site after the inventory phase is complete. Because the Reserve System is being created over several decades there will likely be extensive overlap between activities in each phase during the first 10–20 years of Plan implementation (Figure 7-4).

Inventory Phase

The initial inventory phase of monitoring occurs following permit approval and continues on new parcels as they are acquired and added to the Reserve System. Baseline information collected during the inventory phase will be used to assess changes in biological resources in the Plan area, and will lay the foundation of the overarching monitoring and adaptive management program. Inventories will need to occur over multiple seasons to ensure that all species present are identified. For example, if a parcel is acquired in a drought, it may take several years for certain plants to appear. Under normal conditions, the initial inventory will take place within one to six years of acquisitions for each site. The PCA will inventory and assess landscapes, natural and semi-natural communities, and populations or status (e.g., presence/absence) of species, as appropriate, within the Reserve System. During the inventory

phase, the PCA will also develop and test hypotheses about key relationships between species, habitats, and processes; the identification and assessment of threats and stressors to communities and species; the prioritization of conservation actions; the refinement of species groups; and the selection of biotic and abiotic indicators for evaluating ecosystem condition.

Document Baseline Conditions

A primary goal of the inventory phase is to determine the baseline condition of Reserve System lands and stream systems in the Plan area. While the conservation strategy was developed based on the best available science and knowledge, for many covered species there is little available information on their distribution, abundance, and habitats, and the threats to their populations in the Plan area. During the Inventory Phase, the PCA will focus monitoring efforts to document baseline conditions on the distribution, and in some cases, abundance (or relative abundance) of covered species, their habitats, and the threats to their populations. Baseline information may come from surveys conducted by the PCA and other entities (e.g., CDFG, USFWS, Dry Creek Conservancy), from past surveys that have been conducted in the Plan area (e.g., tricolored blackbird survey), and from pre-acquisition surveys and assessments. These data will provide baseline data for a long-term monitoring program, to help develop the monitoring program, and to help refine the conservation actions and management strategy. The initial inventory and assessment of reserve lands incorporated into the PCCP will occur within two years of conveyance of such lands. Documenting baseline conditions will consist of the following tasks.

- Inventory and document resources and improve mapping as the Reserve System is assembled. The results of the surveys for land acquisition (i.e., pre-acquisition surveys; see Chapter 8) will be the first source of baseline data. Data-collection methodologies and nomenclature will be standardized to facilitate sharing of information.
- Assess threats to communities and covered species present to help refine application of initial conservation actions.
- Research and document historical data and trends, as appropriate. Historical trends and known occurrence data in the Plan area for covered species are included in the species accounts (Appendix D).
- Use baseline data to validate and refine species-habitat models as lands are surveyed and acquired.
- Conduct post-acquisition biological inventories. Additional surveys may be needed to supplement data gathered in pre-acquisition assessments.
- Use aerial photos and ground surveys, as needed, to assess quality and location of local and regional landscape linkages between unprotected natural areas and adjacent protected lands.

- Use existing and collect additional baseline data needed to refine conceptual models.

Initiate Management Planning

Management planning will occur during the inventory phase and will consist of the following tasks.

- Prioritize implementation of projects to best achieve biological objectives.
- Develop reserve management plans (described in Chapter 5).
- Confirm species groups and refine the monitoring schedule.
- Identify biotic and abiotic indicators (see Section 7.2.3, Guidelines for Monitoring, *Indicators*) for testing during the targeted studies phase.
- Select monitoring protocols and develop sampling design for monitoring of status, trends, and effects. Test experimental designs during the targeted studies phase, as necessary.
- Develop criteria for measuring success of enhancement, restoration, and creation efforts.
- Develop criteria to assess effectiveness of conditions on covered activities (described in Chapter 6, Conditions on Covered Activities)

Upon implementation of the Plan, the PCA will document baseline conditions and develop survey methods and monitoring schedules based on the guidelines for monitoring described below. Population sizes of some species can vary widely between years, often in relation to weather or other variables (e.g., some of the covered plants). Long-term monitoring, survey protocols, and success criteria will be developed to account for this. These protocols and schedules will provide the overarching framework that will be implemented in each management unit. Where feasible, the PCA will draw from relevant and established protocols (e.g., Wildlife Agency survey protocols) and will adapt them as more information becomes available.

A monitoring component will be developed for each reserve unit management plan that identifies protocols, indicators, monitoring schedule, and success criteria. This component will be revised to include information from methods testing, pilot projects and directed studies as results become available. Before the reserve unit management plan for a given reserve is complete, monitoring on lands in the Reserve System will consist of baseline inventories, pilot projects to test monitoring methods, and directed studies.

Targeted Studies Phase

The targeted studies phase of monitoring also follows permit approval and will continue as long as critical uncertainties persist (Figure 7-4). However, most targeted studies will take place within the first 5–10 years of Plan implementation, such that results can inform long-term management. The following are some of the monitoring and adaptive management actions that the PCA will conduct during the targeted studies phase:

- Develop conceptual models for key natural and semi-natural communities and covered species that identify critical management uncertainties;
- Design and initiate pilot projects to test management and monitoring methods;
- Develop and initiate experiments to resolve critical uncertainties;
- Begin pre-treatment monitoring of sites considered for enhancement, restoration, or creation;
- Test the use of indicators to monitor and measure desired functions and aspects of natural and semi-natural communities and covered species;
- Establish control plots for long-term management; and
- Review the literature for guidance on sampling, experimental design, and management.

Develop Ecological Models

Management-oriented conceptual ecological models developed for covered species and natural and semi-natural communities will be a cornerstone of the monitoring program and will be created during the initial years of implementation. These models will inform the monitoring program by identifying relationships between ecosystem components and by identifying management assumptions. The envirograms for the covered species (see Species Accounts, Appendix D) provide a framework for the development and refinement of the conceptual models. The conceptual models will be refined based on data collected through the monitoring program. These models will serve as a framework for management decisions and will function as reference points for the PCA's understanding of the relationship between management and natural and semi-natural communities and/or covered species within the Reserve System.

Test and Refine Monitoring Protocols

In the targeted studies phase, the PCA will conduct methods testing to develop, test, and refine monitoring protocols. Monitoring protocols will be developed for landscapes, natural and semi-natural communities, species groups, and individual covered species. The purpose of this testing is to identify the best and most cost-effective monitoring methodologies with sufficient statistical power to detect biologically-relevant and management-relevant changes (Atkinson et al. 2004). For example, if the objective is to monitor trends in the distribution of vernal pool crustaceans in the Reserve System, methods testing might compare different levels of monitoring intensity (e.g., number of pools to sample, frequency of sampling). Monitoring will be conducted in a repeatable manner by multiple individuals and will provide quantitative and qualitative data to inform management design within the Reserve System.

During the targeted studies phase, different management techniques will be implemented and evaluated experimentally. In some cases, restoration, enhancement, and monitoring methods are not known or have not been successfully reproduced on a large scale by land managers or the scientific community. Before such restoration or enhancement actions are applied at large-scales, they should be tested on a smaller scale. These pilot projects, designed to test the effectiveness of restoration and enhancement, are necessarily long-term (i.e., 5–15 year) endeavors; they will inform long-term management but will also be included as part of the long-term management program. Results from these early studies will guide future efforts in the Reserve System.

Develop Experiments to Resolve Critical Uncertainties

Another element of the targeted studies phase is the development of directed studies, often using experiments that will be designed to resolve critical uncertainties. Critical uncertainties are uncertainties about key ecological processes that potentially limit the effectiveness of management actions. In some cases, critical uncertainties will be identified as conceptual models are developed. In other cases, critical uncertainties have been identified and described as part of the biological objectives of the Plan. For example, poor regeneration by oaks is limiting recruitment of trees in oak woodlands. The specific mechanism(s) that cause poor recruitment needs to be better understood to refine management actions that will effectively enhance regeneration of oak woodlands. The targeted studies phase will entail initiation of projects that resolve the critical uncertainties discussed below in Section 7.3, Monitoring and Adaptive Management Actions as well as other critical uncertainties identified as the conceptual models are developed.

Long-Term Monitoring and Adaptive Management Phase

The long-term monitoring phase generally begins after the inventory and targeted studies phases. Long-term monitoring will be conducted to identify and evaluate the status and trends of landscapes, natural and semi-natural communities, and covered species and the effectiveness of the management actions in achieving the biological goals and objective of the Plan (Figure 7-4). Monitoring that does not depend on the results of targeted studies will occur as soon as a comprehensive strategy has been developed and baseline studies are complete or sooner, if appropriate. Long-term monitoring will use the framework developed during the inventory phase to carry out effectiveness monitoring and to implement adaptive management.

The long-term monitoring phase includes the following tasks.

- Update GIS layer of land-cover with aerial photographs or satellite imagery at intervals that will detect substantive changes in land use (e.g., every 5 years). Assess status and trends at the landscape and natural community levels.
- Monitor the response of species (covered species or indicator species) to habitat enhancement, restoration, and creation.
- Monitor restoration sites and assess success of restoration by comparing data from monitoring to success criteria; remediate sites if initial success criteria are not being met.
- Monitor covered species using methodologies developed in targeted studies phase. Assess status and trends of covered species by monitoring populations (e.g., obtaining indices of relative abundance, and/or presence/absence, depending on species), groups, or guilds of covered species or indicators.
- When enhancement and restoration projects are complete and meet success criteria, scale back monitoring effort at these sites to be consistent with the rest of the Reserve System.
- Work with other individuals and organizations (e.g., CDFG, regional universities) to facilitate targeted studies on the Reserve System and streams that will improve management.

In addition to long-term monitoring, this phase will include steps to adaptively manage the Reserve System to achieve the biological goals and objectives. Adaptive management tasks are listed below.

- **Evaluate efficacy of monitoring protocols.** Pilot projects will take place before large-scale and long-term monitoring efforts to test the efficacy of proposed monitoring protocols.

- **Incorporate information from recent literature into management.** Periodic reviews of literature as well as interaction with the Science Advisors will ensure that new understanding of the species or monitoring approaches is incorporated into the monitoring and adaptive management program.
- **Evaluate and refine conceptual models.** Conceptual models will be refined for covered species and for natural and semi-natural communities as new information becomes available. In addition, the existing species-habitat models developed for this Plan will be refined. These models will reflect changes and continue to provide guidance for future monitoring efforts.
- **Review any unexpected or unfavorable results and test hypotheses to achieve desired outcome.** Unexpected or unfavorable results will be evaluated to inform efforts to improve management actions. Hypotheses about management outcomes will be tested.
- **Adjust management actions and monitor.**
- **Adjust success criteria and conservation actions, if necessary.** The success criteria and conservation actions developed for the Plan will be adjusted if they have been determined to be inappropriate indicators of success (too high or too low, based on biological information), if more cost-efficient actions are developed and agreed upon, or if they are inadequately conserving species or communities. Operational success criteria will be developed during the Targeted Studies phase of implementation.

7.2.3 Guidelines for Monitoring

Because the biological outcome of many management actions is uncertain, the monitoring and adaptive management program utilizes scientific methods (e.g., formulating and testing hypotheses by evaluating data obtained through experiments and systematic observations) to guide continual refinement of conservation efforts to achieve the Plan's biological goals and objectives. The adaptive management program will develop alternative management actions and test the effectiveness of those management actions in the Reserve System. To that end, there is a continuum of management actions that incorporate scientific principles of adaptive management to varying degrees (Figure 7-3). The most basic monitoring involves simply assessing effects once a management action has been implemented, without any replication, controls, or comparison of management treatments. In contrast, directed studies test hypotheses using controlled and replicated experiments or systematically collected observational data and statistical inference. Even simple experimental methods can yield valuable results that can be used to help guide and improve management. The principles listed below will guide adaptive management and will influence how monitoring is conducted.

- Management actions, especially early in Plan implementation, will be implemented with replicated treatments and controls, and will be monitored before and after treatment to best assess the impacts of management actions, where feasible. Pilot projects will be implemented during the targeted studies phase to refine monitoring protocols and directed studies to resolve key management uncertainties.
- Management and monitoring actions, especially early in Plan implementation when uncertainty about management actions tend to be greatest, will be designed to test hypotheses about the ecological relationships between species and their environment and responses to management actions.
- When feasible, adaptive management or directed studies will be designed and replicated to provide sufficient power to detect effects.

Adaptive management, and the design of targeted studies, will be driven by hypotheses about the natural and semi-natural community in which the management is applied. For example, if the goal of management is to expand the distribution and increase the sizes of populations of covered plant species in vernal pools, land managers must develop hypotheses about factors that limit their distribution and abundance. Numerous factors may limit populations of covered plants, such as competition with invasive plants for resources, overgrazing by livestock in vernal pools, and reduced pollination success caused by loss or fragmentation of upland habitat. Management and monitoring actions will be directed toward testing the validity of those hypotheses. For key management questions, where feasible, directed studies will be conducted on a small scale using an experimental design that will yield statistically testable data. Ultimately, if competition with invasive species for resources (e.g., light, space, nutrients) limits the abundance of covered plants, reducing cover of invasive plants from vernal pools will allow populations of covered and other native plants to increase. If cover of invasive species are reduced or eliminated, and the covered plant species do not respond in sufficient numbers, then other factors apparently limit their abundance.

In addition to the scientific guidelines described above, the following steps will precede experimental and sampling design.

1. **Define the question.** Develop and state the assumptions in the hypotheses and models before collecting monitoring data or conducting manipulations. Monitoring strategies will be designed to address specific hypotheses. Conceptual, statistical, or spatially-explicit models can be used to formulate hypotheses. Conceptual models are described below.
2. **Determine what to measure.** Establish the attributes or variables that will be measured to answer the question defined above. Variables should be feasibly measured in a repeatable, cost-effective

manner. This step includes the development of clear success criteria for evaluating creation, restoration, and enhancement actions.

3. **Develop monitoring protocols.** Questions to be answered by the monitoring program will be at the species, natural and semi-natural community, and landscape levels. Monitoring protocols will vary with scale and with the target of the monitoring. Monitoring protocols will be developed in accordance with the guidelines provided below in the Protocols section.
4. **Use indicator species, if appropriate.** In some cases, groups of species or indicator species will streamline monitoring. Indicators are selected because they are easy to survey and provide usable information on the species or system in question. Guidelines for selecting and using indicators are described in detail below.
5. **Consider sampling design.** Experimental and sampling design will be established prior to initiating the experiment or observational study. Aspects of experimental and sampling design include site selection, replication, and sampling protocol. The number and location of sampling units should be selected randomly (or some variation, i.e., stratified random sampling) to allow inference to other areas. Treatments or sampling efforts should be replicated in space and time. Sampling design is described in detail below.

Indicators

Indicators can be used in many ways: to predict species richness (Fleishman et al. 2005), to estimate biodiversity (Kati et al. 2004, Chase et al. 2000), to assess levels of disturbance, to provide targeted information on a system or species (Caro and O'Doherty 1999; Carignan and Villard 2004), and to determine the availability of habitat for a species (e.g., the surface area of vernal pools may be used as an indicator of habitat available for vernal pool invertebrates). In this Plan, abiotic and biotic indicators will be used, when appropriate, to provide information on covered species and other components that are difficult to survey, and to provide information on natural community or ecosystem function.

In cases where an indicator is used to monitor an ecosystem or natural community, conceptual models will be used to help identify an appropriate indicator species or variable. Indicators, in general, are easy to monitor and demonstrate changes or trends that are quantifiable. Indicator species can be used as an index of attributes too difficult, inconvenient, or expensive to measure of other species or environmental conditions of interest (Landres et al. 1988). Indicators need not be species, but may be ecological variables or structure-based characteristics such as diameter and age class of trees, size and distribution of vernal pools, duration that pools remain wet, or key structural features of certain habitat types (e.g., snags or downed logs in forests, woody debris in rivers) (Noss 1999; Lindenmayer et al. 2000). Effective indicators (or variables) have some

or all of the following characteristics (Carignan and Villard 2002; Atkinson et al. 2004).

- They are relevant to program goals and objectives and can be used to assess the program performance at the appropriate spatial and temporal scales.
- They are sensitive to changes in the ecosystem, providing early warning of response to environmental or management impacts.
- They indicate the cause of change, not just the existence of change.
- They provide a continuum of responses to a range of stressors such that the indicator will not quickly reach a minimum or maximum threshold.
- They have known statistical properties, with baseline data, references, or benchmarks available.
- They are technically feasible, easily understood, and cost effective to measure by all personnel involved in the monitoring.

If possible, the selection of indicators or variables will also be coordinated with existing programs and data sets. Prior to adopting an indicator, field verification and fine tuning in the system of interest may be necessary (Atkinson et al. 2004). Once monitoring variables have been selected, the following descriptions will be made in monitoring plans (Atkinson et al. 2004 as adapted from Gibbs et al. 1999 and National Research Council 2000).

- "What" will be monitored.
- "Why" the monitoring is useful (i.e., the specific question the variable is designed to address).
- The conceptual ecological model underlying the selection of the monitoring variable.
- The geographical area where it will be monitored.
- The specific variable that will be measured and the protocol that will be used.
- The range of values the monitoring can produce and what these would mean.
- The expected response (as in response to management or outside pressures) and the magnitude of change expected.
- The time frame and spatial scale over which change is expected to be demonstrated.

Monitoring plans will clearly present the rationale for using indicators. Indicators must be applicable and appropriate measures of the biological goals and objectives. For example, the monitoring plan will specify why monitoring the presence of egg sacks for covered amphibians is an

appropriate indicator of population-based goals and objectives. In this example, the monitoring plans will justify that counting individual adults, larvae, and/or metamorphs is not the only or preferred way of monitoring for population status. Finally, it is important to consider how the results will be interpreted and how they can be used to create change, if necessary.

Protocols

When possible, accepted monitoring protocols will be adopted to facilitate comparison of data with other studies. Monitoring protocols will be appropriate to the task, accurate, and as cost-effective as possible. Monitoring protocols will be standardized across the entire Reserve System and will be incorporated into all reserve management plans. To be successful, the monitoring protocols must be applied consistently by different observers and across monitoring cycles. Ongoing training by PCA staff or their contractors will be necessary to ensure consistency.

Local monitoring programs, when available, will be evaluated for compatibility with and relevance to PCCP management needs. These local programs can be replicated or augmented where appropriate by the Plan's Monitoring Program.

Monitoring protocols will vary by covered species. For species that are difficult to detect in the Plan area (e.g., Conservancy fairy shrimp), monitoring may be limited to assessing it's occurrence on Reserve System lands and determining whether the species persists from sample period to sample period, what features define its habitat, and what threats it faces. Monitoring for less rare (or more detectable) species (e.g., loggerhead shrike) may detect whether the species' range is increasing or decreasing on the Reserve System. Species that are sufficiently detectable to obtain estimations of population size or probability of detection (e.g., Modesto song sparrow, many covered plants) may be monitored by surveying a randomly selected subset of the population to make statistical inference to the whole population.

Sampling Design

Sampling design will vary with the goals and phases of monitoring. During the inventory phase, baseline inventories may require a less rigorous sampling design, relying, for example, on visual surveys for detecting presence or absence. "Rapid Assessment" techniques may also be used. As on-the-ground monitoring progresses, site selection and replication merit increased attention based on the goals of the monitoring at that time and rapid assessment techniques may no longer be appropriate.

An important goal in sampling and experimental design is to minimize extraneous variance in the measured values of indicators or variables. Selection of variables will be guided by a thorough knowledge of the ecological relationships that structure natural communities. Sampling intensity and probability of detection will be considered, as much as possible, to ensure that rare species are adequately inventoried and monitored. Recent studies have indicated that monitoring programs that fail to address issues of detectability and spatial variation have drastically overestimated population trends over time (Martin et al. 2007). Prior to implementing simple count-based surveys to detect trends of populations of covered species, for example, researchers must have confidence that detectability will remain constant over time. Methods of data analysis will be established prior to study design and a statistician or biologist with sufficient statistical expertise will be consulted.

7.3 Landscape-level Monitoring and Management Actions

Landscape-level monitoring will be directed at tracking geographically large areas (e.g., the entire Reserve System or large portions of the Reserve System), landscape-scale processes, and regional issues that affect the Plan area. Functioning landscapes encompass multiple ecosystems and natural and semi-natural communities and the movement of nutrients, materials, and organisms between those units. Landscape-level monitoring addresses the following issues relevant to the Plan.

- The amount of land-cover types in the Reserve System and Plan area and their relationship to each other (e.g., succession or conversion from one community type to another, transitions zones between communities, degree of habitat fragmentation);
- Status and trends in the amount and quality of land-cover types, natural communities, and other landscape features;
- The location, distribution, and range of invasive plants, nonnative wildlife species, and disease in the Plan area;

- The extent of recreation and associated impacts in the Reserve System; and
- The frequency, intensity, and geographic scope of disturbance events such as fires and floods.

This section summarizes specific monitoring actions that the PCA will carry out to track environmental issues at the landscape scale and ensure that landscape-level goals and objectives are being met. Compliance monitoring is described above in the Section 7.2.1, and will take place at all scales of monitoring, including landscape level.

Because most effectiveness monitoring takes place at the natural community and species levels, monitoring at the landscape level focuses on detecting changes in natural process that cannot be detected on smaller scales. This type of monitoring will ensure that impacts to biological resources, as specified by the Plan, are not exceeded; that restoration and enhancement requirements are being met; that threats are being targeted and reduced; and that any large-scale issues affecting resources regionally are identified early and addressed. Following is a description of the types of landscape-level monitoring that will occur on the Reserve System and throughout the Plan area.

7.3.1 Monitor Land-cover in the Plan Area

The PCA will monitor land-cover types in the Reserve System and throughout the Plan are to track the amount of land-cover types, changes in land-cover types (and hence, natural and semi-natural communities) over space and time, and the degree of fragmentation and connectivity in the landscape.

The purpose of monitoring changes in the extent of land-cover types within the Plan area is to track long-term, landscape-level changes and, by inference, changes to the habitats and natural communities contained therein. Long-term changes can indicate local, regional, or global problems such as unanticipated impacts of covered activities, influence of invasive species and disease, and effects of climate change. Monitoring long-term changes will also track the contribution of the PCCP toward maintaining or improving the extent, distribution, and continuity of natural and semi-natural land-cover types. Changes in land-cover type will result from conversion by covered activities (e.g., urban and suburban development) and management actions (e.g., restoration and creation of vernal pool complexes and other land-cover types). If landscape-level changes differ from the expected outcomes due to management actions, the PCA will attempt to identify reasons for the differences and address them through the adaptive management program as appropriate.

Tracking land-cover in the Plan area will also allow the PCA to monitor landscape-level changes in habitat fragmentation. Throughout the term of the permit, development and other covered activities will fragment the

landscape (primarily in the Potential Future Growth Area), whereas protection, restoration, and creation of natural and semi-natural communities in the Reserve System will help to connect contiguous blocks of habitat (primarily in the Reserve Acquisition Area). Parcels of land will be regularly added to the Reserve System throughout the term of the permit; however, because acquisition is limited by the availability and location of willing sellers, the exact location of future reserves is unknown. Monitoring and tracking changes in land-cover will facilitate an adaptive land acquisition strategy by helping the PCA identify parcels that can be acquired to re-connect fragmented habitat (e.g., between reserves that are acquired in the future) and through preservation and restoration, expand unfragmented habitat.

Land-cover will be tracked using information from pre-acquisition and other surveys and using aerial photos or satellite imagery to refine land-cover maps. These data will be used to refine existing species-habitat models (see Appendix D), to develop conceptual models of natural and semi-natural communities, and to refine the land-cover GIS database. Results of pre-acquisition surveys and initial monitoring soon after acquisition will be used to determine baseline conditions and to evaluate future changes against that baseline.

At the landscape level, the PCA will use aerial photos and/or satellite imagery to monitor the extent and distribution of land-cover types within the Plan area every 10 years. If feasible, this monitoring could occur at a more refined level following significant natural events that affect the Reserve System (e.g., flood and wildfire). This effort will begin during the Inventory Phase but will continue throughout all phases of Plan implementation. Land-cover mapping will be verified in the field at sites where air or satellite-photo interpretation is difficult. Current species models reflect landscape-level data available at the time of the writing of this Plan (2009-2010). Species models, including maps, will be improved as new data become available.

7.3.2 Track Invasive Species

Control of invasive species is a serious regional issue; while efforts to control invasive species will directly benefit communities and individual species, control efforts should be evaluated and prioritized regionally and at the level of the landscape. For example, nonnative plants that occur in the Plan area must be identified and prioritized for eradication or control regionally and on individual reserves. Efforts to eradicate or control existing invasive species and to prevent new invasions in the Reserve System will be more successful if coordinated with other land management agencies and private landowners in the region to ensure consistency with those programs and facilitate the sharing of monitoring data. These data will be evaluated to assess the need for management actions to control the spread of invasive plants that have already colonized the Plan area and future, potential invasions.

Within the Reserve System, the PCA will map occurrences of noxious weeds and invasive nonnative plants as they are identified (by planning and other surveys) and periodically monitor these occurrences. The monitoring program will track the success of efforts to eradicate and control invasive species through status and trends monitoring and the use of directed studies to evaluate the efficacy of different eradication and control methods.

Invasive Plants

During the inventory phase of monitoring, the PCA will identify and prioritize problems; map occurrences of invasive plants, if possible; develop a nonnative species control program; and develop success criteria to assess the effectiveness of eradication or reduction efforts. Protocols will be developed to monitor invasive species and to test methodologies for monitoring eradication efforts during the targeted studies phase. The objective during the targeted studies phase is to determine the most cost-effective and accurate way of controlling invasive species. Long-term monitoring will entail implementation of methodologies identified in the targeted studies phase.

Invasive Animals

Occurrences of invasive animals will also be documented in GIS and management actions will be developed to prioritize and control nonnative, disruptive animals. For example, bullfrogs compete with and depredate native amphibians and fish. Following a baseline inventory of nonnative predators in ponds and perennial wetlands within the Reserve System, threats will be prioritized and areas supporting bullfrogs will be identified for eradication programs (through trapping and hunting). During the targeted studies phase, protocols will be developed to monitor the presence/absence of bullfrogs over time. Monitoring will track the effectiveness of bullfrog eradication and assess the response of targeted covered species (and other native species) to eradication efforts (e.g., do populations of covered species increase in response to eradication of invasive species). Ideally, sites that do not receive treatments (i.e., control sites) will be compared to sites that received treatment to improve understanding of the effectiveness of eradication efforts. Monitoring will also be designed to detect new invasions and the spread of invasive species to unaffected parts of the Reserve System. These protocols will then be used as part of long-term monitoring for bullfrog eradication.

Track Disease

Disease, as defined by this Plan, is a condition leading to decreased or impaired function or increased rate of mortality in plants and wildlife; it can be caused by a variety of pathogens. Disease is a serious threat to plant and wildlife populations throughout California, including the Plan area, and can be detrimental to the health and function of entire

ecosystems. Instances of disease will be monitored in the Reserve System, and reported, as needed. The PCA will maintain a watch-list of dangerous diseases for the Plan area and will periodically monitor animals and plants, as part of species and natural community monitoring, to identify outbreaks of diseases.

7.3.3 Track Recreation in the Reserve System

Many areas of the Reserve System will serve the dual purpose of habitat protection and limited recreational use. The impacts of recreational use on biological resources will be monitored and managed adaptively to reduce or eliminate impacts. During the inventory phase, potential impacts on species and communities will be identified, recreational plans developed, and protocols created to evaluate effects of public access and use. During the targeted studies phase, signs of disturbance from recreational use will be documented and assessed annually using established protocols. Long-term monitoring will track trends in recreation impacts to adjust management practices to reduce or eliminate impacts.

Monitoring will distinguish between different types of uses (e.g., hiking, horseback riding) that can have varying levels of impacts on covered species. Monitoring will also be designed to help inform if and when seasonal or other restrictions on recreational uses will be imposed in sensitive areas (e.g., near Swainson's hawk nests, near vernal pools, and near ponds that support covered amphibians and reptiles).

7.3.4 Monitor Disturbance Events

Within the context of this Plan, a disturbance is a temporary or intermittent change in environmental conditions that causes a pronounced change in an ecosystem. Ecological disturbances include natural events such as fire, drought, and flooding. Where possible, natural disturbance processes such as fire and flooding will be allowed to occur. Disturbance events such as fire and flood will be monitored opportunistically. Should fire or flooding occur in an area that has been previously monitored, the PCA will conduct post-disturbance monitoring to assess the effects of the disturbance and to inform future management.

7.4 Natural and Semi-Natural Community–Level Actions

Table 5-1 relates community-level monitoring actions with biological goals, objectives, and conservation actions for natural and semi-natural communities.

7.4.1 Natural Community Monitoring Tools

While monitoring occurs at three spatial scales, the natural communities provide the organizational framework for monitoring — species are associated with and occur within natural communities. Landscapes are made up of collections of natural and semi-natural communities. In this way, understanding natural and semi-natural communities and evaluating the effects of management on natural communities is one of the most important tasks of the monitoring program. The following sections describe approaches that may be used to monitor natural communities.

Conceptual Ecological Models

Conceptual ecological models describe how an ecosystem functions. They provide a framework for learning about a system and help formulate hypotheses about the relationships between components of the modeled ecosystem. Conceptual models are useful for management because they can represent and document uncertainty (Williams et al. 2007). They also help summarize information about a system, identify which factors may be influenced by management, and help identify critical uncertainties for targeted studies (Atkinson et al. 2004).

Conceptual models can inform the monitoring program in several important ways:

- by developing hypotheses about the relative importance of certain ecological and ecosystem relationships and processes;
- by helping to identify threats or stressors that require monitoring;
- by identifying species or other attributes that function as indicators; and
- by serving as a repository of the changing understanding of the system as more data become available.

Conceptual models can also be used to explain ecosystem processes and relationships to other scientists and the public and to facilitate review by outside experts. Conceptual models are being applied successfully to several regional HCPs and NCCPs in California, such as the Coachella Valley HCP/NCCP in Riverside County and the San Diego MSCP in San Diego County.

Models can be either narrative or diagrammatic. In most cases, diagrams show the hypothesized relationships that characterize the ecosystem and are supplemented by written materials. Several types of models can be used, including stress-response models and habitat models (e.g., habitat models and envirograms developed for covered species Appendix D).

During the inventory phase, the PCA will develop conceptual models for each natural community type. A critical task in the development of these

models is the identification of uncertainties and threats or stressors. Uncertainties identified in these models can be evaluated with targeted studies. The models will also incorporate the anticipated effect of management actions on natural communities.

Natural Community Inventory Protocols

Once parcels for the Reserve System have been acquired, an inventory of the constituent vegetation communities will be conducted. The inventory will build on the results of the pre-acquisition surveys. This inventory will draw as much as possible from accepted protocols for typing vegetation communities and wildlife habitats. These typing protocols include the California Native Plant Society "Vegetation Rapid Assessment Protocol" (California Native Plant Society 2002) and "Releve Protocol" (California Native Plant Society 2003) for plants. Another option is DFG's Keeler-Wolf "protocols." Protocols are updated frequently and the most recent or most appropriate protocols at the time of assessment will be used. Streams will be mapped and included as one of the land-cover types addressed in the inventory protocols.

Similarly, acquired parcels will be surveyed for wildlife (including covered species), invasive species, and other potential disturbances. Survey protocols will be developed by the PCA during the initial phase of implementation. .

Along with the existing species models, the California Wildlife Habitat Relationships (CWHR) classification and modified "Placer CWHR" system (see Chapter 3) is recommended to understand the relationship between natural communities, their habitat, and wildlife species (Mayer and Laudenslayer 1988). Information from CWHR or other wildlife-habitat systems, the results of protocol-level surveys, and any other relevant, new information will be incorporated into species and community models throughout the lifetime of the PCCP. When feasible, the PCA will seek to develop protocols that use a multi-species or habitat-based approach.

Monitoring Community Function

Conserving, restoring, and managing ecosystem function is a requirement of the NCCP Act[2]. Often, biotic or abiotic indictors are used to assess function. In the PCCP, conceptual models will be used to select attributes for monitoring. For example, songbirds may be monitored across terrestrial habitat types as a guide to measuring overall natural community structure and function. It is important to recognize that monitoring of covered species is not the metric by which communities are evaluated under the PCCP and that the conceptual models will guide development of monitoring for community function.

[2] California Fish and Game Code Section 2820 (a)(4)(A).

Evaluating Creation, Enhancement, and Restoration

A primary component of natural community monitoring will be the assessment of natural community enhancement, restoration, and creation actions. Monitoring will focus on the response of natural communities, and where appropriate, covered species, to enhancement, creation, and restoration actions. Because natural communities are likely to occur in different stable states, determining the desired restoration goals is a complex but necessary first step (Hobbs and Norton 1996). The targeted studies phase will establish a range of measures or success criteria to evaluate restoration efforts for each natural community. This monitoring will ensure that the restored natural communities are functioning as habitat for particular covered species or suites of species associated with the subject communities.

Key steps to evaluate restoration and creation projects (Hobbs and Norton 1996) are listed below.

1) Identify processes leading to decline.

2) Develop methods to ameliorate degradation or decline.

3) Determine realistic goals for functional ecosystems.

4) Develop easily observable success criteria.

5) Develop practical techniques for implementing these goals and ensure that they are commensurate with the problem.

6) Document and communicate these techniques.

7) Adaptively manage the system.

The PCCP monitoring program will be constrained by financial costs and efficiencies and will take place within the larger context of funding other components of the PCCP. Success criteria for the enhancement, restoration, and creation of each natural community type will be established during the early phases of Plan implementation. It is beyond the scope of this monitoring chapter to establish the criteria for successful management and restoration.

7.4.2 Monitoring Grassland and Vernal Pool Grassland Complex Actions

In the Plan area, vernal pools are imbedded within a landscape of annual grasslands and are closely linked through various ecological and ecosystem processes – nutrients, water, and, organisms move between vernal pools and grasslands. Therefore, vernal pools and grasslands will

be managed together as a system. Adaptive management in vernal pool grassland complexes will be focused on enhancing and restoring hydrological processes of vernal pool complexes to benefit the suite of covered plants and animals that use vernal pool complexes and to promote populations of covered species and native biodiversity in grasslands. Management actions will be monitored to evaluate the effectiveness of management actions to enhance and restore vernal pool topography, hydroperiod, and water quality; to reduce or eliminate invasive nonnative vegetation; and to enhance and restore biodiversity and populations of covered species (e.g., vernal pool plants and invertebrates, western spadefoot toad, and grassland-dependent birds such as western burrowing owl and ferruginous hawk).

Primary management actions will be monitored and refined within an adaptive management framework to meet the biological goals and objectives for vernal pool grassland complex and annual grassland communities. These management techniques include livestock grazing, prescribed burning, mowing, and seeding to increase the cover of native plants and reduce the cover and biomass of nonnative, invasive plants; inoculating vernal pools with seeds and cysts of covered invertebrates and plants; physical manipulation of the topography of vernal pools to restore and enhance the hydroperiod of vernal pools; diverting polluted runoff from vernal pools; eliminating ground squirrel control efforts to allow populations of ground squirrels to increase; and restricting recreation and other damaging activities from sensitive vernal pool ecosystems.

Assess Condition of Natural Community

The PCA will monitor the status and trends of indicators of conditions in vernal pool grassland complexes and annual grasslands to evaluate community function. Monitoring protocol will ensure that sites are sampled consistently and at the same time of year to collect biologically meaningful and statistically comparable data. Baseline conditions will be documented to compare to future monitoring data to assess changing conditions, and to identify and prioritize enhancement and restoration actions. Monitoring actions may include the following:

- Using recent aerial photographs or other methods of remote sensing (e.g., Light Detection And Ranging [LIDAR]), pre-acquisition surveys, and post-acquisition surveys, document the density and distribution of vernal pools, seasonal wetlands, and grassland land-cover within the Reserve System. Wetland area will be mapped, and quality of hydrologic functions assessed and documented, during the wet season when pools are inundated.

- Identify sites suitable for restoration, and potentially, creation.

- Identify factors that may be limiting ecological and hydrologic functions, assess vernal pool complexes and grasslands (e.g., extent

of covered species, inundation period, water quality, extent of nonnative species, and extent of damage due to off-road vehicles). If ecological and hydrological functions are of low quality, or if quality is declining, adaptive management actions will be implemented. These actions will be site specific and may include restoring vernal pool topography through mechanical means; restoring hydrological function; diverting sources of pollution; managing vegetation through prescribed burning, prescribed grazing, introducing inoculae; and fencing vernal pools and creating recreational boardwalks.

- Assess and monitor invasive, nonnative species. The distribution of particularly invasive, problematic nonnative species will be mapped. The known or potential effects on ecosystem function, native biodiversity, and covered species will be documented to inform the management plan to eliminate invasive plant cover within the Reserve System.

- Develop a management-oriented conceptual model for the grasslands and vernal pool grassland complexes and identify indicators for community function as well as any critical uncertainties that may require additional directed studies. Important factors that affect vernal pool grassland communities that may be included in the conceptual model include precipitation, fire, grazing, invasion by nonnative species, and nitrogen deposition. Critical uncertainties may include the effects of global climate change on amounts and temporal patterns of precipitation on vernal pool hydroperiod and the effects of nitrogen deposition on populations of nonnative and native plants.

- If prescribed burns are feasible, and expected to benefit covered species and native biodiversity, prepare burn plans that include the monitoring of habitat before and after burns to assess the efficacy of prescribed burning in enhancing vernal pool grassland complexes and populations of covered species.

- Begin pre-treatment monitoring of sites considered for restoration and enhancement. Develop criteria for measuring success.

Monitor the Success of Vernal Pool Restoration Actions

The PCA will monitor vernal pool hydrological functions (e.g., hydroperiod, depth and size of pools, water quality) to assess the success of actions designed to enhance and restore vernal pools. As discussed in Chapter 5, although restoration actions will be determined on a case-by-case basis, they will generally include restoring vernal pool topography; restoring isolation of vernal pools from permanent (or longer-term water sources); re-introducing vernal pool cysts, seeds, and/or plants; restoring water quality; and removing nonnative, invasive, and non-vernal pool native species. Specific tasks are listed below.

- In coordination with the Wildlife Agencies, develop criteria to assess success of vernal pool restoration. Appendix Q, *Placer County Vernal Pool Functionality Assessment Method* provides guidance for developing protocol and criteria to assess the success of vernal pool restoration and enhancement efforts. Criteria may be based on the total acreage of wetted acres; the cover of native vernal pool plant species; inundation period; the relative abundance of species covered by this Plan; measures of biodiversity; and the amount of effort required to sustain hydrologic function. Baseline data associated with each success criteria will be collected from local, high quality reference pools. These data will be compared to data collected from restored and enhanced pools to assess the success of management actions.

- For each success criteria, develop monitoring protocol and define target measures. Target measures may be based on reference sites, previous restoration projects, and/or habitat requirements for covered species.

- Monitor the occurrences and trends of covered vernal pool species. Populations may colonize, or go extinct from, vernal pools. Monitoring efforts will track populations of covered species to evaluate the effects of management actions and changing environmental conditions (e.g., related to global climate change) on populations of covered species to help identify and assess potential future threats. Trends of populations can be assessed using indices of population status, such as number of pools occupied.

- Collect baseline information associated with each success criteria.

- Compare results of restoration efforts against baseline conditions and target measures.

Evaluate Effects of Water Quality Management Actions

The PCA will monitor water quality in vernal pools to assess the effectiveness of management actions implemented to protect and improve water quality in vernal pools. The tasks listed below will be implemented to determine the effectiveness of these actions on water quality.

- Survey watersheds to identify potential sources of polluted runoff. Develop a plan to treat (e.g., create vegetated buffer strips) or divert polluted runoff away from vernal pools, if feasible, without damaging the integrity of pools.

- Determine water quality indicators and develop target measures for each indicator. Target measures may be based on reference sites and/or habitat requirements for covered species.

- Collect baseline measures associated with each water quality indicator.

- Compare results of efforts to improve water quality (e.g., diverting point-source pollution; managing livestock) against baseline and target measures.

- Develop pilot projects that test the effects of different grazing practices (e.g., grazing intensity, duration, and season) on vernal pool water quality.

Evaluate Effects of Vegetation Management Actions, Tools, and Techniques

As discussed in Chapter 5, actions that relate to vegetation management include reducing thatch, nonnative plants, and invasive plants in vernal pool complexes; increasing forb diversity in vernal pool uplands and non-vernal pool grasslands; enhancing remnant populations of native grasslands; and reducing the risk of wildfire. Tools and techniques for implementing these actions include prescribed grazing, manual vegetation removal, prescribed burning (where feasible and when it can benefit the natural community and covered species), and the selected use of herbicides. The tasks below will be implemented in order to determine the effectiveness of these tools and techniques.

- For each action to be monitored, determine the appropriate monitoring indicators. Indicators may include the relative cover, abundance, or distribution of invasive plant species; the relative cover, abundance, frequency, or distribution of covered plant species; and the relative frequency of native forb species.

- Determine success criteria for selected indicators to evaluate the success of management actions in reducing the cover of nonnative, invasive vegetation and promoting the extent and diversity of native plants. Success criteria will be based on reference sites.

- Determine the appropriate protocol for measuring selected indicators. Collect baseline information associated with each indicator. Compare results of vegetation management against baseline and target measures.

- Develop a grazing plan for the Reserve System that integrates an experimental approach to achieving the biological goals and objectives of the Plan.

- If monitoring determines that tools and techniques have not been successful in improving indicators beyond baseline measures, or for achieving target measures, develop pilot projects that compare tools

and techniques, or that compare the effects of various regimes associated with each technique (e.g., intensity, duration, season).

7.4.3 Monitoring Oak Woodland Actions

Adaptive management of oak woodlands on the Reserve System will be implemented to protect and enhance a diversity of functional oak woodland types to benefit covered species and promote native biodiversity. To achieve this goal, management actions will be focused on promoting regeneration and recruitment of native oak species by planting seeds and seedlings and protecting seedlings from browsing; restoring valley oak woodland; managing invasive, nonnative plants, particularly in the understory using techniques such as grazing and prescribed burns; controlling feral, nonnative animals; and managing fuel loads to reduce the likelihood of catastrophic wildfire. To ensure the long-term persistence of oak woodlands in the Reserve System, the PCA will monitor the effectiveness of these management actions designed to restore the natural processes and native species found in these oak woodlands.

Assess Condition of Natural Community

Recruitment and regeneration within oak woodland communities will be enhanced through a limited prescribed-burn program, mechanical thinning, and other enhancement tools (e.g., planting seeds and seedlings) designed to reduce competition with seedlings by nonnative vegetation and to protect seedlings from herbivores (e.g., using seedling shelters). Baseline conditions will be documented on the Reserve System to identify areas where recruitment appears to be limiting oak regeneration; to identify areas in need of fuels treatments and the most suitable techniques to manage wildfire fuels. Documenting the baseline conditions against which change can be effectively evaluated may entail the tasks listed below.

- Assess oak stands (e.g., canopy coverage, tree condition, seedling and sapling abundance and survival, population age structure) to identify factors that may be limiting ecological functions. If canopy coverage is declining and/or tree recruitment is insufficient, adaptive management actions will be implemented to improve recruitment. These actions will be site-specific and may include modifying livestock practices, plantings, fencing saplings, reducing competing herbaceous vegetation, and controlling wild pigs.

- Develop a management-oriented conceptual model for oak woodland communities and identify indicators for community function as well as any critical uncertainties that may require additional directed studies.

- If prescribed burns are feasible and desirable, prepare burn plans that describe pre- and post-burn monitoring to determine effects.

- Begin pre-treatment monitoring of sites considered for enhancement. Develop criteria for measuring success.

Evaluate Effects of Actions to Restore and Enhance Oak Regeneration

Seedling recruitment and regeneration within oak woodlands can be limited by invasive weeds and nonnative plants in the understory (e.g., Gordon and Rice 2000), mammal herbivory (Borchert et al. 1989; Bartolome et al. 2002; Tyler et al. 2002), and seed predation by feral pigs (Sweitzer and Van Vuren 2002). Depending on timing, frequency, and intensity, fire may have a negative or no effect on recruitment and regeneration in oak woodland (Griffin 1977; Bartolome et al. 2002). However, fire decreases the density of understory weeds and plants, indirectly creating favorable conditions for recruitment and regeneration. Because of the complex interactions of herbivory, grazing, competition from invasive plants, and native species composition, monitoring in the community will focus on assessing potentially limiting factors. Oak woodlands on the Reserve System that have been identified by baseline surveys as being limited in their ability to recruit and regenerate native species will be targeted for enhancement and restoration efforts aimed at improving oak regeneration and recruitment into the canopy.

The monitoring program will evaluate the effects of wildfires, prescribed burning, and mechanical thinning on the regeneration and recruitment of dominant plants in oak woodlands. Additionally, the effectiveness of other enhancement efforts will be evaluated at targeted sites. The tasks listed below will be conducted to determine the response of enhancement and restoration actions on promoting regeneration and recruitment in oak woodlands.

- Initiate a pilot project to develop restoration measures for individual sites. The pilot project will include investigation of plant material requirements (e.g., collected and propagated from local sources); planting methods; and adaptive management and monitoring requirements including indicators and success criteria.

- Compare post-restoration vegetation to reference stands within the Plan area to determine effectiveness of restoration efforts. Remediate sites if initial success criteria are not being met.

- Determine indicator species for enhancement efforts and develop success criteria.

- Monitor success of enhancement efforts (seeding and planting, altered livestock practices, fencing saplings, reducing competing herbaceous vegetation and invasive plant species, and controlling wild pigs).

- Monitor the survivorship of plantings (e.g., oaks species and understory vegetation) in restored and enhanced sites.

7.4.4 Monitoring Riverine and Riparian Actions

Adaptive management of riverine and riparian communities is focused on the overall goal of promoting natural community functions and habitat heterogeneity and connectivity to benefit covered species and native biodiversity. Monitoring activities will focus on the effectiveness of management to accomplish the following:

- Improve habitat quality and connectivity for covered species and improve native biodiversity along riverine and riparian corridors;
- Enhance and restore riparian habitats at a diversity of successional stages;
- Control invasive species in riverine and riparian habitats;
- Improve in-channel habitat by removing or modifying anthropogenic features such as rip-rap and in-stream barriers, and installing in-channel habitat features (e.g., large woody debris) designed to enhance habitat for covered species; and
- Reduce sediment entering into Plan area streams and remove sediment in targeted stream reaches to improve habitat for target covered species (e.g., spawning habitat for salmonids).

Assess Baseline Condition of Natural Community

Understanding baseline conditions is an essential component of the monitoring and adaptive management process. Baseline conditions provide the background information necessary to interpret and quantitatively and qualitatively assess management success. Documenting baseline conditions will require the following tasks:

- Conducting pre-acquisition assessments and site inventories to document and map the distribution and condition of riparian and riverine communities to verify and revise, if necessary, existing maps of land-cover;
- Identifying and prioritizing sections of riparian and riverine habitat, within and outside of the Reserve System, suitable for restoration and enhancement;
- Documenting and assessing the connectivity of stream and riparian corridors throughout the Plan area and between reserves and other public lands, and prioritizing key riverine and riparian sections for acquisition, restoration, and enhancement;

- Synthesizing known water quality data, including sediment data; identifying key uncertainties; and prioritizing issues/topics for directed study;

- Developing a Quality Assurance/Quality Control Water quality monitoring plan for target Plan area streams;

- Monitoring presence of covered fish above and below potential barriers to identify and prioritize barriers for removal;

- Developing a management-oriented conceptual model of riverine and riparian habitat, and identifying ecological indicators for community function and uncertainties that may require directed studies; and

- Assessing the distribution and relative abundance of targeted nonnative, invasive plant species, including threats to ecosystem processes, covered species, and biodiversity, and prioritizing species for eradication.

Monitor Riparian Restoration and Enhancement Projects

Prior to the initiation of large-scale restoration projects, a pilot project(s) will be used to test and assess restoration methods, identify indicator species and success criteria to be used for larger-scale restoration projects. The monitoring activities listed below may be implemented to improve the likelihood of success of restoration efforts

- Assess recent riparian restoration projects within western Placer County watersheds for the successful use of monitoring protocols;

- Implement a pilot restoration project to test and develop restoration methods for individual riparian habitat and stream reaches, monitoring requirements, ecological indicators, and success criteria. Suitable local reference site(s) will be used to help develop success criteria, ecological indicators, and to serve as a comparison for restored sites. The results of pilot projects will be used to guide future riparian and riverine restoration efforts;

- Monitor the survivorship of plantings (e.g., riparian species such as willow, cottonwood, oaks, and elderberry) in restored and enhanced sites;

- Monitor the effectiveness of measures to control invasive species, and the effects of control on covered species. Monitoring efforts should provide data to evaluate potential impacts of invasive species control on covered species.

- Develop a long-term monitoring project to assess the effects of restoration and enhancement projects on native diversity, ecological processes, and covered species habitat.

Monitor Sedimentation

Although sediment deposition is natural, development enhances sedimentation rates and results in significant habitat degradation for most native aquatic species. Best Management Practices and other conditions on covered activities will be implemented in watersheds throughout the Plan area that will reduce sedimentation rates into Plan area streams by minimizing the creation of sediment at the source and reducing the rate at which it is deposited into stream systems (see Chapter 6). Sediment load will be monitored in targeted stream systems in the Plan area. The sediment load in a stream system can serve as a good indicator of habitat quality, particularly for covered salmonids and foothill yellow-legged frog. The monitoring efforts listed below will aid the PCA in measuring the efficacy of PCCP programs and identifying those areas that require more targeted study and/or action.

- Monitor the turbidity of flows in strategic locations throughout target stream systems in the Plan area to identify areas for sediment control projects, monitor the effects of activities in the watershed on sediment load, and monitor the effectiveness of sediment control efforts;

- Evaluate the effectiveness of in-stream, streambank, and riparian habitat improvements at minimizing and immobilizing sediment in Plan area streams; and

- Evaluate the effectiveness of gravel cleaning and augmentation in improving spawning habitat for covered fish species in a pilot study before cleaning and replenishing gravel more widely in Plan area streams.

Monitor Stream Restoration Projects

Stream restoration and enhancement projects in the Plan area will focus on removing channelization features, stabilizing banks, removing or modifying barriers to fish passage, recreating natural stream features such as meanders, pools, runs, and riffles, and reconnecting the floodplain to the active channel. These projects will serve multiple purposes, including reducing sediment deposition, improving fish passage through stream systems, improving salmonid spawning and rearing habitat, improving habitat for northwestern pond turtle and covered amphibians and biodiversity in general, and restoring ecological processes. Areas slated for stream restoration will be monitored before restoration commences and after restoration is completed to assess the effectiveness of the restoration project. The monitoring program will focus on evaluating whether an enhancement or restoration project is achieving its goals and objectives. This will be assessed by comparing the target of enhancement and restoration actions with success criteria. Success criteria will be project-specific, and will be established in project and reserve management plans. In addition, the following monitoring

tasks will be conducted to evaluate the efficacy of stream restoration projects.

- Develop specific, measurable success criteria for restoration projects and monitor indicators in restored areas to assess the efficacy in restoring natural hydrogeomorphic and ecological processes, and improving habitat for covered species;

- Use data from previous monitoring efforts (e.g., by CDFG, Dry Creek Conservancy, and implementation of the Auburn Ravine/Coon Creek Ecosystem Restoration Plan) and new PCCP monitoring activities to assess whether populations of targeted covered and other native species are increasing in relation to stream enhancement and restoration efforts; and

- Monitor sediment loading rates pre- and post project for projects designed to reduce sedimentation.

7.4.5 Monitoring Wetland and Pond Actions

Adaptive management of wetland and pond communities will be implemented to protect, enhance, restore, and create wetland and pond habitats for the benefit of covered species and native biodiversity. To achieve these goals, management actions will be focused on

- Restoring and creating wetlands and ponds;

- Managing ricelands to provide habitat for giant garter snake and native biodiversity (e.g., overwintering waterbirds);

- Managing native wetland vegetation to provide habitat for covered species (e.g., California black rail);

- Reducing the cover of invasive plants;

- Controlling or eliminating invasive animals from wetlands and ponds;

- Enhancing structural complexity of wetlands and ponds to provide cover and basking sites for covered and other native species;

- Protecting wetlands from impacts caused by overgrazing; and

- Enhancing hydrologic function and maintaining water-levels suitable for target covered species.

Monitoring actions will focus on monitoring these conservation activities to assess and improve their effectiveness in achieving the biological goals and objectives through adaptive management. Monitoring actions will

also track the response of target species to habitat management activities.

Assess Condition of Natural Community

The PCA will monitor status and trends of key characteristics of wetland and pond communities to evaluate community function. The tasks listed below will be conducted to determine the baseline condition of wetland and pond communities on the Reserve System.

- Use pre-acquisition assessments, site inventories, and other surveys to establish the distribution and abundance of ponds and wetlands within the Reserve System. Map the distribution and assess connectivity of wetlands, ponds, and associated upland areas.

- Develop a conceptual ecological model for wetlands and identify indicators for community function as well as any critical uncertainties that may require additional directed studies.

- Prioritize wetlands and ponds for enhancement, restoration, and creation efforts. Potential restoration sites will be identified and selected on the basis of their physical processes and hydrologic, geomorphic, and soil conditions to ensure that successful restoration can occur and be self-sustaining.

- Evaluate the hydrological conditions of wetlands and ponds to determine whether hydrological conditions (e.g., hydroperiod, water quality, etc.) are suitable to support target covered species. Prioritize sites for restoration and enhancement actions to restore and improve hydrological function.

- Assess the distribution and relative abundance of nonnative invasive animals in wetlands and ponds. Prioritize these sites for invasive animal control/eradication programs.

- Assess the distribution and relative abundance of nonnative invasive plants; their known or potential effects on ecosystem function, covered species and other native biological diversity, sensitive natural communities; and the means and risk of their spread to other areas inside and outside the Reserve System.

- Assess the condition of adjacent upland habitats to identify restoration and enhancement actions to restore and improve adjacent upland habitat for target wetland-dependant species. (see Chapter 5, Conservation Actions and Appendix D, Species Accounts, for a description of the upland conservation actions and habitat requirements for wetland-dependant species);.

- Begin pre-treatment monitoring of sites considered for enhancement and restoration and develop criteria for evaluating success. These

criteria will be suitable to evaluate management of hydrogeomorphic and ecologic functions, habitat value, and landscape connectivity.

- Identify and track additional threats (e.g., disease, invasive) and manage adaptively to contain these threats.

Evaluate Habitat Enhancement, Restoration, and Creation Activities

Wetland and pond enhancement, restoration, and creation will be monitored to assess the efficacy of these actions and improve success through adaptive management. The tasks listed below will be conducted to determine the response of covered species, water quality, invasive plants and animals, and other community functions to these enhancement, restoration, and creation actions.

- Determine indicator species for monitoring enhancement, restoration, and creation and develop success criteria to assess the effectiveness of these actions.

- Initiate a pilot project to develop restoration, enhancement, and creation measures for individual sites on the basis of hydrologic conditions; extent and quality of existing habitats (e.g., percent native vegetation and presence/absence of nonnative wildlife such as bullfrogs); existing wildlife using the site; and the potential for adverse impacts to covered species (e.g., removal of invasive vegetation that is being used for substrate by covered species). These measures will include descriptions of plant material requirements (e.g., collected and propagated from local sources); planting and construction methods; and adaptive management and monitoring requirements.

- Determine and quantify changes in habitat that result from wetland and pond enhancement, and restoration. Monitor the survivorship of planting; quantify the extent of emergent wetland vegetation in ponds; and describe habitat quality, connectivity, and response of covered species to enhancement, restoration, and creation projects. Use predetermined criteria to measure success.

- Monitor hydrological conditions of wetlands and ponds to ensure that indicators of target hydrological function have been achieved and are being maintained (e.g., do wetlands restored to provide nesting and year-round habitat for California black rail have adequate levels of water throughout the year?)

- Determine use of artificially created ponds by covered species.

- Evaluate the use of wetland-upland complexes by covered species.

7.4.6 Monitoring Agricultural Land Conservation Actions

The PCCP seeks to preserve a sustainable balance of agriculture and conservation within the landscape. To achieve this, the Reserve System will include agricultural land managed for a variety of wildlife-compatible agricultural uses (see Chapter 5, Section 5.3.7, Agricultural Land Conservation and Management). Monitoring actions will evaluate the effectiveness of agricultural land uses and management to provide habitat for target covered species and other wildlife (e.g., migratory waterfowl and shorebirds, raptors), protect and improve water quality, enhance connectivity between natural communities, and buffer natural communities and other existing biological resources from urban/suburban development.

Assess Condition of Agricultural Land and Ability to Provide Habitat for Covered Species

The PCA will monitor agricultural land to document baseline conditions, evaluate community function, and identify enhancement and other management actions to be implemented to enhance community functions and habitat for covered species and other wildlife. These tasks include:

- Use pre-acquisition assessments, site inventories, and other surveys to identify land to be managed for agriculture; the distribution of wetlands and potential habitat for covered species and wildlife; the distribution of areas that will be enhanced to improve community functions and to provide habitat and connectivity for covered species; and to inform the development of agricultural land management plans.

- Assess the use of existing agricultural land by covered species and other wildlife. This information will be used to assess the success of future agricultural uses and management practices in providing habitat for covered species and other wildlife.

- Develop a conceptual ecological model for agricultural lands and identify indicators of community function.

- Prioritize habitats and other areas for enhancement and restoration (e.g., planting of nest trees for Swainson's hawk; planting vegetated buffer strips; erecting nest boxes). Sites will be identified and selected based on their potential to provide habitat for covered species and wildlife, to provide ecosystem services (e.g., filter runoff; pest management), and compatibility with economically viable agriculture.

- Identify areas that will be managed to provide habitat for target species such as giant garter snake, bald eagle, tricolored blackbird, over-wintering waterbirds, and other wildlife.

- Identify suitable wildlife-compatible agricultural uses and management practices for the reserve that are compatible with the biological goals and objectives of the PCCP.

- Begin pre-treatment monitoring of sites considered for enhancement and develop criteria for evaluating success. These criteria will be suitable to evaluate whether management enhances habitat for target covered species and other wildlife and enhances target ecosystem services.

Monitor Actions to Promote use of Agricultural Land by Covered Species and other Wildlife

As discussed in Chapter 5, the biological goals and objectives for agricultural lands include agricultural land management activities that support habitat for covered species and other wildlife and benefit natural communities. The following are specific monitoring tasks that will help the PCA achieve these goals and objectives:

- Develop criteria to evaluate the success of agricultural land management (e.g., leaving winter cover crops; depth of water and timing of flooding in ricelands) in enhancing habitat for target covered species, other wildlife, and ecosystem services.

- Monitor ricelands and other habitats (e.g., irrigation canals and other waterways) managed to provide habitat for giant garter snake for occurrence of giant garter snake.

- Develop pilot projects that test the effects of different agricultural management techniques (e.g., different cover crops, crop harvest height) on use by target covered species and wildlife.

7.5 Species-Level Actions

The PCA will monitor the status of covered species to determine the extent to which the biological goals and objectives for species are being met. Species monitoring will address the following issues relevant to the PCCP.

- Status and trends of covered species and other relevant species within the Reserve System.
- The response of covered species to PCCP conservation measures and adaptive management (i.e., effects-of-management monitoring, described above in section 7.2.1).

- Directed studies to resolve critical management uncertainties for some covered species (i.e., directed studies, described above in section 7.2.1).

In some cases, covered species are the response variable for effects-of-management monitoring at the community level (e.g., relative abundance of vernal pool invertebrates found in restored pools compared to reference pools). In those cases, monitoring is described in section 7.4, Natural and Semi-natural Community-level Actions.

7.5.1 Species-Specific Monitoring Tools

Species monitoring will provide data for use by the PCA as well as the Wildlife Agencies, universities, and wildlife conservation organizations to assess the status of populations of species (e.g., presence/absence, indices of relative abundance), to identify the conservation needs of species, and to direct future conservation efforts. This information may also be used to redirect or refine PCCP conservation efforts in future years to improve conditions on reserve lands for declining species. (Any redirection of Plan funds in response to monitoring must be carried out in accordance with the terms and conditions of the Implementing Agreement and permits, including the No Surprises assurances.)

Indicators

Surrogate Species. It may be difficult to detect individuals of certain species due to small body size, rarity, or behavior. Where appropriate, other species can be used as surrogates for covered species that are difficult to monitor. The PCA will document the rationale for using surrogates. A more general discussion of indicator species is provided above in Section 7.2.3, Guidelines for Monitoring.

Focal Covered Species. The status of all covered species will be monitored during the 50-year permit term. To facilitate the monitoring of covered species, a multi-species approach will be used, to the extent possible, for long-term monitoring. Focal species are defined in the literature in different ways. Focal species can be used as indicators in landscape or community-level monitoring (Lambeck 1997) or (as in this Plan) as indicator species that are used in multi-species monitoring. In either case, focal species should be sensitive to threats and provide information on the suite of species with which they are associated. Focal covered species within species groups will be monitored routinely to provide the data most likely to influence the conservation strategy and to manage costs effectively. In some cases, focal covered species may be used when information on some species is highly correlated with other species, and intensively monitoring all species provides little additional information.

Species will be grouped for ease in prioritizing and standardizing survey requirements for individual species. If appropriate, sampling stations may be used to collect information on multiple species.

Habitat Indicators for Species. Selecting the best attributes by which to measure the population status of covered species increases the effectiveness of monitoring. Monitoring presence/absence, relative abundance, and distribution of adults (e.g., as opposed to eggs or juveniles) is often the most appropriate, direct measure of status of covered species. However, in many cases monitoring protocols for certain species yield variable and imprecise results or requires a prohibitively expensive sampling effort. In these cases, key habitat variables may be used—in conjunction with other information—to evaluate the status of species. This method requires targeted studies to determine the relationship between the habitat attribute and the presence or relative abundance of a species. The hypothesized relationships will be periodically retested to confirm that that the relationship between the indicator and the condition of the species has not changed to a point where the indicator is no longer useful. (See *Indicators* in Section 7.2.3, Guidelines for Monitoring, for additional information on selection of biotic and abiotic variables.) An effective monitoring program balances efficiency and cost-effectiveness with the reliability of the information obtained.

Species Models

Species Habitat Distribution Models. Parameters for the species habitat distribution models (see Chapter 3, Section 3.3.3, Covered Species, for a description of the habitat distribution models and the methods used to develop the models for the covered species; each species habitat distribution model can be found within the corresponding species account in Appendix D) will be refined and revised throughout Plan implementation as more information becomes available. These species-habitat models document the best current understanding of the biological and physical parameters that influence the habitat associations of each species in the Plan area and, in this way, are species-specific conceptual models. Species-habitat models were developed for all covered species to hypothesize a relationship between land-cover type and the distribution of covered species. These models served as the basis for estimating impacts and developing the conservation strategy. Information from the pre-acquisition surveys and post-acquisition inventories will be used to further refine these models to more accurately help predict distribution and occupancy.

Species Conceptual Models. As described above, conceptual models are an important component of the Monitoring and Adaptive Management Program. A critical task in the development of these models is the identification of uncertainties and threats or stressors. The identification of uncertainties provides a springboard for additional targeted studies. The models will also incorporate the anticipated effects of management actions on covered species.

In addition to the species habitat distribution models, conceptual models (i.e., envirograms, see below) have been developed for the covered species (Appendix D). These models will be refined using data from species surveys and other monitoring efforts. The envirograms provide a framework for the further development and refinement of conceptual models. The envirograms can be modified or used to develop different types of conceptual models.

An envirogram is simply a tool to identify important ecological factors that affect a population or group of populations of a particular species. The concept was developed originally by Andrewartha and Birch (1984), and envirograms were first applied to conservation planning by James et al. (1997) who used them to identify factors limiting the abundance of endangered red-cockaded woodpeckers in the southeastern United States.

An envirogram consists of a "centrum," components of the environment that directly affect a species' likelihood to survive and reproduce, and several "webs" – distal factors that act in sequence to affect the proximate components of the centrum. The centrum consists of four major categories: resources, reproduction, threats, and dispersal. Each of these can be subdivided as necessary. For example, resources could be subdivided into foraging habitats, breeding habitats, and food. The web identifies the underlying ecological processes or human actions that influence each centrum component. The idea is that distal factors in the web activate proximate components of the centrum. Each chain of activating factors forms a pathway. Pathways in the web are constructed from right to left, with Web-1 factors directly affecting centrum components, Web-2 factors affecting Web-1 factors, and so on.

Envirograms are intended to be used in conjunction with the species accounts and habitat distribution models to help inform conservation actions. They are considered to be "works in progress" and always can be modified by new and better information.

Grouping Species

Species have been categorized into three groups for the purposes of prioritizing monitoring and maximizing efficiencies (see Group numbers in following species-specific text). The grouping of each species will be re-evaluated every five years, or if listing status changes and species may move between the categories during the course of Plan implementation. The target species for status and trend surveys in acquired parcels will be based on informed by species models and preacquisition assessments.

Group 1 species include most of the covered species that are currently listed as endangered or threatened by either state and/or federal wildlife agencies. Baseline surveys will be initiated within one year of land acquisition. A survey schedule will be developed to ensure that species status is monitored at the appropriate seasonal periods within the year.

Initially, Group 1 species will be monitored on an annual basis; however, the frequency of monitoring may be adjusted on a species-by-species basis once the status of species in the Reserve System is established. For example, if western spadefoot toad has been monitored annually for 15 years and their populations are known to be stable or growing, annual monitoring may be adjusted to bi-annual monitoring to reserve budget for other conservation or monitoring actions. Recommended annual monitoring is for species status only. However, monitoring frequency for species addressed in finalized USFWS recovery plans will not fall below the recommend frequencies in these plans.

Targeted studies and monitoring related to the effects of management actions will take place on a time schedule that is relevant to the specific effort at hand, and the monitoring schedule for these activities will be developed on a case-specific basis. Success criteria and monitoring protocols will be developed to incorporate monitoring results into the adaptive management strategy. These monitoring actions are common for all Species Group 1 species within the Plan area.

Group 2 species are not currently listed, but the Plan area comprises a potentially important portion of the species' range. On average, a moderate level of monitoring effort will be needed for these species. Baseline surveys will be conducted within two years of land acquisition. Species-specific conceptual models will be developed on an as-needed basis. Monitoring variables and additional indicators (biotic or abiotic) will be selected within one year. A survey schedule will be developed to ensure that species status is monitored every 2–3 years. Success criteria and monitoring protocols will be developed to incorporate monitoring results into the adaptive management strategy. These monitoring actions are common for all Group 2 species within the Plan area.

Species in Group 3 may or may not be listed but the Plan area is not considered a critical component of the species' range. A relatively lower monitoring effort will be undertaken to establish the status and trends of these species. Baseline surveys will be conducted within five years of land acquisition. Monitoring variables and additional indicators (biotic or abiotic) will be selected. A survey schedule will be developed to ensure that species status is monitored at least every five years but up to annually, as appropriate. Success criteria and monitoring protocols will be developed to incorporate monitoring results into the adaptive management strategy. These monitoring actions are common for all Species Group 3 species within the Plan area.

7.5.2 Monitoring Birds

Document and Monitor Status of Covered Birds

Birds are relatively detectable by sight and sound with widely used, standardized survey methods such as point counts, transects, area searches, and spot mapping (Ralph et al. 1993). The status (e.g., presence, relative abundance) of most of the covered bird species can be monitored using these basic survey methods in the appropriate habitat (e.g., point counts are the preferred method for survey birds in forested habitats, but does not provide reliable data for waterfowl [Ralph et al. 1993]). Furthermore, relatively little additional effort is needed to document all birds detected, in addition to targeted covered species, so observers should document all birds detected at each point or on each transect. Bird species diversity can then be used to assess habitat quality or to evaluate the success of restoration and enhancement actions.

The status of covered birds can be monitored on the same surveys when they occur in the same habitats at the same time. To streamline survey efforts, bird surveys are grouped by season (overwintering and breeding season), habitat (e.g., grassland, oak woodland, valley foothill riparian), and location (Valley and Foothill). Surveys will be conducted regularly in each natural community to ensure that each covered bird species is sufficiently monitored. Some species may require additional monitoring; where necessary, species-specific monitoring is discussed in species-specific sections, below. Some species may be included in multiple sections because they winter and breed in the Plan area (e.g., western burrowing owl) and they occur in multiple habitat groups (e.g., Modesto song sparrow in wetlands and valley foothill riparian). The sampling protocol will be developed during early Plan implementation based on standardized methods (e.g., Ralph et al. 1993). In general, surveys will be conducted at regular time intervals, depending on monitoring group (e.g., once every three years), at fixed points or transects to allow comparison across years and sampling units. Observation effort will be standardize to a fixed period of time per point (e.g., 10 min) or length of transect (e.g., 100 m in 10 min) to standardize search effort. At each survey point or along each transect, the observer will document the number of individuals of each species detected and the distance to each individual (e.g., less than or greater than 50 m from the observer). Most individuals are reliably detected within a certain threshold distance, with the distance being greater in open habitats (e.g., 50 m in woodland habitats and 200 m in open, grassland habitat). Points or transects will be documented in GIS layers.

Evaluate Response of Birds to Habitat Enhancement

For many species, unless otherwise noted, habitat will be monitored at the natural community-level (see Section 7.4) to characterize the sites being surveyed; to relate habitat characteristics to estimates of distribution and abundance (e.g., compare relative abundance of ferruginous hawk detected in grassland vs. agricultural fields); and to evaluate the species' response to habitat enhancement and restoration. Therefore, it will be important to coordinate the locations of natural community-level monitoring plots or sites with bird (and other species-level) monitoring points or transects.

Species-specific monitoring actions are discussed in Table 5-X. The monitoring actions in this table identify "effectiveness monitoring" of conservation actions that will benefit covered species.

7.5.3 Overwintering Raptors – Valley Habitats (Group 3)

American Peregrine Falcon
Bald Eagle
Ferruginous Hawk
Western Burrowing Owl (Group 1: Breeding Season - Valley)

Document and Monitor Status of Overwintering Raptors

These four species primarily overwinter in open habitats in the Valley (though western burrowing owl may nest in the Valley in small numbers), and can be monitored using the same sampling protocol in their respective habitats. Winter bird surveys will be conducted to document baseline estimates of the number of overwintering American peregrine falcon, bald eagle, ferruginous hawk, and western burrowing owl (the PCA will also monitor western burrowing owl during the breeding season. See Section 7.5.5) on the Reserve System. Surveys will be conducted between December – February. These species can be readily detected on visual surveys. Observers will count all American peregrine falcon, bald eagle, ferruginous hawk, western burrowing owl and other bird species detected within a fixed radius of a point or distance from a transect. Other covered species such as grasshopper sparrow, loggerhead shrike, northern harrier, tricolored blackbird, and Cooper's hawk also overwinter in the Valley and may be detected on winter bird surveys. These species will also be monitored on breeding season surveys (see Sections below). Winter bird surveys will be conducted in the Valley habitats used by these species, including vernal pool grassland complexes, annual grasslands, wetlands (for American peregrine falcon and bald eagle), and agricultural land.

Monitor Potential Threats

Within the Plan area, these species are primarily threatened by factors that impact the amount, distribution (e.g., fragmentation), and quality of their habitats. Protection, enhancement, and restoration of habitat in the Reserve System are designed to ameliorate these factors. Other factors that threaten overwintering populations of these species are more difficult to identify, as the numbers of these species overwintering in the Plan area may be limited by factors occurring during the breeding season or migration. The PCA will regularly compare winter bird survey data with regional data collected by other monitoring projects (e.g., Christmas Bird Count and Breeding Bird Survey) to evaluate whether trends in the Plan area are consistent with trends elsewhere. Severe declines in the Plan area, when other regional populations remain stable, may indicate that threats in the Plan area are impacting overwintering raptors. If that is the case, the PCA will consult with the Wildlife Agencies and species experts to re-assess the conservation strategy and develop alternative strategies to benefit the affected species.

7.5.4 Breeding Season Birds – Open Habitats in the Valley (Group 1)

Swainson's Hawk
Grasshopper Sparrow
Northern Harrier
Loggerhead Shrike
Western Burrowing Owl

Document and Monitor Status of Breeding Covered Birds in the Valley

Grasshopper sparrow, northern harrier, loggerhead shrike, and western burrowing owl are included with Swainson's hawk in Group 1 (Swainson's hawk is listed by the State as threatened) because they can be detected together in open habitats in the Valley during the breeding season (though northern harrier nests in more densely vegetated patches) such as vernal pool grassland complex, annual grassland, fresh emergent wetlands, and agricultural lands. Modesto song sparrow may also be detected in some of these habitats, particularly in fresh emergent wetlands and shrubby areas. The status of Modesto song sparrow will also be monitored with surveys in valley foothill riparian habitats in the Valley and Foothills. Similarly, tricolored blackbird may be detected on these surveys if they are foraging or moving through these habitats or if a nest colony is located near a survey point or transect. Monitoring actions for tricolored blackbirds are discussed in Section 7.5.11. Breeding bird surveys will be conducted to document baseline estimates of the number of Swainson's hawk, grasshopper sparrow, northern harrier, loggerhead shrike, and western burrowing owl on the Reserve System. Surveys will

be conducted from April 15 – June 15 using standardized protocol discussed above (Section 7.5.3).

Monitoring Potential Threats and Species-specific Actions

Reproductive success (e.g., estimated as the number of offspring fledged from a nest) is an important indicator of the effects of potential threats to populations of breeding birds. However, estimating reproductive success is time and labor intensive (nests can be difficult to find, and must be monitored frequently to determine the outcome [e.g., fledged or depredated]), and large sample sizes are needed to reliably assess the relative effects of different management treatments or threats on reproductive success. Therefore, for most species, occurrence, relative abundance and/or distribution will serve as an indicator of population health. The PCA will regularly compare breeding bird survey data with regional data collected by other monitoring projects (e.g., Christmas Bird Count and Breeding Bird Survey) to evaluate whether trends in the Plan area are consistent with trends elsewhere. Severe declines in the Plan area, when other regional populations remain stable, may indicate that threats in the Plan area are impacting overwintering raptors. If that is the case, the PCA will consult with the Wildlife Agencies and species experts to re-assess the conservation strategy and develop alternative strategies to benefit the affected species.

Some species, such as Swainson's hawk, have relatively conspicuous nests and can be readily identified and monitored. Swainson's hawk nests sites will be surveyed once every three years to determine whether the nest site is being used by a nesting pair. The location of nest sites will be documented in GIS and used to inform restoration and enhancement actions to benefit Swainson's hawk. For example, areas with suitable foraging habitat, but no nesting activity may be planted with potentially suitable nest trees.

Western burrowing owl is rare in the Plan area and no longer breeds in the County (Pandolfino, pers. comm). Recent records of western burrowing owl in Placer County are likely of overwintering birds. Therefore, the western burrowing owl conservation strategy focuses primarily on protecting and enhancing overwintering habitat, with a secondary objective of facilitating the expansion of a breeding population into the Plan area (see Chapter 5, Section 5.5.5). The availability of suitable burrow potentially limits the distribution and abundance of western burrowing owl in the Plan area. Natural community-level monitoring in grasslands and suitable agricultural lands will survey for burrows and burrowing mammals to assess potential habitat for western burrowing owl and to inform enhancement actions. In addition, populations of burrowing animals will be monitored at sites where western burrowing owl is detected on overwintering and breeding season surveys (see Section 7.5.4), to help direct actions to protect and enhance habitat for burrowing animals and western burrowing owl.

7.5.5 Breeding Birds – Riparian and Oak Woodland (Group 3)

Riparian
Yellow Warbler
Yellow-breasted Chat
Modesto Song Sparrow
Cooper's Hawk

Oak Woodland
Cooper's Hawk

Document and Monitor Status of Breeding Covered Birds

The status of these four species will be monitored with breeding season surveys (May – June 15) in riparian habitats in the Valley and Foothills. Cooper's hawk will also be monitored with surveys in oak woodlands in the Foothills. Yellow warbler and yellow-breasted chat no longer breed in the Valley portion of the Plan area; however, riparian habitats are important migratory stopover habitat for these two warblers during spring and fall migration. Sites should be surveyed twice in a breeding season, at least 14 days apart, to help distinguish migrating individuals from breeding individuals, as migrating individuals are less likely to remain at a stopover site later in the breeding season.

Restoration of riparian habitat in the Valley may provide breeding habitat for yellow breasted-chat and yellow warbler: small numbers of yellow warblers have recently colonized restored sites at the San Joaquin River National Wildlife Refuge, where they had been previously extirpated. Restored riparian woodland should be monitored regularly, and sites should be included in these breeding bird surveys beginning seven to ten years after planting (or once canopy vegetation has reached sufficient height), to assess the use of restored sites by covered species and other birds.

Cooper's hawk can be difficult to detect on breeding grounds because of their secretive behavior, and detections on breeding surveys can be too low to estimate trends in abundance (e.g., North American Breeding Bird Survey [Sauer et al. 2008]). Standardized surveys should be used to assess presence, though will not be sufficient to determine absence, of Cooper's hawk. These data should also be supplemented with incidental observations of birds outside of standardized surveys.

Monitor Potential Threats and Possible Directed Studies

Brood parasitism and predation of nest contents (i.e., eggs, nestlings) can reduce reproductive success of individual yellow warblers, yellow-breasted chats, and Modesto song sparrow; however, impacts to populations of these species is variable and not well understood (Heath 2008; Comrack 2008; Gardali 2008). For example, densities of yellow warbler at Mono Lake restoration sites are high, and steadily increasing, despite relatively high rates of parasitism and no cowbird management (PRBO unpubl. data, as cited in Heath 2008).

Monitoring reproductive success (and sources of nest predation) is time and labor intensive (nests can be difficult to find, and must be monitored frequently to determine the outcome [e.g., fledged or depredated]). The PCA will consider conducting a directed study to assess brood parasitism and nest predation rates on yellow warbler, yellow-breasted chat, and Modesto song sparrow nesting in riparian habitats if future data from other sources indicate that nest predation is threatening populations of these species in the Plan area. If nest predation and/or parasitism rates are contributing to population decline, the PCA will consider controlling non-native nest predators (e.g., feral cats) and/or brown-headed cowbirds at sites where monitoring indicates that nest predation rates by non-native species and/or brood parasitism are high. Control methods (e.g., trapping) can be costly, controversial, and must be continued in perpetuity to maintain benefits; therefore the PCA will evaluate the use of brown-headed cowbird and nest predator control methods in collaboration with the Wildlife Agencies before implementing a program to control nest predators and brown-headed cowbirds. Furthermore, the PCA will use a pilot trapping study to determine the effectiveness of control in improving reproductive success of target bird species before implementing a control program.

7.5.6 California Black Rail (Group 1)

Document and Monitor the Status of California Black Rail

Potentially suitable habitat for California black rail includes fresh emergent wetlands in the Foothills. The primary objective of status-monitoring is to determine occupancy of wetlands by California black rail. Potentially suitable habitat will be surveyed where they occur on the Reserve System to detect presence. Occupancy is easier to determine than relative abundance (Richmond et al. 2008), so status surveys should initially focus on determining occupancy. California black rail is difficult to observe because of its secretive behavior and the dense vegetation of its habitat. To increase detectability, California black rail will be surveyed using call-playback response surveys (Evens et al. 1991; Richmond et al. 2008). With this method, recordings of calls are broadcast and the numbers of responding black rails are documented. Surveys will be conducted in spring through summer to assess occupancy and of

wetlands (although surveys can be conducted any time of year, if necessary, as California black rail are year-round residents in the Sierra Nevada foothills and respond to calls year-round). Protocol will be developed by the PCA based on standardized methods such as those used by Evens et al. (1991) and Richmond et al. (2008).

Populations of California black rail in the Sierra Nevada foothills likely persist as a metapopulation, or a population of separate populations linked by dispersal. Each wetland supports a population; these subpopulations may go extinct, but are recolonized by individuals dispersing from other populations. Unoccupied sites are important for the persistence of a metapopulation; therefore, unoccupied, but potentially suitable habitat should be regularly monitored to detect the presence of California black rail.

At each potentially suitable wetland, observers will assess habitat to inform restoration and enhancement actions. Restored fresh emergent wetlands in the Foothills will also be surveyed to assess occupancy and habitat features. Baseline habitat surveys will include the following:

- Document the location and perimeter of the wetland in GIS;
- Characterize the vegetation, including percent cover of vegetation and open water, and general species composition;
- Measure water depth and determine the source of water for each wetland (e.g., spring-fed, leak from canal). Because water levels likely fluctuate seasonally, the water levels in potentially suitable habitat should be measured regularly to assess habitat quality and identify remedial enhancement actions, if necessary; and
- Identify any apparent threats to the habitat (e.g., unreliable source of water, presence of nonnative predators, excessive grazing).

Baseline habitat assessments should be conducted outside the breeding season (from approximately July 15 – March 1), to minimize disturbance to breeding birds and nests. Location will be documented using GIS and to update the habitat model for California black rail (see Appendix D). The assessment data will be used to determine the potential for California black rail habitat to be enhanced or restored to support breeding adults in the future.

Monitor Potential Threats

The source for water for the majority of the wetlands inhabited by California black rails in the Sierra Nevada foothills is from intentional and unintentional inputs of irrigation water. As demands for water continue to grow in California, there will be increasing pressure to increase efficiency and thereby reduce water loss from agricultural delivery systems. California black rail habitat will be lost when a consistent source of water

is eliminated due to water conservation measures. As discussed above, the PCA will determine the source of water for wetlands that support or could support California black rail, and regularly monitor water levels in these wetlands, to inform management of California black rail habitat. When suitable habitat is threatened by loss of water, the PCA will work to purchase water to protect habitat.

Wetlands may also be threatened by overgrazing. Livestock may trample nests or individuals, destroy vegetation, and degrade water quality. Habitat assessments will evaluate potential threats to potential habitat to inform remedial actions. Such management actions may include fencing the wetland to restrict access by livestock; providing alternate water sources; or reducing stocking rates in adjacent grasslands and pastures.

It is expected that it will be relatively feasible to successfully restore and create habitat for California black rail in the Sierra Nevada foothills (Jerry Tecklin, personal communication 2009). However, habitat restoration is experimental in nature, and wetlands restored to provide habitat for California black rail may not be colonized by rails. Restored sites will be monitored to assess the status and condition of restoration efforts; to determine whether they are being colonized by California black rail; and to identify and remedy factors that may limit successful colonization.

7.5.7 Bank Swallow (Group 3)

Document and Monitor the Status of Bank Swallow

Although bank swallow is listed by the State as threatened, it is included in monitoring Group 3 because the Plan area is not considered a critical component of this species' range. Potentially suitable nest colony habitat for bank swallow occurs in banks along the Bear River down-stream from Camp Far Reservoir. Should reserves be acquired along the Bear River, banks will be surveyed for nesting bank swallow during the nesting season (April – May) by traversing the length of the stream within the reserve. In addition, reserves that include other larger streams (i.e., Coon Creek, Auburn Ravine) will be surveyed to document the presence of nesting bank swallows or the presence of potentially suitable nesting habitat. Observers will

- Document the presence of active nest colonies;
- Estimate the number of individuals and nests or actively used nest holes at the colony;
- Document the presence of apparently old colonies (i.e., old colony site no longer occupied) and the number of nest holes; and
- Assess potential threats to the colony.

Potentially suitable habitat will be surveyed once every five years. Should bank swallows be found nesting on reserves, colonies will be monitored annually to determine presence, estimate colony size, and assess potential threats to the colony.

Monitor Potential Threats

Bank swallow nesting habitat is naturally ephemeral, as natural river processes erode existing banks while creating new, suitable nesting habitat; therefore, the existing colony site on the Bear River is subject to erosive forces that may collapse the existing nest colony site while potentially generating new, suitable habitat. The existing colony is on private property, however, so opportunities to monitor and manage nesting habitat may be limited.

7.5.8 Tricolored Blackbird (Group 2)

Document and Monitor Status of Tricolored Blackbird

The primary purposes of monitoring tricolored blackbird are to document and estimate the size of nesting colonies on the Reserve System and to assess the quality, distribution, and quantity of potentially suitable nesting and foraging habitat to inform management of tricolored blackbird habitat.

Suitable tricolored blackbird nesting habitat will be surveyed during the nesting season to identify nest colonies. Surveys for nesting tricolored blackbird will occur during the peak nesting season (approximately April – June), when nest colony sites are occupied. Potentially suitable nest sites include large stands of Himalayan blackberry, generally located in pasture and grassland (as opposed to stands within riparian woodlands) and fresh emergent wetlands such as those dominated by cattails and bulrushes. All sites known to previously support a nest colony will be surveyed. Sites should be surveyed twice, approximately 10–14 days apart, to confirm the use of a potential nest colony site, and to estimate the number of breeding individuals at the colony. Surveys should be conducted by two observers at the same time, to obtain a more reliable estimate of breeding individuals. The mean number of breeding individuals counted by the two observers can be used as an estimate of the size of the breeding colony (observers should also estimate the range in size of the breeding colony). The observers will observe the colony through binoculars or a spotting scope at a distance that will minimize any changes in the behavior of the nesting birds. Where feasible, the PCA will coordinate with other efforts to monitor tricolored blackbird to standardize survey protocol to facilitate interpretation across monitoring efforts (e.g., Statewide Tricolored Blackbird Survey).

At each potential colony sites, the following information will be documented:

- Location and type (e.g., wetland, stand of Himalayan blackberry) of occupied and unoccupied nesting habitat. The perimeter of the colony site should be mapped with GPS, and the percent cover of wetland vegetation should be estimated;
- Presence of tricolored blackbirds and nesting individuals;
- Estimate of the range of size of the nesting colony;
- Type of nest colony substrate; and
- Presence of potential threats to the nesting colony (e.g., nearby rookery of black-crowned night herons).

Information on nest colony sites will be used to inform management of fresh emergent wetlands (e.g., those that may be managed to provide nest colony habitat for tricolored blackbird) and to inform the management of foraging habitat surrounding nest colony sites. Information on foraging habitat quality will be gathered during community-level surveys.

Evaluate Species Response to Restoration and Enhancement

The PCA will assess the use of wetlands enhanced and restored to provide nest colony habitat for tricolored blackbird. Potentially suitable wetland habitat will be surveyed regularly, using the methods described above, to assess the use of restored and enhanced habitat by tricolored blackbirds and to inform future restoration and enhancement projects. Restoration and enhancement actions in or adjacent to nesting colonies will occur outside the breeding season.

Monitor Potential Threats

Predation has been documented as a cause of complete nesting failure at some tricolored blackbird colonies in the Central Valley (e.g., Beedy and Hamilton 1999). Historical accounts documented the reproductive failure of nesting colonies to predation of nest contents by a diversity of avian, mammalian, and reptilian predators. Recently, especially in permanent freshwater marshes of the Central Valley, entire colonies (>50,000 nests) have been lost to black-crowned night herons, common ravens, coyotes, and other predators (Beedy and Hamilton 1999). Initial monitoring will not focus on monitoring reproductive success of tricolored blackbird because this species is easily disturbed while nesting (but see Meese 2010 for methods to estimate reproductive success). Furthermore, monitoring nest success may be too time consuming within the framework of this multi-species/natural-community monitoring program. The PCA will assess threats from potential nest predators by noting the presence of potential predators (e.g., heron species, common ravens, raccoons, etc.) during nest colony surveys. Should colonies be potentially threatened by

predators, the PCA will consult the Wildlife Agencies to develop remedial measures (e.g., flush black-crowned night herons from nearby roosts).

7.5.9 Vernal Pool Animals and Plants (Group 1)

Conservancy Fairy Shrimp
Vernal Pool Fairy Shrimp
Vernal Pool Tadpole Shrimp
Bogg's Lake Hedge Hyssop
Dwarf Downingia
Legenere
Ahart's Dwarf Rush
Red Bluff Dwarf Rush

Because the covered vernal pool invertebrates and plants inhabit the same or similar habitats, frequently co-occur, and are subjected to the same or similar threats and management actions, they are grouped together for monitoring priority and to increase monitoring efficiency. Many of the actions related to monitoring and adaptive management of habitat for covered vernal pool species are described in Section 7.4.3, Monitoring Grassland and Vernal Pool Grassland Complex Actions. The PCA will conduct species-specific monitoring actions to ensure that the enhancement and restoration actions are achieving the biological goals and objectives for the covered vernal pool species. In many cases, species-specific monitoring is a component of vernal pool community-level monitoring actions. For example, species diversity, occurrence, and/or relative abundance will be used to evaluate the success of community-level restoration and enhancement actions. Species-specific actions will include

- Documenting and monitoring the status of covered vernal pool species;
- Conducting targeted studies to resolve critical uncertainties about threats and management issues (i.e., directed studies; for example, evaluating the potential effects of increased nitrogen deposition on native species diversity in vernal pools), to improve management techniques (i.e., pilot projects), and to develop and refine protocol to monitor the status and trends of covered species (i.e., methods testing); and
- Evaluating the response of populations of target species to restoration and enhancement.

Document and Monitor Status of Vernal Pool Covered Species

All of the covered species in this group occur in vernal pool grassland complexes. Although the distribution of vernal pools and vernal pool

grassland complexes in the Plan area is generally known, little is known about the distribution of the individual vernal pool covered species in the Plan area. In particular, it is not known how widely the Conservancy fairy shrimp is distributed within the Plan area. One occurrence of the Conservancy fairy shrimp has been documented within the Plan area. However, that occurrence may have been a mis-identification or may have been the result of a rare dispersal event (C. Rogers, pers. comm.). As new reserves are acquired into the PCA Reserve System, the PCA will survey potential vernal pool habitat to document occurrence of covered vernal pool species and to prioritize sites for long-term adaptive management and monitoring. Protocols and sampling methods for monitoring occurrences and relative abundance of covered vernal pool species (including timing of surveys and monitoring intervals) will be developed by the PCA in coordination with USFWS, CDFG, and scientific working-groups. Targeted studies will be conducted to develop and test monitoring protocols designed to assess status and trends of covered species and community function. Appendix Q, *Placer County Vernal Pool Functionality Assessment Method* provides guidance for developing protocol and criteria to assess the success of vernal pool restoration and enhancement efforts. This guidance can be used to design initial protocol to monitor status and trends of populations of covered vernal pool invertebrates. A separate protocol will be developed to monitor status and trends of covered vernal pool plants. Existing protocols, such as the interim survey guidelines for vernal pool branchiopods (USFWS 1996) may also be used as a template for developing sampling protocols. Protocols will be standardized with regionally-used protocols to facilitate comparison of data with other monitoring efforts throughout the geographic ranges of the covered species. Pilot studies may be used to design cost-effective sampling protocols of sufficient statistical power to detect trends in populations of target species. Sampling methods will be designed to allow statistical inference to a greater area than that which is sampled (e.g., using randomized or stratified random sampling designs), such as the portion of the Reserve System within the Valley.

Because many of the vernal pool covered plant species are annuals that do not bloom every year, it may be difficult to determine whether one or more of the covered plant species occurs at a site and how to prioritize management efforts. Immediately after acquisition, monitoring of plant populations should occur frequently (e.g., annually) and for a long enough period (e.g., long enough to encounter a season with average and above average rainfall) to determine the distribution of covered plant species on Reserves.

Monitoring of covered plant species and other native plant populations will be timed to occur during the period when plant species are flowering (e.g., generally spring months). Species such as legenere can be difficult to detect during monitoring surveys, because legenere can occur within matted vegetation at the bottom of drying vernal pools. Protocols will be designed to maximize detection probability while minimizing impacts to covered species.

As discussed above, protocols will be refined using methods testing and pilot projects. One potential monitoring method is to sample representative portions of the pool bottom, edges, and vertical water column using a seine, dip net or aquarium net appropriate for the size of the pool (USFWS 1996). Then, covered species may be detected by identifying the sexually mature, adult branchipods that occur within the samples.

To identify factors that may be affecting populations of covered species at pools being sampled to assess status and trends, the PCA will

- Assess the vegetation management regime (e.g., grazing/ mowing regime) that has been implemented within the sampled vernal pool complexes and associated upland habitat;
- Assess water conditions such as quality, hydroperiod, and depth and size of pools;
- Survey the distribution and relative abundance of invasive plants and animals; and
- Assess the presence of other potential factors seemingly affecting habitat at a given location.

Occurrences of species will be documented using GIS and will be used to prioritize sites for enhancement and restoration actions, to identify factors that limit the distribution of each species in the Plan area, and to inform future acquisition. Variables that characterize vernal pool habitat (e.g., size, depth, pH, vegetation composition) will be measured at each pool, and along with species occurrence data, will be used refine species-specific habitat models, management-oriented conceptual models, future acquisition (e.g., acquisition may need to target larger pools if baseline data indicate that large pools are underrepresented on the Reserve System and habitat-relationships indicate that certain covered species tend to occur in larger pools [e.g., Bogg's Lake hedge hyssop, vernal pool tadpole shrimp]), and restoration and enhancement.

At locations where potential habitat for vernal pool covered species occurs, but where they are not found, the PCA will document the presence of factors that may be impeding use of the site (e.g., presence of nonnative predators, inability to colonize site, etc.). These assessment data will be used to identify unoccupied vernal pools to be enhanced or restored to support covered species populations in the future, and to identify pools to be inoculated with cysts and/or seeds of covered vernal pool invertebrates and plants.

Evaluate Species Response to Enhancement and Restoration of Vernal Pool Habitat

Vernal pool restoration is an important component of the vernal pool conservation strategy. However, effective species-specific management and restoration techniques have not been developed for many of the vernal pool species covered in this Plan (USFWS 2005). Management actions will likely need to be tailored to site-specific conditions because threats and environmental conditions vary geographically and for each species. Therefore, the success of enhancement and restoration in aiding the conservation and recovery of these species depends on monitoring and adaptive management to refine enhancement and restoration methods.

The PCA will monitor the response of populations of covered vernal pool species to restoration and enhancement actions to adaptively improve enhancement and restoration efforts. For example, controlling invasive plant species in vernal pools is a high management priority. However, some management techniques may benefit some species, while being detrimental to others. Studies of various measures to control invasive species will be conducted to assess the response of populations of covered species to these methods to ensure the conservation of all vernal pool covered species within the Reserve System. Furthermore, populations of vernal pool species are likely to fluctuate regardless of management actions. Therefore, it may be necessary to also compare the fluctuations in the relative abundance of species at restoration and enhancement sites to the fluctuations that occur at reference sites. Studies may also evaluate the success of restoration and enhancement actions by comparing the relative abundance of adult invertebrates before and after treatments, as indicated by the number of adults found in pre-specified numbers of water samples. As discussed above, Appendix Q, Placer County Vernal Pool Functionality Assessment Method can be used to guide the design of protocol to monitor status and trends of populations of vernal pool invertebrates and their response to restoration and enhancement actions.

The condition and function of vernal pools are intimately tied to the surrounding uplands, and management of upland grasslands can affect populations of covered species in vernal pools. Therefore, vernal pool grassland complexes will be adaptively managed as a system. In general, changes in the relative abundance of covered vernal pool species will be monitored and correlated with upland restoration and enhancement actions to determine how those actions (and associated management techniques) are affecting their populations. For example, if actions such as prescribed grazing or re-vegetation are implemented in an upland area surrounding a vernal pool, and the relative abundance of covered species increases in that pool over time, then some of that success could be attributed to the upland management techniques. This would be especially true if the relative abundances within reference pools did not increase (or did not increase at the same rate).

Restored and created vernal pools must be constructed to support a hydroperiod suitable for the targeted covered species. Monitoring of the depth and inundation period of vernal pools can be used to determine whether restored and degraded vernal pools remain inundated long enough to allow covered vernal pool invertebrate species to complete their life cycles—but are also short enough to restrict predation by dragonflies and other predatory invertebrate species that emerge late in the spring. One way to monitor the depth and inundation period of relatively large vernal pools is to install staff gauges in the deep and shallow portions of a pool. For relatively small pools, it may be possible to use temporary gauges in combination with hydrographs and photo-monitoring. Restored pools that are not providing a hydroperiod sufficient to support target species will be repaired or enhanced to improve hydrological function. Similarly, hydrological monitoring can be used to identify degraded pools in need of modification/enhancement to improve hydrological function.

Potential Directed Studies

Evaluate the Effects of Grazing Intensity

Moderate grazing can benefit vernal pool covered species by decreasing evapotranspiration, and thus increasing inundation periods and the amount of time available for covered species to complete their life cycles (Marty 2004, 2005; Pyke and Marty 2005). However, grazing can also lead to trampling of cysts and plants, as well as leading to impaired water quality. The negative impacts of grazing can be minimized by determining optimal stocking rates, using cattle stock that are less likely to congregate in pools, and moving cattle away from vernal pools in the late spring months through fencing and the placement of stock ponds. Because the most optimal grazing regimes for vernal pools have yet to be determined, directed studies (such as pilot projects) can provide much needed information regarding the grazing regimes that most increase populations of covered vernal pool species.

Evaluate the Pollination Biology of Legenere

Fragmentation and degradation of upland habitat surrounding vernal pools may reduce the amount of pollinators (e.g., bees) that pollinate flowers of plants in vernal pools. If pollination rates are too low, plants may not be producing enough seeds to sustain their population. Therefore, it is important to understand the pollination biology of vernal pool plants to determine whether enhancement actions should be directed at factors that could be limiting pollination rates. The pollination biology of legenere has not been studied (the other covered plant species are either wind pollinated or self-compatible, so factors that limit the abundance of pollinators are not as great an issue for the other covered plant species). To determine whether legenere is self-pollinated, insect exclosure experiments could be conducted on legenere in the field to determine whether legenere sets seed in the absence of insects.

Covering flowers with fine mesh netting and comparing the production of seeds to those produced by nearby uncovered flowers is a simple way to test whether legenere is self-pollinated. If legenere requires insects for pollination, management actions should be implemented to protect and enhance populations of pollinators.

Monitor Potential Threats

In unprotected areas, vernal pools are often degraded by off-road vehicles and other recreation activities. It may be necessary to monitor visitor use, especially at sites that are vulnerable to trespass. This is especially important for covered vernal pool invertebrates because cysts and adults can be trampled by off-trail hiking and off-road vehicular use. Visitor use can be monitored by using randomized patrols or monitoring the amount of all-terrain vehicle (ATVs) tracks or the amount of trash that is found in and around vernal pools.

Global climate change will likely impact vernal pool ecosystems through changes in the amount and timing of precipitation and changes in temperature. Such changes could impact the hydrological conditions in vernal pools, potentially altering the species composition and diversity in vernal pools. The PCA will monitor indicators of vernal pool community function that can be compared to climate data collected from local weather stations to correlate changes in climate to conditions in vernal pools. Such data may be used to develop hypotheses about the causes of abiotic and ecological changes in vernal pools, which can be further evaluated through directed studies. Directed studies, in turn, could inform new management strategies adapted to treat the new conditions.

7.5.10 Western Spadefoot Toad (Group 2)

Document and Monitor Status of Western Spadefoot Toad

Western spadefoot toad occurs primarily in vernal pool grassland complexes in the Plan area. Although the distribution of vernal pools and vernal pool grassland complexes in the Plan area is generally known, little is known about the distribution and abundance of western spadefoot toad in these habitats (all of the documented occurrences in western Placer County occur in the non-participating cities [see western spadefoot toad species account, Appendix D]). As new reserves are acquired into the PCA Reserve System, the PCA will survey potential aquatic and upland habitat to document occurrence of western spadefoot toads, to document baseline levels for population monitoring, and to prioritize sites for long-term adaptive management and monitoring.

Western spadefoot toads are best observed at night (above-ground activity of adults is primarily nocturnal) during the wet season (January – May), when they have emerged from burrows to breed. Surveys for western spadefoot toads will therefore be conducted during the wet

season. Night surveys of calling adults may be conducted during the breeding season to identify occupied habitats or patches. Data on the proportion of occupied patches can be used to evaluate the metapopulation dynamics of western spadefoot toad, as this species may exist in a metapopulation structure[3] (USFWS 2005). Pools may be surveyed for egg masses and/or tadpoles to obtain an index of breeding effort and population size. The seasonal timing of egg-laying depends on a combination of rainfall and temperature; the critical thermal minimum temperature of embryos is approximately 48°F (Brown 1967), so egg laying does not occur until rainfall and temperature are adequate to form suitable sized pools of adequate temperature – generally occurring by late winter (Jennings and Hayes 1994). Surveys to evaluate reproductive effort may assess the proportion of surveyed pools with egg masses or tadpoles, the number of egg masses per pool, or some other index of reproductive output and habitat suitability. Pools may be sampled with seine nets to confirm presence of western spadefoot tadpoles (e.g., Fisher and Shaffer 1996) and the presence of nonnative predators (e.g., mosquito fish, bullfrog). Protocols and sampling methods for monitoring occurrences and relative abundance of western spadefoot toad (including timing of surveys, monitoring intervals, and sampling design to determine how many and which pools will be sampled) will be developed by the PCA in coordination with USFWS, CDFG, and scientific working-groups. As discussed above, protocols may be refined using methods testing and pilot projects.

At each location where spadefoot toads are found, the PCA will assess and document the following:

- An assessment of upland habitat.
- Presence of nonnative bullfrogs, fish, and other potential predators; and
- Presence of other factors and threats that may affect breeding success.

At locations where potential habitat for western spadefoot toad occurs, but where western spadefoot toad is not found, the PCA will assess habitat suitability and document the presence of factors that may be impeding use of the site.

Location will be documented using GIS and will be used to prioritize sites for enhancement and restoration and to prioritize adjacent non-Reserve sites for acquisition. This information will also be used to update the habitat model for western spadefoot toad (see Appendix D). The assessment data will be used to determine the potential for unoccupied

[3] A metapopulation is a group of populations linked by immigration and emigration. Local populations may go extinct, but the metapopulation as a whole is maintained by dispersal between, and colonization of, suitable habitat patches.

breeding habitat to be enhanced or restored to support breeding adults in the future. It will also inform how proposed restoration or enhancement vernal pool grasslands complexes might affect western spadefoot toad breeding and non-breeding, upland habitat.

Evaluate Species Response to Enhancement and Restoration of Vernal Pool and Grassland Habitat

The PCA will monitor the response of western spadefoot toad populations to enhancement and restoration of vernal pool grassland complexes to assess the efficacy of management actions in providing habitat for western spadefoot toad. Restored and created pools will be surveyed for the presence of, and use by, western spadefoot toads for breeding. As with enhanced pools, restored and created pools will be surveyed for the presence of adults, egg masses, and tadpoles. The hydroperiod of restored and created pools will be monitored, along with the phenological progression of reproduction (e.g., seasonal timing of egg-laying through metamorphosis), to determine whether such pools are providing aquatic conditions suitable for successful reproduction (e.g., metamorphosis of tadpoles) by western spadefoot toad. Pools restored or created to provide breeding habitat for western spadefoot toad that are found to not provide suitable aquatic conditions for successful reproduction may be enhanced (e.g., by altering grazing regime to control invasive plants) or physically manipulated to improve hydrological conditions.

Livestock grazing will be used in to manage invasive plant species in vernal pools and the surrounding uplands. Moderate amounts of grazing can increase the hydroperiod (i.e., increase inundation period) of pools compared to ungrazed pools (Marty 2005). However, livestock may trample or consume adults, tadpoles, and egg masses. Overgrazing may deplete water levels in pools, preventing complete metamorphosis of tadpoles or in some cases, causing accelerated metamorphosis to occur which may result in individuals that are less fit (Morey 1998; USFWS 2005). Grazing regimes (e.g., stocking rates, timing, rotations) will be monitored to identify regimes that minimize these potentially harmful impacts to western spadefoot toad.

Western spadefoot toad needs pools free of non-native predators to successfully metamorphose (Jennings and Hayes 1994). Pools will be monitored for the presence of non-native predators such as bullfrog, crayfish, and predatory species of fish to restore and maintain non-native predator-free conditions in breeding habitat. Bullfrog populations may be monitored by counting egg masses or surveying for adults during night surveys. Non-native predators may also be detected during surveys for egg masses and tadpoles.

Monitor Potential Threats

The PCA will monitor for occurrence of diseases, including chytrid fungus and any other harmful diseases that may occur within the Reserve System. This monitoring will include assessing the effectiveness of any disease-control measures. Spreading of diseases-causing agents such as chytrid fungus becomes a concern when biologists access more than one breeding site in a short period of time. Biologists will implement accepted antiseptic protocols during all aquatic survey work to minimize the potential for cross-contamination. The Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005) includes a suggested procedure for minimizing the transmission of disease and pathogens between aquatic resources.

Amphibians are particularly susceptible to exposure to chemicals and toxins that may pollute their habitats. Western spadefoot toad is exposed to a variety of toxins throughout its range, but the sensitivity of this species to pesticides, fertilizers, heavy metals, air pollutants, and other contaminants is largely unknown (USFWS 2005). During surveys of adults, tadpoles, and egg masses, monitors will document incidental observations of dead individuals and individuals that appear to be in ill health. Should incidental data indicate contamination of habitats by disease or toxins, the PCA will notify the Wildlife Agencies to develop an appropriate response.

7.5.11 Valley Elderberry Longhorn Beetle (Group 1)

Document and Monitor Status of Valley Elderberry Longhorn Beetle

As new reserves are acquired into the PCA Reserve System, the PCA will survey potential habitat to document the occurrence and relative abundance of host elderberry plants and valley elderberry longhorn beetle and to prioritize sites for long-term adaptive management and monitoring.

Protocols and sampling methods for detecting and documenting occurrences and relative abundance of valley elderberry longhorn beetle (including timing of surveys and monitoring intervals) will be developed by the PCA in coordination with USFWS, CDFG, and species experts to monitor distribution and relative abundance in the Reserve System. (The USFWS has developed guidelines for monitoring valley elderberry longhorn beetle populations [USFWS 1999]). One potential method for detecting occurrences is to search for the exit holes that are created by the larvae when the larvae move to different stems or when the larvae begin to mature into adults (USFWS 1999). Protocols to monitor status and trends may be refined using methods testing.

At each Reserve where potential habitat for valley elderberry longhorn beetle occurs, the PCA will assess and document the following:

- The distribution and relative abundance of host plants (i.e., elderberry species);
- Relative health and age of the host plants;
- The distribution and relative abundance of valley elderberry longhorn beetle (e.g., as indicated by exit holes);
- The proximity to other habitats; and
- The presence of factors (threats) that could affect breeding success (e.g., adjacent land use, pesticide-use).

Occurrences will be documented in GIS and will be used to prioritize sites for enhancement and restoration and to identify potential factors that limit the distribution of valley elderberry longhorn beetle in the Plan area. This information will also be used to update the habitat model for valley elderberry longhorn beetle (see Appendix D). At locations where potential habitat for valley elderberry longhorn beetle occurs, but where valley elderberry longhorn beetles are not found, the PCA will document the presence of factors that may be impeding use of the site. Based on the assessment data, if conditions are suitable, the PCA will develop a plan to enhance and/or restore riparian habitat for existing populations and transplant elderberry that are occupied by valley elderberry longhorn beetle into appropriate sites.

Evaluate Species Response to Enhancement and Restoration of Riparian Habitat

The PCA will monitor the response of valley elderberry longhorn beetle populations to enhancement or restoration actions designed to improve and restore habitat for valley elderberry longhorn beetle. One way to evaluate the success of restoration and enhancement actions and techniques is to compare the relative abundance of valley elderberry longhorn beetle individuals or exit holes before and after treatments. Valley elderberry longhorn beetle populations are likely to fluctuate regardless of management actions. Therefore, it may be necessary to compare the fluctuations that occur in the relative abundance of valley elderberry longhorn beetle at restoration and enhancement sites to the fluctuations that occur at reference sites.

The PCA will monitor patch occupancy and relative abundance in enhanced and restored sites to assess the effectiveness of enhancement and restoration actions implemented to improve and expand habitat for valley elderberry longhorn beetle. For example, if restoration actions such as re-vegetation with elderberry plants or invasive plant removal are implemented in an area—and if the relative abundance of valley elderberry longhorn beetle increases in that area over time—then some of that increased abundance could be attributed to the actions

implemented. This would be especially true if the relative abundances at reference sites did not increase at the same rate. In such cases, restoration actions would precede as before. However, if the relative abundance of valley elderberry longhorn beetle did not increase over time, or if the population in the habitat patch went extinct, the restoration actions would modified to achieve better results—or would be replaced with alternate restoration actions.

In addition, populations of elderberry plants may be monitored to determine whether the valley elderberry longhorn beetle host plants are abundant and healthy enough to support valley elderberry longhorn beetle populations. In some cases it may also be beneficial to monitor natural recruitment of elderberry plants to estimate whether elderberry populations are stable enough to support valley elderberry longhorn beetle populations over the long-term. Where elderberry re-vegetation is implemented, it will be necessary to monitor long-term survival of transplants to guide propagation and outplanting procedures.

Monitor Potential Threats

Invasion by the exotic Argentine ant into riparian habitat may potentially threaten the survival of valley elderberry longhorn beetle (Huxel 2000). However, the severity, extent of impacts, and ecological relationships between Argentine ants and valley elderberry longhorn beetle are not well understood, and some studies have not found significant relationships between the presence of Argentine ants and valley elderberry longhorn beetle (Huxel 2003; Holyoak and Koch-Munz 2008). Argentine ants may colonize restored and native sites occupied by valley elderberry longhorn beetle on their own, or by being transported to restored sites in the soil of potted plants (Talley et al. 2006). Furthermore, irrigation may promote ideal conditions for the growth and survival of Argentine ants (Talley et al. 2006). The PCA will consider conducting directed studies to evaluate the effects of Argentine ants on populations of valley elderberry longhorn beetles on the Reserve System if monitoring data indicate that valley elderberry longhorn beetles are declining or not successfully colonizing or establishing populations in restored or enhanced sites or if data in the scientific literature indicate that Argentine ants may be limiting the distribution and abundance of valley elderberry longhorn beetle. The PCA will monitor the distribution and relative abundance of Argentine ants at target sites on reserves that support important habitat for valley elderberry longhorn beetle. The PCA will monitor the scientific literature and regularly consult with scientific experts to remain current on new findings that further clarify the relationship between Argentine ants and valley elderberry longhorn beetle. The PCA will adapt future management (including conducting targeted studies) when necessary, based on new knowledge of threats to valley elderberry longhorn beetle.

7.5.12 Giant Garter Snake (Group 1)

Document and Monitor Status of Giant Garter Snake

Giant garter snake inhabits wetlands, agricultural wetlands, and associated waterways. These include sloughs, marshes, low-gradient streams, ponds, small lakes, irrigation and drainage canals, rice fields, and adjacent uplands (USFWS 1999). Because privately-held agricultural land within the Plan area is rarely surveyed, little is known about the distribution of giant garter snake in the Plan area (M. Paquin, pers. comm). The Plan area occurs within the giant garter snake's historic range (USFWS 1999). In addition, the Plan area is located two miles east from a site referred to as "Snake Alley", where giant garter snakes were found often in the late 1990s (Paquin et al 2008). However, it is not known whether that population is still extant, nor whether the population ever extended into the Plan area. Therefore, the primary purpose of initial monitoring is to assess the status of giant garter snake on newly acquired lands, assess the condition of giant garter snake habitat, prioritize sites for management, and identify sites for long-term monitoring.

Two methods will be used to monitor giant garter snake: visual surveys and trapping surveys. Visual surveys are less time and labor intensive and will be used initially to assess the status of giant garter snake on potential habitat, to assess habitat condition and to prioritize sites for long-term management. Visual surveys are conducted when individuals can be counted while basking during the middle of the day during the peak of the snake's active season (April – August). Visual surveys will be conducted using the best available protocol for this species (e.g., USFWS 1999). Visual surveys will be conducted systematically, along transects that run adjacent to potential aquatic habitat. Permanent transects should be established that can be used for future visual surveys, habitat assessments, and trapping surveys to facilitate long-term monitoring of giant garter snake. Habitat assessments will be used to guide management actions, and to assess the relationship between habitat characteristics, management actions, and occurrence of giant garter snake.

If necessary, floating traps, used in conjunction with mark-recapture techniques (e.g., Casazza et al. 2000), may be used to augment visual surveys, to document presence, generate indices of relative abundance, to document the size/age distribution of a population, and to estimate survival and recruitment within populations. If trapping is deemed necessary to augment visual surveys, the PCA will consult with USFWS and/or CDFG to develop trapping survey protocol. Trapping survey sites should be located along transects used for visual surveys and habitat assessments, so that trapping data can be compared with habitat assessments at each sample point.

In addition to surveying potentially suitable habitat for giant garter snake, the PCA will:

- Characterize conditions of potential aquatic habitat conditions (e.g., water depth, temperature).
- Characterize vegetation and structure of physical substrate in potential aquatic and adjacent upland habitat. Features that may be assessed include percent cover of dominant plant species, bare ground, basking sites, and land use of adjacent upland habitat.
- Document the presence of basking sites that could be monitored repeatedly.
- Document the presence of prey species as detected incidentally on visual surveys and caught in traps.
- Assess the presence of small mammal burrows and suitable refugia in adjacent uplands.

Location data will be documented using GIS and will be used to prioritize sites for enhancement and restoration and to prioritize adjacent non-Reserve sites for acquisition. This information will also be used to update the habitat model for giant garter snake (see Appendix D). The PCA will provide occurrence data to the Wildlife Agencies through the CNDDB database--or other protocol approved by the Wildlife Agencies.

Evaluate Species Response to Enhancement and Restoration of Aquatic and Upland Habitat

Wetlands, rice fields, and associated waterways (e.g., canals) and adjacent upland habitat will be managed and restored to provide habitat for giant garter snake. Habitat degradation and fragmentation are primary threats to giant garter snake (USFWS 1999, 2006) and ultimately, habitat fragmentation may limit the ability of giant garter snake to colonize restored and enhanced habitat on the Reserve System. Therefore, at unoccupied sites, the success of restoration and management will be assessed based on habitat-based performance criteria (e.g., percent cover of emergent vegetation and basking sites, minimum density of small mammal burrows or other suitable refugia in adjacent uplands), rather than the relationship between presence (or abundance) of giant garter snake and enhancement actions. For example, wetland vegetation may be monitored in order to determine whether the vegetative cover and plant composition of a site is at target levels. This will be especially important at sites where habitat is restored. USFWS (1999) recommends that wetland vegetation be monitored to ensure that the cover measured on restored areas is 90% of the amount of cover on reference sites; that species composition of restored areas is 90% similar to that of reference sites; and that wetlands meet Corps jurisdictional criteria (USFWS 1999).

Since there are no known occurrences in the Plan area, reference sites should be selected from nearby regional sites that support relatively stable populations of giant garter snake. Should giant garter snake occur on the Reserve System, the presence and relative abundance (if data are available) of giant garter snake will be compared amongst management treatments to assess the relative success of different management techniques.

Monitor Potential Threats

The PCA will monitor the presence of nonnative predators and competitors in giant garter snake habitat. Nonnative species such as domestic cat may prey on giant garter snake. Domestic cats have been observed hunting and killing giant garter snakes (USFWS 1993, as cited in USFWS 2006), even as far away as two miles from the closest urban development. Nonnative species may also compete with giant garter snake for limited resources (e.g., food, basking sites), thereby potentially excluding giant garter snake from suitable habitat (Stitt et al. 2005, as cited by USFWS 2006). The PCA will develop and implement an invasive animal control program if monitoring data indicate that nonnative predators and/or competitors are threatening the persistence, or expansion of giant garter snake into habitats, on the Reserve System.

7.5.13 Central Valley Steelhead - Evolutionarily Significant Unit and Central Valley Fall/Late Fall-run Chinook Salmon (Group 1)

The monitoring strategy for covered fish will involve the following components:

- Monitoring the status of covered fish in Plan area streams on the Reserve System; and
- Monitoring the effectiveness of riverine and riparian restoration and enhancement actions in achieving success criteria.

Document and Monitor Status of Covered Fish

Plan area streams that support covered fish will be surveyed to document baseline status of these streams and to prioritize riparian and stream sections for restoration and enhancement. Plan area streams are currently surveyed periodically for Central Valley steelhead and Fall/Late Fall-run Chinook salmon by CDFG, Dry Creek Conservancy and other partners. Numbers of live fish, carcasses, and redds are counted on single-day counts, generally in December – January, in the Dry Creek watershed and Auburn Ravine Watershed. The PCA will collaborate with the Wildlife Agencies and the Dry Creek Conservancy to continue monitoring covered fish in these stream systems, and to possibly expand

monitoring efforts to key stream reaches that span future PCCP reserves. Visual surveys will be used along stream reaches to count live fish, carcasses, and redds. Surveys will be conducted annually, from December through January along fixed transects. Existing monitoring protocol will be adopted to ensure consistency with these local and regional monitoring efforts.

In addition to monitoring the status of covered fish in Plan area streams, baseline surveys will be conducted in riverine and riparian habitats within the Reserve System to assess habitat quality and identify sites for restoration and enhancement actions. Baseline surveys of covered fish habitat will

- Assess the quality of streams on reserves that support covered fish. Habitat features that may be characterized include
    - water conditions (e.g., temperature, flow, depth);
    - presence and condition of gravel substrate suitable for spawning and incubation;
    - levels of sediment in spawning habitat;
    - percent cover of rifles, runs, and pools;
    - instream cover (e.g., downed logs and cut-banks);
    - channel width, configuration, and channelization features, and
    - barriers to movement.
- Assess condition of riparian habitat. Habitat features that may be characterized include
    - connectivity of stream to floodplain (e.g., how incised is the stream channel?);
    - condition of streambanks;
    - percent canopy cover; and
    - structural diversity.

Monitor Riverine and Riparian Restoration and Enhancement Projects

Monitoring of riverine and riparian restoration and enhancement actions will focus on collecting data to assess the effectiveness of these actions

in achieving success criteria for project-specific parameters (e.g., percent canopy cover for restoration of riparian habitats; percent area of riffles and pools in targeted stream reaches). Monitoring of these actions will occur at the natural community-level. See Section 7.4.5, Monitoring Riverine and Riparian Actions for a discussion of how restoration and enhancement actions will be monitored.

Monitor Potential Threats

Many of the stream conservation actions involve removing or modifying barriers to increase connectivity for fishes and other species within riverine corridors. While barriers often restrict native species from moving within a riverine corridor, they can also restrict non-native species from invading otherwise pristine reaches. When barriers are removed within stream corridors that support native fish populations, the non-native species populations will be monitored to determine how the barrier removal affects community dynamics and ultimately the relative abundances of covered fish species.

7.5.14 Foothill Yellow-legged Frog (Group 2)

Document and Monitor Status of Foothill Yellow-legged Frog

There are numerous known occurrences of foothill yellow-legged frog in the foothills of central Placer County; however, there are no known occurrences of foothill yellow-legged frog in the Plan area. The nearest known populations occur about three miles east of the Plan area. Potentially suitable habitat occurs primarily in the stream systems in the eastern portion of the Plan area (see Species Account for Foothill Yellow-legged Frog, Appendix D). Potentially suitable aquatic habitat on the Reserve System will be surveyed to assess the status of foothill yellow-legged frog on Reserve System lands. Target streams elsewhere in the Plan area may be surveyed, where access is permitted. Surveys will be conducted to assess occurrence of adults, breeding status, relative abundance, and to assess the condition of habitat to identify areas to target for restoration and enhancement.

Visual encounter surveys may be used to determine the presence, distribution, habitat utilization, and relative abundance of egg masses, tadpoles, juveniles/subadults, and adults (Seltenrich and Pool 2002). The relative number of egg masses can serve as a proxy for the relative number of breeding females and as an estimate of overall population health. Targeted stream reaches should be initially surveyed for presence of adults. If presence is confirmed, subsequent surveys throughout the season may be conducted to monitor other life stages (i.e., egg masses, tadpoles, and juveniles/subadults). Adults and egg masses can be surveyed during the spring breeding period (though adults can be surveyed from spring through early autumn). Egg-laying occurs primarily

from April through June, as the spring hydrograph recedes and when water temperatures reach 12 to 15°C, so surveys for egg masses should be conducted during this period, with surveys for tadpoles occurring approximately four to eight weeks after completing breeding surveys (Seltenrich and Pool 2002). Late summer through early autumn is the best period to survey for juveniles and subadults, as they are often readily observed along stream margins during this period (Seltenrich and Pool 2002).

The actual timing of surveys for foothill yellow-legged frog will depend on the life stage being monitored, and the timing of breeding in the Plan area, which will depend on local characteristics such as the timing and rate of spring runoff and precipitation, average ambient air and water temperatures, and local weather conditions. In general, egg-laying will begin earlier at lower elevations (as air and water conditions are generally warmer). Consequently, spring surveys should be initiated first at the low elevation sites, moving up in elevation as the season progresses (Seltenrich and Pool 2002).

Protocols for documenting occurrences of all life-stages of foothill yellow-legged frog (including monitoring intervals) and assessing their habitat will be developed by the PCA based on the best available protocol for this species (e.g., Seltenrich and Pool 2002). The baseline surveys will document the following characteristics:

- Stream reaches occupied by adult foothill yellow-legged frog and stream reaches used for breeding (e.g., based on presence of egg masses or tadpoles);
- Unoccupied breeding habitat with the potential to support breeding populations;
- An assessment of riparian vegetation and stream substrate along occupied and unoccupied stream reaches;
- Presence of nonnative bullfrogs, crayfish, and nonnative, predatory fish species; and
- Presence of other factors that could potentially affect breeding success.

Location data, occupied, and potentially suitable habitat will be used to prioritize sites for enhancement and restoration and to prioritize adjacent non-Reserve sites for acquisition. This information will also be used to update the habitat model for foothill yellow-legged frog (see Appendix D). At locations where potential habitat for foothill yellow-legged frog occurs, but where foothill yellow-legged frogs are not found, the PCA will assess the condition of riparian vegetation and stream substrate and document the presence of factors that may be impeding use of the site. The assessment data will be used to determine the potential for unoccupied

breeding habitat to be enhanced or restored to support breeding adults in the future. It will also inform future restoration and enhancement actions to benefit foothill yellow-legged frog.

Evaluate Species Response to Enhancement and Restoration of Aquatic Habitat

The PCA will monitor the response of foothill yellow-legged frog populations to enhancement or restoration actions designed to improve and provide habitat for foothill yellow-legged frog. Unless foothill yellow-legged frog occurs in the Plan area, monitoring the response of this species to restoration and enhancement actions will entail the use visual surveys to assess the presence of individuals described above. Should Foothill yellow-legged frog occupy or colonize habitats on the Reserve System, more intensive monitoring will be conducted to assess the relative success of different management actions in maintaining or increasing populations of foothill yellow-legged frog.

Monitoring will be used to assess the relative success of different techniques for maintaining or increasing foothill yellow-legged frog populations to guide future management efforts. One way to evaluate the success of restoration and enhancement actions is to compare the relative abundance of foothill yellow-legged frogs before and after treatments, as indicated counts of egg masses. As discussed above, the number of detected egg masses is likely to fluctuate regardless of management actions—especially due to weather. Therefore, it may be necessary to analyze changes in the relative abundance of foothill yellow-legged frogs (i.e., egg counts) at reference sites as well. Similarly, the PCA will monitor the response of foothill yellow-legged frog populations to riparian vegetation restoration and enhancement actions. For example, restoration of mature riparian overstory cover may improve cool-water habitats for covered fish, but could potentially reduce breeding conditions for foothill yellow-legged frog.

In general, changes in the relative abundance of foothill yellow-legged frogs will be assessed in relation to restoration and enhancement actions that the PCA implements in aquatic and upland habitats to determine how those actions (and associated management techniques) are affecting the populations. For example, targeted stream reaches will be restored and enhanced to improve channel and substrate conditions for breeding by foothill yellow-legged frog (see section 5.5.19 for more details on the conservation strategy for foothill yellow-legged frog). Response to restoration and enhancement actions by foothill yellow-legged frogs may be slow, as individuals may be unable to successfully disperse from source populations to newly restored/enhanced habitat. Under such conditions, the PCA, in consultation with the Wildlife Agencies, may consider translocation individuals to restored/enhanced habitat on the Reserve System.

Monitor Potential Threats

The PCA will monitor for occurrence of diseases, including chytrid fungus and any other harmful diseases that may occur within the Reserve System. This monitoring will include assessing the effectiveness of any disease-control measures. Spreading of diseases-causing agents such as chytrid fungus becomes a concern when biologists access more than one breeding site in a short period of time. Biologists will implement accepted antiseptic protocols during all aquatic survey work to minimize the potential for cross-contamination. The Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005) includes a suggested procedure for minimizing the transmission of disease and pathogens between aquatic resources, which may be adapted for use in riverine and stream habitats to protect foothill yellow-legged frog, California red-legged frog, and other native amphibians.

Many of stream conservation actions involve removing or enhancing barriers to increase connectivity for fishes and other species within riverine corridors. While barriers often restrict native species from moving within a riverine corridor, they can also restrict nonnative species from invading otherwise pristine reaches. When barriers are removed within stream corridors that support foothill yellow-legged frogs, both the yellow-legged frog population and the nonnative species populations will be monitored to determine how the barrier removal affects community dynamics and ultimately the native population.

7.5.15 California Red-legged Frog (Group 3)

Document and Monitor Status of California Red-legged Frog

Although California red-legged frog is federally listed as threatened, it is included in monitoring Group 3 because the Plan area is not considered a critical component of this species' range. There are no known occurrences of California red-legged frog in the Plan area. The known occurrences closest to the Plan area are approximately 14 miles east of the Plan area. Potentially suitable aquatic habitat occurs in the eastern, foothills portion of the Plan area and is comprised of ponds, fresh emergent wetlands, seasonal wetlands, riverine, valley foothill riparian, and wetland land-cover types. Much of the suitable habitat within the Plan area has not been systematically surveyed for the occurrence of California red-legged frogs. Potentially suitable aquatic habitat on the Reserve System will be surveyed to assess the status of California red-legged frog. Target streams and other aquatic habitats elsewhere in the Plan area may be surveyed, where access is permitted. Surveys will be conducted to assess occurrence of adults, breeding status, relative abundance, and to assess the condition of habitat to identify areas to target for restoration and enhancement.

Early in the breeding season (November–March), when adult California red-legged frogs typically move into breeding habitat, surveys will be conducted in potential breeding habitat to assess the presence of potential breeding adults. Surveys during the breeding season will be conducted using the most recent protocols adopted by USFWS and CDFG (e.g., USFWS 2005) and in coordination with monitoring of regional Sierra Nevada foothill populations (where applicable). If individuals are present, a more in-depth survey during the breeding season, as defined by USFWS protocols, will be conducted to determine the size of the breeding population and to estimate breeding success.

Surveys of all potential breeding habitats will be conducted on land acquired for the Reserve System. Initial surveys will be used to document baseline levels for population monitoring during the permit term and in perpetuity. The baseline surveys will document the following characteristics:

- Stream reaches, ponds, or wetlands occupied by California red-legged frog. If California red-legged frog is found on surveys, additional baseline surveys will be conducted to estimate numbers (or an index of abundance) of adults, tadpoles, and egg masses;
- Unoccupied breeding habitat with the potential to support breeding individuals;
- An assessment of habitat conditions and characteristics of occupied and unoccupied sites (e.g., the extent and species composition of aquatic vegetation; the extent of open water, etc.) and the possible factors that may hinder use of the habitat (e.g., lack of suitable emergent vegetation, habitat too far for from known populations to colonize);
- An assessment of upland habitat for potential refugia around occupied and unoccupied potential habitat;
- Presence of nonnative bullfrogs, crayfish, and nonnative, predatory fish species;
- Presence of other factors that could potentially affect breeding success; and
- An estimate of the distance between known or potential breeding sites to help inform understanding of potential dispersal between habitats and populations and to help guide restoration and enhancement actions.

Location data, occupied, and potentially suitable habitat will be documented using GIS and will be used to prioritize sites for enhancement and restoration and to prioritize adjacent non-Reserve sites for acquisition. This information will also be used to update the habitat

model for California red-legged frog (see Appendix D). The assessment data will be used to determine the potential for unoccupied breeding habitat to be enhanced or restored to support breeding adults in the future. It will also inform how proposed restoration or enhancement of riparian corridors and streams might affect California red-legged frog breeding and non-breeding sites.

Potential habitat on the Reserve System will be surveyed every three years to assess the presence of potentially breeding adults. If individuals are detected, visual surveys at occupied sites will be conducted annually during the breeding season to count egg masses and adults. The numbers of egg masses and adults can be used as in index of the size of the breeding population and to estimate breeding success.

If visual surveys do not provide adequate data to estimate the size of the breeding population and breeding success, other more intensive methods to survey adults, juveniles, metamorphs, and tadpoles (e.g., dip-netting, seining) may be used. These more intensive methods will only be employed every five years to minimize impacts on populations.

Evaluate Species Response to Enhancement and Restoration of Aquatic Habitat

The PCA will monitor the response of California red-legged frog populations to enhancement or restoration actions designed to improve and provide habitat for California red-legged frog (e.g., vegetation management aquatic habitats; installing woody debris to provide basking sites; removal of invasive predators from ponds). Unless California red-legged frog occurs in the Plan area, monitoring the response of this species to restoration and enhancement actions will entail the use of presence/absence surveys described above.

Should California red-legged frog occupy or colonize habitats on the Reserve System, more intensive monitoring will be conducted to assess the relative success of different management actions in maintaining or increasing populations of California red-legged frog. More intensive monitoring design and survey protocols will be developed based on the most recent protocols adopted by USFWS and CDFG (e.g., USFWS 2005). Reserve unit management plans will identify which stream reaches, ponds, and wetlands will be monitored, and at what frequency the monitoring will occur, to determine habitat availability and population response to management actions. Those habitat features will be monitored to record changes over time. Monitoring frequency will be established in the reserve unit management plan.

Aquatic habitats will be surveyed for the presence of nonnative predators (e.g., bullfrog, predatory fish) to prioritize control efforts in sites managed to provide habitat for California red-legged frog. Subsequent surveys for bullfrogs and predatory fish will be conducted to determine the effectiveness of control efforts. Post-treatment surveys will also be

conducted to assess the response of native amphibian populations to invasive species control efforts.

Evaluate Use of Adjacent Uplands and Non-breeding Aquatic Habitats

Upland habitats surrounding occupied aquatic habitat will be monitored to assess the condition of the habitat and it's suitability for terrestrial habitat uses (e.g., dispersal, aestivation). Upland habitat adjacent to unoccupied breeding habitat that is being actively managed for California red-legged frog will be surveyed to assess habitat conditions and to inform enhancement and restoration of upland habitats. Upland habitat adjacent to occupied and unoccupied habitat will be surveyed every five years to ensure that upland habitat conditions are suitable to allow for use of upland habitats and colonization of adjacent, unoccupied breeding habitat.

Monitor Potential Threats

Monitoring will also be conducted for diseases including chytrid fungus and any other harmful diseases that are discovered in the Reserve System during implementation. This monitoring will include assessing the effectiveness of any disease-control measures. Spreading of these diseases becomes a concern when biologists access more than one breeding site in a short period of time. Biologists will utilize accepted antiseptic protocols during all aquatic survey work to minimize the potential for cross-contamination.

7.5.16 Northwestern Pond Turtle (Group 2)

Document and Monitor Status of Northwestern Pond Turtle

Little is known about the distribution of northwestern pond turtles in the Plan area. Surveys of potential northwestern pond turtle habitat will be conducted on the Reserve System to document baseline population levels and to assess the condition of northwestern pond turtle habitat, prioritize sites for management, and identify sites for long-term monitoring.

Northwestern pond turtle is generally monitored by visual and/or trapping surveys. Despite its visibility when basking, northwestern pond turtle can be a difficult species to survey and monitor (Rosenberg et al. 2009). This species can be very wary of human observers, and often retreats from basking sites when approached, taking refuge below water's surface (Rosenberg et al. 2009). Trapping surveys may be more reliable in estimating relative abundance (Rosenberg et al 2009), but are more time consuming and labor intensive. Visual survey protocol, however, such as

those developed by Barkhurst et al. (1997), and updated by Bury et al. (2001), have been deemed suitably reliable in estimating occurrence and relative abundance (Horn 2001, as cited in Rosenberg et al. 2009). Visual surveys, therefore, may be adequate for monitoring status and trends. Protocols for monitoring northwest pond turtle will be developed by the PCA, in coordination with the Wildlife Agencies, using the best available methods (e.g., Barkhurst et al. 1997; Bury et al. 2001).

Adult northwestern pond turtles can be observed year-round in perennial streams, ponds, wetlands, and on the fringes of reservoirs. Fixed basking sites can be surveyed repeatedly, and the relative abundance of northwestern pond turtles observed can serve as an index of abundance. In such cases, artificial basking sites could be installed in ponds and wetlands to facilitate standardized monitoring. Although monitoring may be initiated in March, in order to coincide with monitoring for stream populations of California red-legged frogs, the ideal time for detecting turtles is during the summer months when individuals can be counted while basking during the middle of the day.

Baseline surveys of potential habitat for northwestern pond turtle will

- Assess the quality of occupied and unoccupied northwestern pond turtle habitat in stream reaches, ponds, and wetlands;
- Document the presence of basking sites that could be monitored repeatedly;
- Assess the relative quality of adjacent upland nesting and overwintering habitat;
- Evaluate the presence of factors that could affect breeding success (e.g., adjacent land use); and
- Document whether young turtles are present (as an indication of whether successful reproduction is occurring).

Location data will be documented using GIS and will be used to prioritize sites for enhancement and restoration and to prioritize adjacent non-Reserve sites for acquisition. This information will also be used to update the habitat model for northwestern pond turtle (see Appendix D).

At unoccupied potential habitat, the PCA will document the presence of factors that may be impeding use of the site. The habitat assessment data will be used to identify site-specific management actions to enhance and restore habitat and to determine the potential for unoccupied breeding habitat to be enhanced or restored to support breeding adults in the future.

Evaluate Species Response to Enhancement and Restoration of Aquatic and Nesting Habitat

The PCA will monitor the response of northwestern pond turtle populations to enhancement or restoration actions designed to improve and provide habitat for northwestern pond turtles. For example, if restoration and enhancement actions such as the addition of artificial basking sites (or the protection of nesting sites from grazing) are implemented at a pond—and if the relative abundance (or an index of reproductive output) of northwestern pond turtles increases in that area over time—then some of that success could be attributed to the restoration and enhancement actions. This would be especially true if the relative abundances at reference sites did not increase at the same rate. In such cases, the restoration and enhancement actions would precede as before. However, if the relative abundance of northwestern pond turtles did not increase over time, the tools and techniques used to implement the restoration actions could be modified to achieve better results—or the restoration actions could be replaced with alternate restoration actions. Because northwestern pond turtle populations are likely to fluctuate regardless of management actions, it may be necessary to consider changes in the relative abundance of northwestern pond turtles at reference sites as well.

In ponds and wetlands where northwestern pond turtles occur, the relative number of nesting attempts or the success rate of nests will be monitored to evaluate how management treatments are affecting the use of upland habitat for nesting. However, the opportunities to conduct this type of monitoring may be limited by the difficult nature of monitoring nesting turtles without disturbing important nesting areas. One alternate method for monitoring nesting success is to monitor the relative abundance of juveniles, as indicated by basking or trapping surveys conducted during the following year. A second alternative method is to search nests for egg shells at the end of the nesting season. The PCA will determine the best approach for monitoring northwestern pond turtle once reserves are acquired and reserve unit management plans are being developed.

Some stream stretches will be fenced to limit access by livestock, and/or, alternate, off-stream water sources will be provided for livestock to discourage them from entering the stream. Some ponds will be partially fenced to exclude grazing and promote growth of emergent vegetation. Northwestern pond turtle populations will be monitored and compared to baseline conditions to determine if these methods improve habitat quality and increase numbers of turtles.

Monitor Potential Threats

Little is known about northwestern pond turtle in the Plan area, including the specific factors that may be limiting and threatening populations.

Baseline surveys and habitat assessments will be used to evaluate potential threats to assess the relative importance of various factors that limit populations of northwestern pond turtle in the Plan area and that may limit recovery efforts. For example, existing populations may be isolated, and individuals may be unable to disperse to unoccupied restored and enhanced habitat. If the success of restoration efforts is ultimately limited by lack of colonization, the PCA will evaluate the possibility of restoring dispersal corridors from extant populations, or translocation from local populations. Translocations of adults may be useful for recolonizing unoccupied sites (Reinert 1991; Rosenberg et al. 2009); studies indicate that this method may useful for expanding populations (Holland 1994; Horn 2001; both as cited in Rosenberg et al. 2009). The use of translocations is controversial, however (Rosenberg et al. 2009); if deemed necessary, translocations to colonize unoccupied sites will be assessed in consultation with the Wildlife Agencies.

7.6 Data and Reporting

Proper data management, analysis, and reporting are critical to the success of the monitoring and adaptive management program. Data on monitoring methods, results, and analysis must be managed, stored, and made available to PCA staff, decision makers, scientific advisors, and other appropriate persons. A database and clear reporting procedure are also required for permit compliance. The requirements for database development, maintenance, and data reporting for monitoring are described in Chapter 8, *Implementation*, synthesizing the overlapping needs of monitoring, implementing the conservation strategy (Chapter 5), and tracking impacts on covered species and natural communities (Chapter 4).

7.7 Implementation of Monitoring Program

7.7.1 Program Infrastructure

As described above, adaptive management is a critical element of the Plan because it addresses many of the uncertainties of the Plan and provides for continual adjustment and improvement toward meeting Plan goals and objectives. Key to the success of the adaptive management program is a clear and effective structure for making decisions on the basis of new data from Plan monitoring and information from other sources. The PCA will be advised by five groups that play an important role in adaptive management:

- Wildlife Agencies,
- Other land management agencies (or a Technical Advisory Committee),
- Science advisors,

- Independent Conservation Assessment Team, and the
- Public.

As a preliminary planning step to coordination, the PCA will inventory monitoring projects and programs in the Plan area, their goals, timelines, design, protocols, etc. This will help coordinated information and will be an important first step in developing the Monitoring Plan as part of implementation. The PCA's responsibilities for executing the adaptive management program are listed below.

- Designing and implementing a scientifically robust effectiveness monitoring program (described above)
- Gathering monitoring and research data, including relevant information developed by others, and maintaining databases.
- Disseminating monitoring and research data generate by the Habitat Plan, including monitoring reports, conference presentations, and published papers, to others.
- Assessing the effectiveness of conservation measures relative to the biological goals.
- Identifying the need to modify existing or to adopt additional conservation measures and defining what to change and how to change it.
- Identifying the need to modify the monitoring program and defining what to change and how to change it.
- Identifying the need for and implementing experimental pilot projects.
- Identifying and prioritizing research needs and conducting critical directed studies.
- Developing the adaptive management elements of Reserve Management Plans.
- Incorporating monitoring, research, and other adaptive management–related activities into annual work plans.
- Creating and maintaining a network of science advisors (see below) to provide advice to the PCA, as needed, on adaptive management and monitoring issues including important data gaps, monitoring and management methods, and data interpretation.
- Periodically convening the Independent Conservation Assessment Team (see below) to conduct a program-wide review of Habitat Plan implementation, including monitoring and adaptive management, and providing recommendations to improve Habitat Plan implementation.

The PCA will consider all input regarding adaptive management recommendations from wildlife agencies, science advisors, Independent Conservation Assessment Team, other outside experts, and the public. In

addition, the PCA may convene technical committees to seek focused advice on key adaptive management topics.

Ultimately the PCA and their senior staff or senior contract biologists will determine which course of action to take. Decisions made in the adaptive management program will be based primarily on which course of action is most likely to meet the biological goals and objectives of the Plan within budget constraints and while avoiding or minimizing conflicts with other biological goals and objectives.

Wildlife Agencies

The primary role of the Wildlife Agencies is to provide policy-level feedback to the PCA regarding recommended changes to Plan implementation based on the results of research and monitoring and on the recommendations of the science advisors and the Independent Conservation Assessment Team. Wildlife Agency staff will also provide expertise in the biology and conservation of covered species and natural communities. Types of feedback the Wildlife Agencies are likely to provide could include assessments of the consistency of proposed changes with terms and conditions of Habitat Plan permits, costs associated with the proposed changes relative to successful implementation of other elements of the Plan, how conservation actions are working in practice and how they can be improved, guidance on aligning the Plan with species recovery goals and recovery criteria, and attainment of overall Plan goals and objectives.

The PCA will strive at all times to work in good faith with the Wildlife Agencies to reach mutual agreement on key implementation tasks such as adaptive management, monitoring, and conservation actions. If disagreements arise that cannot be resolved easily, the PCA will follow the “meet and confer” dispute resolution process outlined in the Implementing Agreement (Appendix B).

Land Management Agencies

As discussed above, other land management agencies in the Plan area are encouraged to coordinate with the PCA to share information and resources in implementing management across reserve boundaries and on a regional scale. Input from other land management agencies in the Plan area is an important component of successful adaptive management. Land management agencies that manage land on behalf of the PCA (i.e., as part of the Reserve System) will form a Technical Advisory Committee to coordinate management and ensure consistency across the Reserve System.

Science Advisors

The PCA will consult science advisors who will provide regular advice on Plan implementation. The role of the science advisors is to provide the PCA with science-based expert opinion and recommendations, focused "white papers," peer review, and feedback regarding key scientific aspects of Plan implementation such as reserve design, reserve management, and monitoring protocols. Science advisors will be contacted by the PCA as needed. They may also be convened as a group as needed to address specific topics. Science advisors will be scientists and resource managers with expertise in one or more of the following areas:

- Covered species,
- Landscape ecology,
- Natural communities in the Reserve System,
- Ecological processes,
- Resource management,
- Biological monitoring, and
- Statistical analysis and experimental design.

Science advisors will be selected by the PCA with input from the Wildlife Agencies. The PCA may also request that the science advisors review the following types of information prepared by or for the PCA.

- Proposals for directed studies to address important management questions.
- Management and monitoring reports and recommendations to the PCA provided by others.
- Monitoring priorities, sampling design, survey protocols, data analysis, and data storage.
- Proposals for experimental pilot projects to test unproven natural community enhancement/creation/restoration or management techniques.
- Proposed changes in reserve design and management, natural community enhancement/restoration/ creation techniques, alternative conservation measures, and monitoring methods, based on interpretation of monitoring or research results and consistent with the protocols for, and limitations on, the Adaptive Management Program.

Independent Conservation Assessment Team

The Independent Conservation Assessment Team will be composed of highly qualified scientists and resource managers who are independent of

the Habitat Plan and the science advisors. Selecting members who are independent of the Plan is important to ensure an unbiased assessment of Plan implementation. The role of the Independent Conservation Assessment Team is to provide periodic review of overall Habitat Plan implementation, including the following specific areas:

- Assembly of the Reserve System and the progress of habitat restoration efforts;
- The appropriateness of the monitoring and management methods being used to achieve Plan goals, including indicators and success criteria;
- The appropriateness of the interpretation of monitoring data; and
- Changes that may be needed in conservation, management, or monitoring to better achieve Plan goals (see Chapter 7 for additional discussion on the protocols for, and limitations on, the Adaptive Management Program).

The Independent Conservation Assessment Team will provide policy-level recommendations to the PCA. The Independent Conservation Assessment Team will be selected and convened by the PCA at least every five years. The Wildlife Agencies will be consulted regarding prospective members. A 5-year interval will allow progress to be made toward Plan compliance and biological goals and objectives, as well as the collection of monitoring data sufficient to support a thorough and meaningful progress review. It is expected that the composition of the Board will change each period, although some consistency in membership is preferred. It is also expected that the scope of review of the Independent Conservation Assessment Team will vary each time they are convened. For example, the first time they meet their review will likely focus on the initial phases of implementation and early monitoring results and protocols. Later reviews will focus on more extensive monitoring data and results.

The Public

As discussed above, members of the public will have opportunities to learn about Plan status and provide input to the PCA on management during periodic (at least annual) public hearings and regular meetings of the public advisory committee, which will be open to the public. Members of the public may offer important contributions to a successful adaptive management program, such as providing data on covered species, critical reviews of monitoring data, and suggestions for improved land management. Members of the public may also participate in data collection through a volunteer program supervised by the PCA or its designee.

7.7.2 Approval of Monitoring Personnel for Take of Federally Listed Covered Species

Some monitoring activities may require handling or disturbing federally listed covered species; such activities constitute take. The selected methods used to monitor covered species and communities will minimize impacts on species, particularly species with small populations. Take of federally listed covered species resulting from monitoring activities is authorized under the Plan provided that certain conditions are met. Simple surveys, such as habitat assessments will be conducted by the PCA or consulting biologists. However, more complex biological field work would be carried out by biologists "certified" under the Plan. To become certified, the PCA would send out a Request for Qualifications, and applicants would be reviewed by and subject to approval of the Wildlife Agencies. The outcome would be a list of "certified' biologists who are approved to conduct survey work for a five-year period. The certification process would reduce the need for a 10(a)(1)(b) permits as well as the need for the Wildlife Agencies to review qualifications on a case-by-case basis during implementation. In addition, the following conditions would be met.

- Such take occurs during activities specifically described in the monitoring protocols developed for the permit area and is consistent with monitoring provisions set forth for specific sites in the Reserve Management Plans, which will be reviewed by the Wildlife Agencies.
- The person performing the monitoring activities demonstrates an understanding of the monitoring protocols, data collection techniques, and handling procedures for the federally listed covered species through (1) training with the PCA or its representatives on these procedures and standards, or (2) appropriate previous experience with the federally listed covered species or similar species.
- The person performing the monitoring activities carries out his/her duties in conformance with the protocols and procedures specified in the training.
- The names, contact information, and written certification of training and qualifications for the monitoring personnel handling or disturbing federally listed covered species are provided to USFWS for terrestrial species and NMFS for fish prior to each person conducting this monitoring. USFWS or NMFS must approve each person before he/she is authorized to take federally listed covered species. This documentation will also be on file with the PCA.

  These provisions are consistent with the federal Wildlife Agency's policy as described in the *Habitat Conservation Planning Handbook* (USFWS 1996).