Chapter 7

Monitoring and Adaptive Management Program

7.1 Introduction

This chapter describes the monitoring and adaptive management program for the Plan. 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 habitat types outside of the Reserve System; and to evaluate the effects of management actions such that the conservation strategy described in Chapter 5, including the biological goals and objectives (**Tables 5-1a–d**)[2] of the Plan are achieved. 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. An overview of the program, monitoring and management actions, and data and reporting requirements are found below. Monitoring issues and tools relevant to the three levels of the conservation strategy (landscape, natural community, and species) are described in detail in **Appendix J**.

7.1.1 Regulatory Context

By regulation, an HCP must incorporate monitoring of conservation measures and the response of covered species to these measures (50 CFR 17.22[b][1][iii] and 50 CFR 222.22[b][5][iii]). An adaptive management strategy is a recommended component of Plans with data gaps that would substantively affect how the species is managed and monitored in the future (65 FR 35251). 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

[1] In general conservation actions and monitoring take place within the Reserve System (i.e., lands acquired, managed, and monitored by the Implementing Entity to benefit covered species under this Plan). Monitoring for burrowing owl and tricolored blackbirds will extend beyond the Reserve System boundaries as described below. Monitoring outside of the Reserve System will still occur within the Plan's study area.

[2] The biological goals and objectives conform to the guidance provided by the Five Point Policy as much as feasible, given the scope of the conservation strategy and the fact that the Reserve System has not yet been acquired. In some cases, details on the indicator, location, timeframe, etc. are provided in the narrative text of the conservation strategy. In other cases these details will be developed during early implementation where on-the-ground information can better inform specific management actions for specific parcels. These details will be integrated into the reserve management plans.

biological goals and monitoring. To that end, **Tables 5-1a–d** 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.

An NCCP must include both 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 species response to management activities. This program will continually incorporate recommendations for monitoring and adaptive management based on the most recent guidelines provided by the USGS Biological Resources Division, CDFG, and USFWS for regional HCPs and NCCPs (Atkinson et al. 2004).

7.1.2 Adaptive Management

Adaptive Management is a decision-making process promoting flexible management such that actions can be adjusted as uncertainties become better understood or as conditions change (**Figure 7-2**). Monitoring the outcomes of management is the foundation of an adaptive approach, and thoughtful monitoring can both advance scientific understanding and modify management actions iteratively (Williams et al. 2007).

Adaptive management is necessary because of the degree of uncertainty and natural variability associated with ecosystems and their responses to management. Based on the best scientific information currently available, it is expected that the Plan's conservation actions will effectively implement the conservation strategy described in Chapter 5. However, there are varying degrees of uncertainty associated with the management techniques and conditions within and outside the study 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 implementing the conservation strategy described in Chapter 5 than those currently implemented. Results of effectiveness monitoring may also indicate that some management measures are less effective than anticipated. To address these uncertainties, an adaptive approach will be used to inform management; the monitoring program will be designed to support this adaptive approach.

The cornerstone of the monitoring and adaptive management program is an experimental approach in which monitoring will yield scientifically valid results that inform management decisions (**Figure 7-3**). Information collected through

monitoring and other experiments will be used to manage reserve lands and protect covered and other native species habitat and natural communities. The adaptive management process will be administered by the Implementing Entity. The Implementing Entity will also coordinate and share the results of monitoring and targeted studies, as appropriate, with other regional restoration and management programs and among the Local Partners and the Wildlife Agencies. A well-coordinated and scalable monitoring program will enable the Implementing Entity and others to measure and evaluate change in resources and threats within individual reserves, across the entire study area, and throughout 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. Science advisors (see Section 7.2.3 *Program Implementation* subheading *Program Infrastructure*) will evaluate the effectiveness of existing or proposed management actions. The Implementing Entity will incorporate recommendations provided by these reviews, 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 (see **Figure 7-4**).

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 7-4**. 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 7-5**). Conceptual models will help frame questions for monitoring, and results will help guide future management and monitoring efforts while simultaneously updating the models (see **Figures 7-6** and **7-7**). Using monitoring to provide information for adaptive management actions will require a framework for measuring responses (**Figure 7-3**). 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* subheading *Targeted Studies*, below), 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.

In summary, adaptive management is the land manager's response to new information. Adaptive management actions will likely take place at the following junctures:

a) In response to the results of targeted studies including pilot projects,

b) In response to downward trends in the status of covered species or key natural-community variables,

c) When new information from the literature or other relevant research indicates that a feasible and superior alternative method for achieving the biological goals and objectives exists,

d) When monitoring indicates that the expected or desired result of a management action did not take place, and

e) Proactively, when threats are identified through the ongoing development of conceptual models (see **Appendix J**, Section J.2.2 *Natural Community Monitoring Tools* and **Figures 7-6 through 7-9**) or through other monitoring efforts in the study area. An example of an adaptive management action resulting from a pilot project is the decision to use deer exclusion fencing rather than willow planting in target stream reaches to achieve stream restoration based on the empirical results of the study.

Most adaptive management measures will occur when conservation actions do not produce the desired outcome or when species /natural-community trends decrease. In these cases, new actions would be implemented to try and improve the outcome for species and communities. Such actions include but are not limited to the following:

- Alter the timing, location, intensity or type of grazing;
- Reduce, increase or otherwise change the pattern of prescribed burning;
- Change the flow regime released from reservoirs into target streams (e.g., timing, frequency, magnitude of flow levels or events);
- Re-evaluate and, if necessary, alter avoidance and minimization measures;
- Modify age, timing, location, or type of seedling transplantation for natural-community restoration;
- Prioritize or de-emphasize one aspect of noxious weed control such as targeted pesticide use;
- Increase, decrease or desist species-specific conservation actions such as translocation of individuals based on experimental results.

Any of the conservation actions proposed in **Tables 5-1a–d** can be modified in response to new information following the principles of adaptive management.

7.1.3 Program Objectives

The overarching objective of the monitoring and adaptive management program is to ensure that the conservation strategy described in Chapter 5 and the biological goals and objectives (**Tables 5-1a–d**) are being achieved. This chapter presents a foundation for accomplishing this task. The reserve unit management plans, which will include monitoring and adaptive management components, will be submitted to the Wildlife Agencies for review and approval within 5 years of the acquisition of the first parcel of each reserve unit. 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 key habitat outside of the Reserve System using existing data, modeling, and the results of ongoing field surveys.
- Develop conceptual models for natural communities and covered species, if applicable, that can be used as the basis for collecting information, verifying hypotheses, and designing and changing management practices (see **Appendix J**, Section J.2.2 *Natural Community Monitoring Tools* and **Figures 7-6 through 7-9**).
- Incorporate hypothesis testing and experimental management, including targeted studies to address key uncertainties and to improve management and monitoring efforts.
- Develop and implement scientifically valid monitoring protocols at multiple levels to ensure that data collected will inform management and integrate with other monitoring efforts.
- Ensure that monitoring data are collected, analyzed, stored, and organized so the data are accessible to the Implementing Entity, 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 Implementing Entity develop a detailed monitoring component for their reserve unit management plans. Before each reserve unit management plan monitoring component is developed, basic monitoring will be initiated within the Reserve System. Upon permit approval, the Implementing Entity will compile information from ongoing monitoring efforts conducted by the Permittees throughout the study area.

Monitoring priorities will be guided by the species groupings (described in detail below in Section 7.3.3 *Species-level Actions*). Species have been categorized

into three groups on the basis of listing status and portion of range in the study area. Group 1 includes most of the covered species currently listed as endangered or threatened and covered species for which the study area constitutes a critical portion of the species' range.

Conceptual models will be developed for Group 1 species, and baseline surveys will be initiated for newly acquired parcels. If restoration actions are proposed before the reserve unit management plan is in place, a design plan, including experimental design, monitoring actions and adaptive management will be developed, specific to that action. **Table 7-1** provides a summary of monitoring tasks throughout the Plan permit and beyond. Detailed information of monitoring tasks by program phase is found in Section 7.2.2 *Program Phases*.

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 all target areas for monitoring outside the Reserve System are not known at this time, it would be 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* subheading *Targeted Studies*, below) before they can be implemented on a large scale.

This approach of providing a framework, guidelines, and specific recommendations in the Plan 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, and East Contra Costa County HCP/NCCP. In earlier plans (e.g., the San Diego County Multi-Species Conservation Plan) that promulgated extensive details of the monitoring protocols and standards, it was found early in implementation that many of the protocols were infeasible or did not produce the right data to evaluate Plan success (B. Johnson pers. comm.).

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 Implementing Entity 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. Because lands for the Reserve System will be assembled over the course of the permit, the exact configuration of the Reserve System is unknown. However, the general locations of acquisition priorities have been defined (**Figure 5-8**). As the Reserve System grows, the monitoring program will also grow. Monitoring of streams and select covered species[3] will occur within and outside the geographic border of the Reserve System. The regional and global context of species and natural communities will be considered when designing and implementing monitoring and adaptive management.

Levels

Because the conservation strategy functions at multiple levels, the monitoring and adaptive management program must collect information at these multiple levels. 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, shifts in natural community distribution, and the integrity of landscape linkages. Community-level monitoring is designed to detect changes in the composition and function of natural communities, populations of key predator or prey populations, 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 abundance, distribution, and other variables of covered species in the Reserve System and the study area. Additional detail on monitoring over these three levels is provided in **Appendix J** *Monitoring Issues and Tools.*

Coordination with Other Programs

Monitoring already occurs throughout the study area to varying degrees on public and private lands. Long-term monitoring and scientific experiments are conducted at several sites along Coyote Ridge for Bay checkerspot butterfly and many serpentine plants. The Plan's monitoring program will borrow from these existing programs where appropriate. During the inventory phase, the Implementing Entity 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. There may also be opportunities to conduct joint monitoring efforts to meet the needs of both

[3] Burrowing owl and tricolored blackbird. See species-specific monitoring discussion later in this chapter.

projects. Monitoring programs relevant to the Plan are referenced throughout this chapter, as appropriate.

The Implementing Entity will also coordinate and share monitoring and other experimental results with other regional restoration and management programs. A well-coordinated and scalable monitoring program design will enable the Implementing Entity 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. Some of the programs and organizations with which the Implementing Entity will coordinate are listed below.

- Pacific Gas and Electric Company Bay Area Operations and Maintenance HCP (in progress).
- San Francisco Public Utilities Commission Alameda Watershed HCP (in progress).
- Proposed Three Creeks HCP (in progress).
- Upland Habitat Goals Project (Bay Area-wide).
- East Alameda County Conservation Strategy.
- Stream and biological monitoring conducted by SCVWD.
- Management and monitoring carried out by the Santa Clara County Parks.
- Bird monitoring conducted by the San Francisco Bay Bird Observatory in Santa Clara County.
- Other species monitoring conducted by local organizations such as the Burrowing Owl Consortium, California Native Plant Society, and local Audubon chapters.
- Post-fire recovery monitoring conducted at Henry W. Coe State Park (beginning in 2008).
- Management and monitoring programs conducted by adjacent land management agencies such as the Midpeninsula Regional Open Space District, Peninsula Open Space Trust, East Bay Regional Park District, Don Edwards San Francisco Bay National Wildlife Refuge, California State Parks in Santa Cruz County, and others.
- Long-term monitoring along Coyote Ridge for Bay checkerspot butterfly populations and several covered plant species.
- Future recovery planning efforts by CDFG and USFWS.

In addition, the proposed Three Creeks HCP monitoring and adaptive management program is being developed and will coordinate with the Habitat Plan regarding monitoring tasks for covered species common to the two plans. SCVWD will be responsible for the monitoring identified within the Three Creeks HCP and will coordinate its efforts with the Habitat Plan. The Implementing Entity may contract with SCVWD to undertake additional

monitoring related to the obligations of the Habitat Plan. Agreements for monitoring will be sought between SCVWD and the Implementing Entity once the Implementing Entity is established and the permits for both plans are issued.

7.1.5 Take Authorization during Monitoring

Some monitoring activities may require handling or disturbing state or federally listed species; such activities constitute take. The monitoring method is optimal when both the quality of information and the impact on the species is assessed. The monitoring program will consider the impact on the species, particularly in cases of very low population numbers. Take of covered species during monitoring activities is authorized providing that all of the following conditions are met.

- The take occurs in association with activities described in the conservation strategy, monitoring chapter, or reserve unit management plan approved by the Wildlife Agencies.
- The take occurs in the permit area, during the permit term, for activities conducted by the Permittees, the Implementing Entity, or any person acting under the direct guidance or authority of these entities.
- The person(s) undertaking such activities is qualified to do so and can carry out their duties in conformance with the protocols and procedures specified in the monitoring chapter and the reserve unit management plan (see Section 6.8.5 *Item 5: Results of Applicable Species Surveys and Monitoring* subheading *Qualified Biologists*).
- The activity is consistent with the Plan's monitoring and adaptive management program.

In order to meet federal and state requirements, the amount and extent of take must be reported in accordance with the permits. The occurrence of all special status species within the Reserve System will be reported to the CNDDB.

Simple surveys, such as habitat assessments, that would not result in take will likely be conducted by the biologists within the Implementing Entity. However, more complex biological field work, (e.g., kit-fox surveys, burrowing owl exclusions) may result in take and therefore must be carried out by a "qualified" biologist as defined in Section 6.8.5 *Item 5: Results of Applicable Species Surveys and Monitoring*.

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). Because this Plan monitors resources at three levels, many different variables are tracked. In addition to the levels of scale (i.e., landscape, community, and species), three main types of monitoring are specified: compliance monitoring, effectiveness monitoring, and targeted studies. A description of each of these types is provided below.

Compliance Monitoring

Compliance monitoring tracks the status of Plan implementation and documents that all 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. It is also known as implementation monitoring. The Implementing Entity will track and ensure compliance monitoring internally and provide results to the Wildlife Agencies who will ensure that the Permittees remain in compliance with the permits, IA, and Plan. As defined by this Plan, compliance monitoring will comprise the components listed below.

- Tracking impacts on land cover types (**Tables 4-2 and 4-3**) and covered species modeled habitat (**Table 4-4**) to ensure impact limits are not exceeded and to ensure compliance with the Stay-Ahead requirements. This includes the time commitments for restoration/creation not tied to impacts (see **Table 5-14**) and time commitments for other conservation actions (see Chapter 5).
- Tracking the loss of occurrences of covered plants to ensure that impacts do not exceed the level authorized under permits (see **Table 4-6** for impact limits) and ensuring that equivalent or healthier plant occurrences are protected in the Reserve System (see Chapter 5).
- Tracking impacts to critical habitat for the bay checkerspot butterfly, California tiger salamander, and California red-legged frog (**Table 4-9**).
- Tracking habitat enhancement, restoration, and creation actions (**Tables 5-13, 5-16,** and **5-21**).
- Tracking implementation of acquisition requirements (**Tables 5-11, 5-13, 5-16, 5-19,** and **5-21**).
- Tracking implementation of management agreements for western burrowing owl nesting habitat (number of acres under management).
- Tracking implementation of other conservation actions on and off the Reserve System.
- Tracking implementation of avoidance and minimization requirements (see Chapter 6).
- Tracking and reporting of management and monitoring activities (Atkinson et al. 2004).

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 includes monitoring the effects of management activities. An important component of this monitoring is determining patterns within the Reserve System relative to the baseline status and trends of biological resources. The Implementing Entity will design, conduct and report on the results of effectiveness monitoring. Wildlife Agencies, Science advisors and an Independent Conservation Assessment Team will have an opportunity to provide input on and evaluate the proposed effectiveness monitoring and its results (see Section 7.2.3 *Program Implementation*). Both status and trends monitoring and effects monitoring are described below.

Status and Trends

Indicators of the status and trends of biological resources are monitored to provide baseline data regarding the increase or decrease of these resources in the study area. 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. Status and trends monitoring will include quantitative data on covered species (population size, distribution), land cover, and modeled habitat as well as nonnative invasive species and other known threats. Additionally, historical data on population size or distribution can be relevant to understanding the current condition. For species or natural communities that go through natural fluctuations or variations, historical trends are more important than single year surveys. Qualitative assessments of vegetative structure and/or habitat quality will also be a component of status and trends monitoring. Examples of status and trends monitoring include quantitative data on covered species numbers, acres of land cover types in the study area, occurrences of invasive plant populations, and incidences of natural disturbance (e.g., fire, flood).

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 conservation strategy described in Chapter 5 was successful.

The preliminary or initial component of effects monitoring will include the development and assessment of success criteria for management actions such as stream restoration, pond creation, and butterfly relocation. Where they exist, the biological goals and objectives will determine the form that success criteria take. Once success criteria are developed, effects monitoring will include monitoring these criteria as well as assessing the effects of management on covered species.

Finally, the effects of threat-abatement activities (e.g., density of nonnative invasive plants) will be evaluated (Atkinson et al. 2004).

To determine the effects of management, management actions will be conducted using an experimental approach when feasible (**Figure 7-3**).

Targeted Studies

Targeted studies fulfill three major objectives:

1. Identify the best methodologies for monitoring;
2. Provide information about the efficacy of management techniques; and
3. 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 will be conducted by the Implementing Entity or its contractors. Directed Studies could be carried out or funded by the Implementing Entity. However, the Implementing Entity may also utilize graduate students, University researchers, or other scientists whose project goals inform critical uncertainties and further the biological goals and objectives of the Plan. In addition, directed studies may be funded by outside sources if the work carried out on Reserve Lands furthers the Implementing Entity's understanding of covered species and natural communities.

Method Testing

Method testing is designed to evaluate alternative monitoring protocols and sampling designs and to select the best technique for obtaining information. For example, if the objective is to quantify wildlife use of a corridor crossing, methods testing might compare the use of tracking plates, bait stations, and trail cameras. The results of method testing would then be used to develop a long-term monitoring protocol.

Pilot Projects

Pilot projects will 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

The term *critical uncertainties* refers to key questions that shape how the ecological system is actively managed. 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 the levels of uncertainty related to achieving biological goals and objectives. These uncertainties are generally related to the factors listed below:

- The ecological requirements of covered species, and
- The likely response of covered species and natural communities to implementation of conservation actions within the Reserve System.

All of the conservation actions identified as "STUDIES" in **Tables 5-2a–b** are considered directed studies. The Implementing Entity may propose additional directed studies not identified as conservation actions. Directed studies will be carried out to gain insights into key questions identified in the conservation strategy and during Plan implementation. All proposed directed studies will be prioritized during implementation and will be carried out based on their priority ranking. Directed studies identified in **Table 5-2b** will be prioritized and funded as part of conservation strategy implementation.

Results of directed studies conducted under the Plan will inform management and ensure attainment of the biological goals and objectives. It is expected that some or all of the directed studies specifically outlined in the conservation strategy will be conducted by the Implementing Entity or consulting scientists. Additional long-term directed studies, identified during Plan implementation, will 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 Implementing Entity 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. In addition to the directed studies undertaken to answer critical uncertainties, it is expected that the Implementing Entity 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 *Costs and 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 5 years of Plan implementation and thereafter 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 5 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 7-1**). Also, see **Table 7-1** for a summary of monitoring tasks throughout the permit term.

Inventory Phase

The initial inventory phase of monitoring occurs following permit approval and continues as new parcels are acquired and added to the Reserve System or new conservation actions are initiated outside the Reserve System, primarily on streams. Baseline information collected during the inventory phase 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. If a parcel is acquired in a drought, it may take several years for certain plants to appear, for example. Under normal conditions, the initial inventory will take place within 3 years of acquisitions for each site. The Implementing Entity will inventory and assess landscapes, natural communities, and species, as appropriate, within the Reserve System. This information will build largely on the data collected during pre-acquisition assessments and will be supplemented by post-acquisition monitoring.

In addition to the acquisition of baseline information, the inventory phase will focus on the identification of key relationships between species, habitats, and processes; the prioritization of project implementation; the refinement of species groups; and the selection of biotic and abiotic indicators for evaluating ecosystem condition. Information collected during the inventory phase will build on species information (**Appendix D**) as well as other data sources (e.g., historical ecology reports).

Document Baseline Conditions

Baseline conditions within the Reserve System need to be documented to enable management planning and to serve as a comparison point for all future

monitoring. Accordingly, resources of interest that occur on a site need to be documented, mapped and, if required to measure compliance with biological goals and objectives, censused. Also, baseline surveys and post-construction monitoring will take place in areas where activities may impact a covered plant occurrence. Documenting baseline conditions will consist of the following tasks.

- Update GIS land cover layer with aerial photographs, satellite imagery, and other relevant data sources including serpentine soils maps at the outset of implementation.
- Inventory and document resources and improve mapping as the Reserve System is assembled. The results of the assessments for land acquisition (i.e., pre-acquisition assessment; see Chapters 5 and 8) will be the first source of baseline data. Data-collection methodologies and nomenclature will be standardized to facilitate sharing of information.
- Conduct baseline surveys for plants in areas where covered activities may impact plant occurrences (Condition 20).
- Research and document historical data and trends, as appropriate.
- Use baseline data to validate and refine species habitat models as lands are surveyed and acquired (species models will be updated periodically, but no less frequent than every 5 years, consistent with new survey data collected from the Implementing Entity, from land cover mapping provided by project applicants, and from other relevant sources).
- Conduct post-acquisition biological inventories. Additional surveys will be needed to supplement data gathered in pre-acquisition assessments.
- Conduct post-construction surveys for covered plants in areas where covered activities may have impacted occurrences of covered plants (Condition 20).
- 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.
- Collect additional baseline data needed to refine conceptual models (see **Appendix J**, Section J.2.2 *Natural Community Monitoring Tools* and **Figures 7-6 through 7-9**).

Initiate Management Planning

Management planning will consist of the following tasks.

- Prioritize implementation of conservation actions to best achieve biological objectives.
- Develop reserve unit management plans (described in Chapter 5, Section 5.2.5 *Land Management*).
- Confirm species monitoring groups and refine the monitoring schedule.
- Identify biotic and abiotic indicators (see section on indicators for description) for testing during the targeted studies phase.

- Select monitoring protocols and identify sampling design for status and trends and effects monitoring. Test experimental designs during the targeted studies phase, as necessary.
- Develop criteria for measuring success of enhancement, restoration, and creation efforts (see example criteria in **Table 7-2**).
- Develop criteria to assess effectiveness of conditions on covered activities (described in Chapter 6 *Conditions on Covered Activities and Application Process*).

Upon implementation of the Plan, the Implementing Entity will document baseline conditions along with survey methods and monitoring schedules based on the guidelines for monitoring described below. Some species have boom/bust population dynamics that are highly dependent upon weather (e.g., Bay checkerspot butterfly and some of the covered plants). Survey protocols and the success criteria developed will account for this. These protocols and schedules will provide the overarching framework that will be implemented in each management unit. The Implementing Entity will draw from relevant and established protocols (e.g., Wildlife Agency and CNPS survey protocols) and will adapt them throughout the permit term to incorporate the best available scientific data.

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 7-1**). 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 Implementing Entity will develop conceptual models for key natural communities (see **Figure 7-8**) and covered species (see **Figure 7-9**) that identify critical management uncertainties; design and initiate pilot projects to test management and monitoring methods; develop and initiate experiments that resolve critical uncertainties; and begin pretreatment monitoring of sites considered for enhancement, restoration, or creation.

Develop Ecological Models

Management-oriented conceptual ecological models 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. As the monitoring program collects additional data, these "living" models will serve as a framework for management decisions and will function as reference points for the Implementing Entity's understanding of the relationship between management and natural communities and/or covered species within the Reserve System. In addition, species conceptual models that identify threats, management and monitoring for species will be developed. A full description of conceptual ecological models and species conceptual models is found in **Appendix J**, Sections J.2.2 *Natural Community Monitoring Tools* and J.3.1 *Species-Specific Monitoring Tools* respectively.

Test and Refine Monitoring Protocols

In the targeted studies phase, the Implementing Entity will conduct methods testing (described above) to develop, test, and refine monitoring protocols. Monitoring protocols will be developed for landscapes, natural communities, species groups, and individual covered species. The purpose of this testing is to identify the best and most cost-effective monitoring methodologies to derive the desired information. For example, one of the biological objectives of the conservation strategy is to increase the permeability of certain barriers, such as highways, in the study areas. Monitoring will need to assess wildlife movement in target areas. The targeted studies phase will test methods (e.g., camera traps, track plates, use of bait) to determine the desired protocols for long-term monitoring. Monitoring protocols will be conducted in a repeatable manner and will provide both quantitative and qualitative data to inform management design within the Reserve System.

In some cases there is little distinction between pilot projects and long-term monitoring. 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 restoration or enhancement through management can occur successfully, these methodologies need to 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. This feedback will increase the efficiency with which reserve lands can be managed and the overall success rate of management activities. For example, a study published in 2004 evaluated the effectiveness of methodologies for restoring riparian vegetation (Opperman and Merelender 2004). Similar pilot projects will be developed in the targeted studies phase when multiple techniques are intended to achieve a desired outcome and are appropriate for monitoring habitat function within the Reserve System and overall study area.

Testing the use of indicators for natural communities or covered species; refining monitoring protocols; establishing control plots for long-term management; and

reviewing the literature for guidance on sampling, experimental design, and management will all be a part of the targeted studies phase of implementation.

Develop Experiments to Resolve Critical Uncertainties

A final element of the targeted studies phase of implementation is the development of experiments that resolve critical uncertainties. In some cases, critical uncertainties will be identified as conceptual models are developed (see **Appendix J**, Section J.2.2, *Natural Community Monitoring Tools*, **Appendix J**, Section J.3.1, *Species-Specific Monitoring Tools*, and **Figures 7-6 through 7-9**). In other cases, critical uncertainties have been identified and described as part of the biological objectives of the Plan (see especially the Directed Studies section of **Table 5-2b**). For example, in order to enhance the chaparral land cover types, the critical uncertainty of factors contributing to the health and regeneration of native chaparral species must be resolved. The targeted studies phase of implementation will entail initiation of projects that resolve the critical uncertainties identified in the Directed Studies section of **Table 5-2b** as well as any other critical uncertainties identified as the conceptual models are developed.

In addition, the Implementing Entity will work with other individuals and organizations (e.g., local universities) to facilitate targeted studies on the Reserve System and streams that will improve management.

Long-Term Monitoring and Adaptive Management Phase

Both the inventory phase and the targeted studies phase will be followed by long-term monitoring to determine the status and trends of landscapes, natural communities, and species and the effectiveness of the management of the Reserve System in achieving the biological goals of the Plan (**Figure 7-1**). Monitoring that does not depend on the results of targeted studies will occur as soon as the reserve unit management plans have been reviewed and approved by the Wildlife Agencies and baseline studies are complete (inventory phase) or sooner, if appropriate. Long-term monitoring will use the framework developed during the inventory phases to carry out effectiveness monitoring and to implement adaptive management.

The long-term monitoring phase includes the following tasks.

- Update GIS land cover layer with aerial photographs, satellite imagery, and other relevant data sources including serpentine soils at least every 5 years. Assess status and trends at the landscape and natural community levels.
- Monitor species (covered species or indicator species) response to enhancement, restoration, and habitat creation.

- Monitor restoration sites for success; remediate sites if initial success criteria are not being met. The reserve unit management plan will identify triggers for remediation, if necessary.
- Monitor covered species using methodologies developed in targeted studies phase. Assess status and trends of covered species by monitoring covered species populations, groups, or guilds of species or indicators over time.
- Assess status and trends of covered plants that may have been partially or temporarily impacted by covered activities to ensure that plant protection in the Reserve System adequately offsets impacts.
- When enhancement and restoration projects are complete and have met final success criteria, scale back monitoring effort (i.e., frequency, extent) but continue to adaptively manage these sites[4].
- Update **Figure 2-5** *Private Development Areas Subject to the Plan* based on best available science throughout implementation to ensure projects in specific portions of the permit area are required to go through the Plan are appropriately identified. Revisions to the map will be tracked in the annual report.

In addition to long-term monitoring, this phase will include steps to adaptively manage the Reserve System to implement the conservation strategy described in Chapter 5. Adaptive management tasks are listed below.

- **Evaluate efficacy of monitoring protocols.** During this phase, the results of pilot projects will be evaluated and incorporated into long-term monitoring efforts.
- **Incorporate best available scientific information into management.** Regular reviews of literature as well as interaction with the Science advisors and the Wildlife Agencies 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 developed for each species and for natural communities (see **Appendix J**, Section J.2.2 *Natural Community Monitoring Tools*, **Appendix J**, Section J.3.1 *Species-Specific Monitoring Tools*, and **Figures 7-6 through 7-9**). In addition, the existing species habitat models developed for this Plan will be refined. As more information becomes available and as assumptions evolve, the 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 results or results suggesting that the conservation actions will not likely meet the conservation strategy commitments described in Chapter 5 of the Plan will be probed to understand

[4] Frequencies of monitoring will be dependent on the natural community or species and will be determined during the development of the reserve unit management plans. In some cases, monitoring will be conducted on an annual basis, in other cases, monitoring may only be necessary every 3–5 years.

the cause or source of the result. 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 but equally successful conservation actions are developed and agreed upon by the Wildlife Agencies, or if they are inadequately conserving species or communities. The magnitude of the change to the success criteria will be based on best available scientific information. New or different conservation actions may be implemented through time, as long as they fulfill the conservation strategy commitments described in Chapter 5 of this Plan. Conservation actions are catalogued in **Tables 5-1a–d and 5-2a–b** and are described in more detail in Section 7.3, *Monitoring and Management Actions*, below. Example success criteria are described in **Table 7-2**. Operational success criteria will be developed during the Targeted Studies phase of implementation. Changes to success criteria and conservation actions will be discussed with and not implemented until approved by the Wildlife Agencies. For significant changes, a permit amendment may be necessary.

7.2.3 Program Implementation

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 Implementing Entity 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 Implementing Entity will inventory monitoring projects and programs in the study area, their goals, timelines, design, protocols, etc. This will help coordinate information and will be an important first step in developing the monitoring component of the reserve

unit management plans. The Implementing Entity'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 generated by the Habitat Plan, including monitoring reports, conference presentations, and published papers to others.
- Assessing the effectiveness of conservation measures relative to the conservation strategy described in Chapter 5.
- 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 targeted studies and conducting studies that inform critical uncertainties.
- Developing and updating the monitoring and adaptive management elements of reserve unit management plans.
- Incorporating monitoring, directed studies, and other adaptive management–related activities into reserve unit management plans.
- Creating and maintaining a network of science advisors (see below) to provide advice to the Implementing Entity, as needed, on adaptive management and monitoring issues including important data gaps, monitoring and management methods, and data interpretation.
- Periodically (at least every 5 years) convening the Independent Conservation Assessment Team (Section 7.2.3 *Program Implementation*) to conduct a program-wide review of Habitat Plan implementation, including monitoring and adaptive management, and providing recommendations to improve Habitat Plan implementation.
- In Year 20 of implementation, work with the Wildlife Agencies to conduct a formal and complete review of progress toward building the Reserve System.

The Implementing Entity will solicit input regarding adaptive management from the Wildlife Agencies, science advisors, Independent Conservation Assessment Team, other independent experts, and the public. In addition, the Implementing Entity may convene technical committees to seek focused advice on key adaptive management topics. The responsibility for which course of action to take in adaptive management rests with the Implementing Entity and its senior staff or senior contract biologists. However, the Wildlife Agencies will assist the Implementing Entity with the adaptive management program. Major shifts in the adaptive management program need to be reviewed and approved by the Wildlife

Agencies. Major shifts include, but are not limited to, proposed actions that may be inconsistent with the Plan or detrimental to a covered species, introducing new and untested management techniques, discontinuing and replacing ineffective management techniques that are recommended in the conservation strategy, or applying management techniques on a much larger or smaller scale than envisioned in the Plan. Decisions made in the adaptive management program will be based primarily on which course of action is most likely to meet the conservation strategy described in Chapter 5.

Wildlife Agencies

A primary role of the Wildlife Agencies is to provide feedback to the Implementing Entity regarding changes to Plan implementation based on the results of targeted studies and monitoring and on the recommendations of the science advisors, the Independent Conservation Assessment Team, academic scientist partners, and others. Where possible, Wildlife Agency staff will provide expertise in the biology and conservation of covered species and natural communities, management tools, monitoring program, and all other Plan implementation.

The Implementing Entity and the Wildlife Agencies will strive at all times to work in good faith with each other to reach mutual agreement on key implementation tasks such as adaptive management, monitoring, and conservation actions. The primary forum in which these discussions will occur is the Technical Advisory Committee described in Chapter 8, Section 8.2.4 *Technical Advisory Committee*. Additional meetings with the Wildlife Agencies may be needed to discuss and resolve key issues related to adaptive management and monitoring. If disagreements arise that cannot be resolved easily, the Implementing Entity will follow the "meet and confer" dispute resolution process outlined in Section 6.6.1 of the Implementing Agreement, and if necessary, the "elevation of dispute" process outlined in Section 6.6.3 of the Implementing Agreement (**Appendix B**).

Land Management Agencies

As discussed above, the Implementing Entity will share information and resources in implementing management across reserve boundaries and on a regional scale with other land management agencies in the study (e.g., County Parks, State Parks, and the Open Space Authority). Input from other land management agencies in the study area is an important component of successful adaptive management. Land management agencies that manage land on behalf of the Implementing Entity (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 Implementing Entity will consult science advisors who will provide regular advice on Plan implementation. The role of the science advisors is to provide the Implementing Entity with science-based expert opinion and recommendations, focused "white papers," peer review, and feedback regarding key scientific aspects of Plan implementation such as reserve assembly, reserve management, and monitoring protocols. Science advisors will be contacted by the Implementing Entity and its partners, including the Wildlife Agencies, as needed. They may also be convened as a group when 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,
- Statistical analysis and experimental design.
- Conceptual models,
- Species-specific surveys, and
- Species protocols.

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

- Proposals for directed studies to address important management questions.
- Management and monitoring reports and recommendations to the Implementing Entity provided by others.
- Monitoring priorities, sampling design, survey protocols, data analysis, and data storage.
- Proposals for experimental pilot projects to test 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.

The Independent Conservation Assessment Team will provide policy-level recommendations to the Implementing Entity. The Independent Conservation Assessment Team will be selected and convened by the Implementing Entity at least every 5 years as part of the 5-year major Plan review. 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

Members of the public will have opportunities to learn about Plan status and provide input to the Implementing Entity on adaptive 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 Implementing Entity or its designee.

7.2.4 Guidelines for Monitoring

Because the biological outcome of many management actions is uncertain, the monitoring and adaptive management program is based on scientific principles that guide continual refinement of conservation efforts in order to implement the conservation strategy described in Chapter 5. The adaptive management program will develop alternative management strategies and test the effectiveness of those strategies 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 7-1**). The most basic monitoring involves simply assessing effects once a management action has occurred without any replication, controls, or comparison of management treatments. At the other end of the spectrum are directed studies that test a hypothesis in a manner that can be validated through statistical inference. Even simple experimental methods will yield important results to help guide and improve management. The scientific principles listed below will guide monitoring and adaptive management.

- Adaptive management actions will incorporate scientific principles of replication, control, and pre- and post-treatment monitoring when necessary to accurately measure the Plan's implementation of the conservation strategy. Targeted studies will refine monitoring protocols and resolve key management uncertainties.
- Adaptive management and monitoring actions will be linked to hypotheses about species' ecological relationships and responses to management actions. Monitoring will be designed in such a way as to test these hypotheses.
- When feasible, adaptive management or directed studies will include an experimental design with appropriate significance levels (alpha level) as well as sufficient statistical power to detect effects (beta level).

Adaptive management, and the design of targeted studies, will be driven by hypotheses about key factors for the landscape, natural community, and/or species for which the management is applied. For example, if the goal of management is to increase populations of small mammals to serve as a prey base for certain covered species (e.g., western burrowing owl, San Joaquin kit fox), land managers must develop hypotheses about what controls small mammal abundance and distribution. Adaptive management actions and monitoring will be directed toward confirming or disproving those hypotheses. Directed studies will be conducted on a small scale using an experimental design that will yield statistically valid results to address critical uncertainties. Ultimately, if small mammal availability limits the abundance of covered species, increasing the prey base may increase the survival and fitness of covered species. If the prey base increases and the covered species do not respond, then other factors apparently limit their abundance.

In addition to the scientific guidelines described above, the following steps will be included in the experimental design.

1. **Define the question.** Monitoring strategies will be designed to address specific hypotheses. Conceptual, statistical, or spatially explicit models will define those hypotheses. Conceptual models are described in **Appendix J**, Sections J.2.2 *Natural Community Monitoring Tools* and J.3.1 *Species-Specific Monitoring Tools.*
2. **Determine what to measure.** Establish the attributes or variables that the monitoring will measure to answer the question defined above. This step includes the development of measurable 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 community, and landscape level. Monitoring protocols will vary with level and with the target of the monitoring. Monitoring protocols will be developed in accordance with the guidelines provided below in Section 7.2.4 *Guidelines for Monitoring* subheading *Protocols*.
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.** Sampling design needs to be a consideration prior to initiating the experiment. The experimental management approach of the HCP/NCCP requires that questions of site selection, statistical power, and significance be incorporated, as much as possible, into the monitoring and adaptive management program. Sampling design is described in detail below.

In addition, **Appendix J** *Monitoring Issues and Tools* provides guidance on monitoring challenges relevant to landscape, natural community and species for the study area.

Indicators

Indicators can be used in many ways: to predict species richness (MacNally and Fleishman 2004), to estimate biodiversity (Kati et al. 2004; Chase et al. 2000), to assess levels of disturbance, or to provide targeted information on a system or species (Caro and O'Doherty 1999; Carignan and Villard 2004). Landres et al. (1988) define an indicator species as

> an organism whose characteristics are used as an index of attributes too difficult, inconvenient, or expensive to measure of other species or environmental conditions of interest.

In this Plan 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 some cases indicators will be used to determine the availability of habitat for a species. For

example, the presence of a California ground squirrel colony would be an indicator for available upland habitat for California tiger salamander if there is also breeding habitat within dispersal distance. In that circumstance, the expansion of ground squirrel colonies would then represent an increase in available habitat for California tiger salamanders. Measuring the increase in ground squirrel colony size is much easier than measuring the increase in use by California tiger salamanders. Additionally, when there are complex interactions among biotic and abiotic factors, modeling species responses or using abiotic factors as an indicator may not be appropriate. Monitoring aspects of the target species may be a more reliable and often easier "indicator" than abiotic factors (like temperature, substrate or turbidity). For the purposes of this Plan, indicators are abiotic and biotic variables that are selected to facilitate monitoring of systems or species that are otherwise difficult to examine.

In cases where an indicator is used to monitor an ecosystem or natural community (health indicator species), the conceptual models will be used to help identify an appropriate indicator species or variable. Draft performance indicators for natural community enhancement, restoration, and creation measures are presented in **Table 7-2**. Indicators, in general, are easy to monitor and demonstrate changes or trends that are quantifiable. Indicators need not be species, but may be ecological variables or structure-based characteristics such as diameter and age class of trees, interpatch distances between habitat, 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 levels.
- 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.

The indicators or variables will be coordinated with existing programs and data sets that are complementary to, and consistent with, the conservation strategy of this Plan. Prior to adopting any indicator, field verification and fine tuning in the system of interest is necessary (Atkinson et al. 2004). Once monitoring variables have been selected, the following descriptions will be made (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).
- "When" will the variable be monitored and at what frequency.
- The conceptual ecological model underlying the selection of the monitoring variable.
- The geographical area where it will be monitored (e.g., transect locations, stream miles).
- 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.

The monitoring component of each reserve unit management plan 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 component will specify why monitoring the presence of egg masses for covered amphibians is an appropriate indicator of population-based goals and objectives. In this example, the reserve unit management plans will justify that counting individual adults, larvae, and/or metamorphs is not the only or preferred way of monitoring for population status. The recommendation of the science advisors will also help guide the selection of indicators and the Implementing Entity will work with Wildlife Agencies to develop appropriate indicators. 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 available, scientifically accepted monitoring protocols that are compatible with measuring the success of the conservation strategy of this Plan will be adopted to facilitate data comparison 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 unit management plans. To be successful, the monitoring protocols must be applied consistently by different observers and across monitoring cycles. Ongoing training by Implementing Entity staff or their contractors will be necessary to ensure this consistency. For example, the National Park Service's Inventory and Monitoring Program guidelines for monitoring protocols (Oakley et al. 2003) or the Bureau of Land Management's guidelines (Elzinga et al. 1998), in addition to other sources, can be used as references for developing monitoring protocols.

Monitoring protocols will vary by covered species. For species that are difficult to detect in the study area (e.g., San Joaquin kit fox), monitoring may be limited

to determining whether the species persists from sample period to sample period, what features define its habitat, and what threats it faces. Surveys for species that are more readily detectible (e.g., California tiger salamander, California red-legged frog) may detect whether the species' range is increasing or decreasing. For species that are sufficiently detectable to obtain estimations of population size or probability of detection (e.g., western burrowing owl, many covered plants), monitoring a randomly selected subset of the population in order to make statistical inference to the whole population can be achieved through adherence to the principles listed below.

- Develop and state the assumptions in the hypotheses and models *before* collecting monitoring data or conducting manipulations such as experiments and adaptive management.
- When designing an experiment or using adaptive management, select the number and location of sampling units so as to apply sufficient scientific rigor for evaluating the hypothesis being advanced.
- Replicate in space and time the number of the sites surveyed for population estimates and/or those receiving a management action. Use controls when appropriate.
- Measure the sensitivity of variables to reflect true changes in the resource being sampled. When appropriate, adjust counts, measures of species richness, and determinations of patch occupancy (i.e., presence/absence) with an estimate of detection probability as described by Lancia et al. (1996), Yoccoz et al. (2001), and Pollock et al. (2002).

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.

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 drive natural communities. Sampling intensity and probability of detection will be considered to ensure that all covered 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 indices for population trends for covered species, 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. Issues to consider (Scheiner and Gurevitch 1993) are listed below.

- Availability of sites on which treatments can be applied.
- Availability of reference sites.
- The site-selection process (is it random? stratified random? non-random?).
- Systematic versus opportunistic sampling.
- Detection probability of the protocol.
- Replication versus pseudo-replication (Hurlbert 1984).
- The clarity of hypotheses.
- Sufficient statistical power (1-β) or significance level (α).

7.3 Monitoring and Management Actions

7.3.1 Landscape-Level Actions

Landscape-level monitoring will be directed at tracking large areas, landscape-level processes, and regional issues that affect the study area. **Table 5-1a** correlates landscape-level monitoring actions with biological goals and objectives for landscapes. Landscape-specific issues such as linkages, invasive nonnative plants and animals, disturbance, disease, and hydrology are described in **Appendix J** *Monitoring Issues and Tools*. The section below summarizes the specific monitoring actions that the Implementing Entity will carry out to track environmental issues at the landscape level and ensure that landscape-level goals and objectives are being met. Compliance monitoring is described above in Section 7.2.1 *Types of Monitoring* and will take place at all levels of monitoring, including the landscape level.

Assimilate Results of Pre-Acquisition Assessments and Other Surveys

Information on landscape features will be collected through pre-acquisition assessments, including biological surveys, updated land cover mapping, assessments of habitat suitability for covered species, air photo interpretation, and the biological resources present or expected on site, that provide information on the extent, quality, and distribution of land cover types in the Reserve System. These data will be used to refine existing species habitat models and develop natural community conceptual models (see **Appendix J**, Sections J.2.2 *Natural Community Monitoring Tools* and J.3.1 *Species-Specific Monitoring Tools*, and **Figures 7-6 through 7-9**). Additionally, this information will be combined with landscape-level information being collected by others in the region to provide resource managers, including the Implementing Entity, with an understanding of how critical biological resources are generally trending under the influence of Plan implementation as well as under the influence of other human activities and other environmental factors (e.g., fire, drought, disease). Annual information on

precipitation and whether the study area is experiencing a wet or dry water year will also be collected to facilitate trends analysis and potential impacts on baseline and other surveys for covered species and natural communities.

Refine Land Cover Maps

At the landscape level, the Implementing Entity will monitor, using aerial photos or satellite imagery, the extent and distribution of land cover types within the study area every 5 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-photo interpretation is difficult. Species models, including maps, will be improved as new data become available.

Assess and Monitor Landscape Linkages

Prioritizing, acquiring, assessing, managing, and monitoring landscape linkages are important tasks at the landscape level (**Table 5-9** and **Figure 5-6**). One of the primary goals of the conservation strategy is to sustain and enhance the effective movement and genetic exchange of native organisms within and between natural communities inside and outside the study area. To monitor landscape linkages the Implementing Entity will use a combination of compliance monitoring (to ensure that land acquisition requirements are met) and effectiveness monitoring (to ensure that species utilize linkages effectively and that management actions to increase permeability or improve connectivity are successful). Effectiveness monitoring will include studies of wildlife and plants.

The inventory phase of monitoring will prioritize acquisition of linkages, develop management protocols to enhance linkages, and develop success criteria for the effectiveness of linkages at sustaining movement and genetic exchange. The targeted studies phase will test methodologies for monitoring linkages. The Implementing Entity will evaluate whether linkages are successful at the small scale (e.g., testing use of culverts by target species using camera traps, track plates, or other techniques) and the large scale (e.g., testing connectivity by monitoring indicator species such as elk or badger or through genetic testing of target species). Studies on plant linkages will focus on plant dispersal dynamics and success (Bullock et al. 2006) and on genetic exchange between populations if and where possible. The objective of the targeted studies phase is to determine the most cost-effective and accurate way of evaluating whether landscape linkages are functioning within the context of the Plan. The long-term monitoring phase will implement methodologies identified in the targeted studies phase.

The Implementing Entity will institute a data-collection program to better understand how wildlife moves within and through the study area, both inside and out of the Reserve System. This data-collection program will be initiated

within the first 2 years of implementation. The data collected through this effort will be available for design and implementation of covered road projects. This program will remove the burden of data collection from each participating agency and ensure that all the data collected during the permit term is collected and collated consistently, is maintained in a central location, and is accessible. The conservation strategy includes funding for a feasibility study to determine the extent and needs for wildlife movement in three focal areas: Tulare Hill to Anderson Reservoir, Pacheco Creek (SR 152), and the Pajaro River (see Chapter 5, Section 5.3.2 *Landscape Conservation and Management*, subsection *Feasibility Study*. This feasibility study will be an important part of the data-collection program for wildlife movement in the study area.

Data collection will consist of two parts: monitoring the presence/absence of target species at designated locations across the study area, and monitoring the presence/absence of target species in specific locations determined by future covered activities. Data collection at consistent locations will entail regular and repeatable monitoring at strategic pinch points (e.g., culverts, bridges) in the study area to determine if existing linkages provide connectivity and if enhancement of these crossings increases wildlife movement. This component of the program could entail establishing monitoring stations at specific points or walking transects. Data-collection techniques could include those listed below.

- Installing motion-activated cameras (video or still).
- Installing and monitoring track plates.
- Visual documentation of tracks, scat, or individuals.
- Radio tracking individuals.

By coordinating with the Local Partners, specific monitoring efforts will be implemented in areas where covered activities (e.g., road widening, urban expansion, creek restoration) are planned to occur in the future. This component of the data-collection program can be used to inform project design and to determine more precisely the cumulative impacts that covered activities will have on habitat connectivity in the study area.

In addition, all structures constructed for wildlife movement (tunnels, culverts, underpasses, fences) will be monitored at regular intervals by the Local Partner facility owner and repairs made promptly to ensure that the structure is in proper condition. For facilities owned by entities not participating in the Habitat Plan (e.g., California Department of Transportation [Caltrans]) and where feasible, the Implementing Entity will secure access and data collection agreements with these entities to allow the Implementing Entity to conduct this monitoring.

Track Climate Change

As indicated in Chapter 10 *Assurances*, climate change-related remedial measures will be triggered if there is an increase in temperature greater than 3°C for any of the three baseline periods measured as a 10-year running average (see

Chapter 10, Section 10.2.1 *Changed and Unforeseen Circumstances*). The annual report will document changes in temperature in the study area throughout the permit term.

Track Invasive Species

A primary goal of the Plan is to enhance or restore representative natural landscapes to maintain or increase native biological diversity. To that end the conservation strategy proposes to eradicate or reduce the cover, biomass, and distribution of targeted populations of nonnative invasive plants. Within the Reserve System, the Implementing Entity will map occurrences of invasive nonnative plants as described in **Appendix J**, Section J.1.2 *Landscape Monitoring Tools* subheading *Mapping of Invasive Plants.*

Monitoring protocols for invasive plants will be coordinated with those of other local entities to ensure consistency with these programs and facilitate the sharing of monitoring results. This monitoring information will be used to determine the need for management actions to control the spread of existing invasive plants as well as potential future invasions. The effectiveness of control methods will also be reviewed. This monitoring information will be shared with state and local land management agencies charged with the control of invasive plants, including the Bay Area Early Detection Network (www.baedn.org) and the California Invasive Plant Council (www.cal-ipc.org) as well as with managers of adjacent public lands.

During the inventory phase of monitoring, the Implementing Entity will identify and prioritize problems; map occurrences of invasive plants, if possible; develop an exotic species control program; and develop success criteria for the effectiveness of eradication or reduction efforts. The targeted studies phase will develop protocols for invasive species monitoring and test methodologies for monitoring eradication efforts. The objective of the targeted studies phase is to determine the most cost-effective and accurate way of controlling invasive species. The long-term monitoring phase will entail implementation of methodologies identified in the targeted studies phase.

Occurrences of invasive animals will also be documented in GIS and management actions will be developed to prioritize and address nonnative, disruptive animals. For example, feral pig is an invasive species of special concern. Rooting disturbance by feral pigs allows nonnative invasive plants to establish in grassland and aquatic communities, and fall acorn foraging likely has a detrimental effect on oak regeneration (Sweitzer and Van Vuren 2002). During the inventory phase, areas frequented by feral pigs will be identified for feral pig eradication (through hunting and trapping) and exclusion (using fencing exclosures and cages). During the targeted studies phase, protocols will be developed to monitor the presence/absence of feral pigs over time. Monitoring will track the effectiveness of feral pig eradication and ensure that exclosures from grassland, oak woodland, and aquatic habitat types are effective and maintained. In addition, protocols will assess the extent and types of damage to vegetation and soils caused by pigs, including detection of exotic plant species in

areas of pig rooting. These protocols will then be used as part of long-term monitoring for feral pig eradication and exclusion.

Instances of disease will be monitored and reported, as they are discovered. The Implementing Entity will maintain a watchlist of dangerous diseases for the study area and will periodically monitor animals and plants, as part of species and natural community monitoring, to ensure that any occurrences of diseases are identified.

The Implementing Entity will track, on an annual basis, the status of diseases and nonnative invasive species in order to expeditiously initiate remedial actions described in Chapter 10, Section 10.2.1 *Changed and Unforeseen Circumstances*.

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 must 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.

Monitor Disturbance Events

Disturbance events such as fire, flood, and earthquakes will be monitored opportunistically. Should fire or flooding occur in an area that has been previously monitored, the Implementing Entity will ensure that post-disturbance monitoring takes place and that results are incorporated adaptively into management actions. Additional information regarding disturbance tracking is described below, in Section 7.3.2 *Natural Community–Level Actions* subheadings *Chaparral and Northern Coastal Scrub* and *Oak and Conifer Woodland Actions*. The Implementing Entity will monitor the effects of these natural disturbances and implement remedial actions as described in Chapter 10, Section 10.2.1.

7.3.2 Natural Community–Level Actions

Natural-community-specific issues such as keystone species, predation, fire, livestock grazing, and altered stream flow are described in **Appendix J** *Monitoring Issues and Tools*. The section below summarizes the specific monitoring actions that the Implementing Entity will carry out to track

environmental issues at the natural-community level and ensure that natural-community-level goals and objectives are being met.

Grassland Actions

As described in Chapter 5 *Conservation Strategy*, adaptive management in grasslands will be focused on the maintenance and enhancement of native grasses, the benefit of covered species, and the promotion of native biological diversity. Monitoring actions will focus on the effectiveness of management to reduce the presence of nonnative plants, to increase the extent and diversity of native plants, and to promote keystone species (i.e., California ground squirrel) within the natural community for the benefit of native plants and animals, including covered grassland species such as Bay checkerspot butterfly, California tiger salamander, serpentine plants, western burrowing owl, and San Joaquin kit fox. **Table 5-1b** correlates natural community monitoring actions with biological goals and objectives for natural communities.

The monitoring program will evaluate the success of key management techniques such as livestock grazing, prescribed burning, mowing, and seeding to promote native plants and reduce the cover and biomass of nonnative, invasive plant species. Additionally, the program will track the ground squirrel population and evaluate the effectiveness of management and promoting additional burrows and monitoring burrow use. Finally, the monitoring program will track the impacts of nitrogen deposition and other threats on natural community function.

Assess Condition of Natural Communities

The Implementing Entity will conduct monitoring to assess the status and trends of the grassland community and to evaluate community function. If feasible, information on the historical ecology of grassland will help guide assessments. The tasks listed below will be carried out to document the baseline conditions from which change will be measured.

- Use pre-acquisition assessments and site inventories to document the distribution and vegetation types of grasslands, including patches of serpentine grassland and rock outcrops not captured in existing maps. Methods to quantify and track the conditions of vegetation types will follow those of existing studies such as the vegetation sampling conducted by the CNPS along Coyote Ridge and WRA Environmental Consultants at the Silver Creek Preserve (Evens and San 2004; WRA Environmental Consultants 2006).
- Develop a management-oriented conceptual model for grasslands that includes important factors such as the effects of rainfall, temperature, fire, herbivory (i.e., grazing) and succession to woody communities (e.g., chaparral/scrub or oak woodland), and identify indicators for community function as well as any critical uncertainties that may require additional directed studies (**Figure 7-8**).

- Assess and monitor invasive nonnative plants. This task will entail developing maps and descriptions of the distribution and abundance of target species; their known or potential effects on ecosystem function; native biological diversity; sensitive natural communities; covered species; and the means and risk of the spread of nonnative species to other areas within and outside the reserves. Focus on species that have the greatest potential to threaten grasslands such as yellow and purple star-thistle, barbed goat grass, teasel, and others.
- Assess the historic extent, conditions, and fire return interval of grassland within the study area using aerial photographs and historic records.
- If prescribed burns are feasible and desirable, prepare burn plans that describe pre- and post-burn monitoring to determine effects.
- Assess grassland landscape connectivity between reserves.
- Asses and track the health of serpentine rock outcrops and serpentine seeps if necessary beyond the monitoring for rare plants that occur in these communities (Santa Clara Valley dudleya and Mount Hamilton thistle).
- Examine potential negative impacts of grazing on sensitive communities and substrates such as rock outcrops and seeps.
- Identify and track additional threats (such as nitrogen deposition) and manage adaptively to contain these threats.

Monitor Actions to Promote Native Plants and Reduce Invasive Species

As discussed in Chapter 5 *Conservation Strategy*, the biological goals and objectives for grasslands include implementation of management actions that will promote propagation of native plants, reduce and control invasive nonnative species, and encourage native biodiversity through the maintenance of dynamic mosaics of vegetation types and biological gradients. Specific tasks to further these goals and objectives are listed below.

- Develop success criteria for grassland enhancement and evaluate the success of management actions (i.e., grazing, burning, mowing, and seeding) in reducing nonnative plants and promoting the extent and diversity of native plants.
- Develop guidance for grazing within the study area and grazing plans for specific parcels, as applicable, using an experimental approach to achieve the biological goals and objectives.
- Develop pilot projects that test the effects of different grazing practices (e.g., grazing intensity, duration, season, species) on the maintenance and regeneration of native grasses and forbs. If possible, combine grazing treatments with other management techniques such as prescribed burns and hand seeding to detect interactions between management treatments.

- Evaluate the success of any herbicide applications used to control nonnative plants in target areas.

Monitor Ground Squirrel Populations and Burrow Use

As discussed in Chapter 5 *Conservation Strategy*, California ground squirrel is considered a keystone species in grassland habitats. Because of its importance in functioning as a prey base for some predatory covered species and providing refugia for some terrestrial covered species, it will be important to monitor populations and/or burrow use and density. At the same time, historical rodent-control programs will need to be continued in localized areas to protect vulnerable infrastructure (e.g., pond berms, levees, road embankments, dam faces). The tasks necessary to carry out the goals and objectives pertaining to fossorial mammals are listed below.

- Monitor ground squirrels and/or populations of other small mammals to determine the abundance of prey and burrows for several covered species (e.g., western burrowing owl, California tiger salamander) and many common species.
- Determine if ground squirrel burrows are being used by target species.

Chaparral and Northern Coastal Scrub Actions

Adaptive management and monitoring of the chaparral and northern coastal scrub communities are built around the conservation goal of maintenance and enhancement of these communities for the benefit of covered species and the promotion of native diversity. To ensure the long-term persistence of the communities, monitoring actions will focus on the effectiveness of management to promote regeneration and succession by maintaining and establishing natural disturbance patterns to create stands of various ages and promote biological diversity.

Many of the plants in the chaparral and northern coastal scrub communities have evolved to be dependent on a disturbance regime of periodic fire for regeneration and succession (Holland 1986; Hanes 1988; Schoenherr 1992). In chaparral communities, disturbance causes canopy openings that allow for the growth of herbaceous vegetation, which is normally shaded out by a nearly continuous shrub stand. In both chaparral and northern coastal scrub communities, chemicals in smoke and charred wood also stimulate germination in a wide variety of native forbs that lie dormant as seeds in the soil for decades before a fire (see Chapter 3). Periodic disturbance allows for structural diversity by creating a range of age classes and promoting successional diversity within the communities. Also, periodic disturbance prevents the encroachment of both grasslands and conifer woodland and forest into chaparral and scrub.

The monitoring program will evaluate the success of burning or mechanical thinning to maintain canopy gaps and promote regeneration. Monitoring will

also focus on identifying areas where adjacent natural communities are encroaching into chaparral and scrub so that appropriate management actions can be implemented at those sites.

Assess Condition of Natural Community

Regeneration and succession stages within the chaparral and northern coastal shrub communities will be managed through both a prescribed burn program and mechanical thinning. The tasks listed below will be carried out to document the baseline conditions from which change will be measured.

- Use pre-acquisition assessments (updated land cover mapping, assessments of habitat suitability for covered species, air photo interpretation) and other field verification to establish the distribution and abundance of small stands of chaparral and northern coastal scrub (<10 acres) not mapped for the Plan that may be important in increasing connectivity between larger stands.
- Develop a conceptual model for the natural community and identify indicators for community function as well as any critical uncertainties that may require additional directed studies.
- Assess the historic extent, conditions, and fire frequency of chaparral and northern coastal scrub stands within the study area using aerial photographs and historic records of fire in the area. This information will be used to determine whether active management is required to maintain the structural diversity of these stands in their current extent and condition.
- If prescribed burns are feasible and desirable, prepare burn plans that describe pre- and post-burn monitoring to determine effects.
- Identify areas where grassland, oak woodland and Douglas-fir habitats are encroaching on chaparral scrub, paying close attention to patches that are necessary for maintaining landscape connectivity.
- Conduct targeted research identifying key factors affecting regeneration and succession.

Evaluate Effects of Periodic Disturbance

It is necessary to monitor the responses of the chaparral and scrub communities to wildfires, prescribed burning, and mechanical thinning. The tasks necessary to determine the response of these actions on promoting canopy gaps, regeneration, and succession in chaparral and northern coastal scrub are listed below.

- Develop structural diversity success criteria and compare post-treatment conditions to baseline conditions to measure the effectiveness of prescribed burning on natural community regeneration and succession.
- Compare results of mechanical thinning to structural diversity success criteria and baseline conditions, and measure the effectiveness of mechanical thinning on natural community regeneration and succession.

Track Adjacent Natural Community Encroachment into Chaparral

The use of prescribed burns is intended to prevent the encroachment of adjacent natural communities into chaparral and scrub communities. Areas burned too frequently risk conversion to grassland, whereas too infrequent burning may result in tree community encroachment. Where the use of prescribed burns is not feasible, there is an increased risk of the spread of trees, especially conifers, into chaparral and scrub communities. For example, there are areas in the Santa Cruz Mountains and in the Diablo Range in Henry W. Coe State Park where conifer encroachment has already taken place. This encroachment presents a risk of not only overall loss of habitat extent, but also the loss of key stepping stone patches necessary for maintaining habitat connectivity and corridors for species movement and distribution. The tasks necessary to track the spread of natural communities into chaparral and scrub are listed below.

- Monitor chaparral and scrub stands within reserves through vegetation sampling and periodic interpretation of aerial photographs to ensure that the overall extent of these stands is not declining substantially.
- Adaptively manage the community to prevent encroachment of grassland, oak woodland, and confer forest in target areas where any significant encroachment is identified.

Oak and Conifer Woodland Actions

The conservation goal of maintenance and enhancement of oak and conifer woodland communities to benefit covered and other native species serves as the basis for the adaptive management and monitoring strategy. To ensure the long-term persistence of these communities, monitoring actions will focus on the effectiveness of management to enhance the natural processes and native species diversity found in these communities.

Persistence of native plant diversity in oak and conifer communities is dependent on a variety of limiting factors. Seedling recruitment and regeneration within oak woodlands can be limited by invasive weeds and nonnative plants in the understory (Jones & Stokes 1995), 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 determining the primary limiting factors.

In conifer woodlands, plant species recruitment and regeneration are influenced by the buildup of dead plant material on the forest floor and the frequency and

intensity of fire. Periodic fire allows for increased structural and biological diversity by increasing the number of native herbs, creating favorable soil conditions for seedling establishment, and stimulating seed release of closed-cone serotinous pines (Vogl et al. 1988). Like oak woodlands, conifer woodlands can be adversely affected by frequent or intense fires.

Certain areas of oak and conifer woodlands have been severely limited in their ability to recruit and regenerate native species, resulting in the loss of natural processes and native species diversity (Pavlik et al. 1991). These areas will be identified and targeted for enhancement within the study area.

The monitoring program will evaluate the effects of wildfires, prescribed burning, and mechanical thinning on the regeneration and recruitment of dominant plants in oak and conifer woodlands. Additionally, the effectiveness of other enhancement efforts will be evaluated at target sites.

Assess Condition of Natural Community

Recruitment and regeneration within the oak and conifer woodland communities will be managed through a limited prescribed-burn program, mechanical thinning, and other enhancement tools (e.g., seeding). Documenting the baseline conditions against which change can be effectively evaluated will entail the tasks listed below.

- Using recent aerial photographs, document the range of percent canopy coverage within the Reserve System to estimate structural habitat diversity.
- Use pre-acquisition assessments, site inventories, and other surveys to establish the distribution, abundance, and age structure of each species of oak and conifer within the Reserve System.
- Determine the status of tree recruitment using historical aerial photographs (e.g., Grossinger et al. 2006; San Francisco Estuary Institute 2008). Determine if the current canopy coverage of oaks is increasing, decreasing, or stable within the Reserve System.
- Assess oak stands (e.g., canopy coverage, tree condition, seedling and sapling abundance and survival, population age structure, acorn production) within 2 years of acquisition of each reserve 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, replanting; fencing saplings; reducing competing herbaceous vegetation; and controlling wild pigs.
- Develop a management-oriented conceptual model for the natural community (see **Figure 7-8** for an example) 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 Periodic Disturbance

It is necessary to monitor the responses of the oak and conifer woodlands to wildfires, prescribed burning, and mechanical thinning. The tasks listed below will be carried out to determine the effect of these actions on promoting regeneration and recruitment.

- Develop structural diversity success criteria and compare post-treatment conditions to baseline conditions to measure the effectiveness of prescribed burning on natural community regeneration and recruitment.
- Compare results of mechanical thinning to structural diversity success criteria and baseline conditions to measure the effectiveness of mechanical thinning on natural community regeneration and recruitment.
- Monitor success of burning and thinning to increase native species diversity in mid-canopy and understory of redwood forest, ponderosa pine woodland, and knobcone pine woodland.

Evaluate Seeding, Planting, and other Enhancement Efforts

The tasks listed below will be conducted to determine the response of enhancement and restoration actions on promoting regeneration and recruitment in oak woodlands.

- 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 controlling wild pigs).

Stream and Riparian Forest and Scrub Actions

Adaptive management and monitoring of stream and riparian forest and scrub are focused on the protection, restoration, and enhancement of these communities for the benefit of covered species and the promotion of native diversity. To ensure the long-term persistence of these natural communities and the species they support, monitoring actions will be the responsibility of the Implementing Entity[5] and will focus on the effectiveness of management to accomplish the following:

[5] In some cases, it may be appropriate for the Implementing Entity to contract with SCWVD to conduct monitoring activities within some streams, particularly where there is overlap in covered species and monitoring responsibilities between the Habitat Plan and the proposed Three Creeks HCP.

- improve habitat quality and connectivity for native fish, amphibians, reptiles, and riparian birds;
- establish or duplicate the effects of natural disturbance in target areas;
- enhance or restore riparian forest and scrub;
- improve channel function; to reduce anthropogenic sediment input to and storage in streams; and
- decrease the spread of nonnative invasive plant species.

Riparian woodland is dominated by trees and shrubs associated with streams and permanent and intermittent water sources. Riparian scrub is an early successional stage of riparian forest. Due to its dependence on stream channels, riparian vegetation is adapted to a particular disturbance regime. The dominant riparian species (Fremont cottonwood, white alders, and several willow species) generally require bare mineral soil and high light levels for germination. Floods can provide these conditions through the processes of erosion and deposition.

Streams throughout the study area are highly regulated due to the presence of reservoirs and the role of streams as conveyance features for flood protection and water supply (groundwater percolation). Reservoirs modify stream flows, reducing flood peaks and increasing summer stream flow, including during many drought years. The conservation strategy aims to improve the habitat quality of streams and to increase overall ecological functions and values (e.g., native species richness and diversity, vegetative cover, wildlife habitat function). The monitoring program will evaluate the effectiveness of achieving these objectives as well as additional objectives focused on promoting community functions, habitat heterogeneity, and connectivity, including specific success criteria for maintaining hydrologic and geomorphic stream processes or duplicating their effects.

Assess Condition of Natural Community

The establishment of ecological indicators and establishment of success criteria are integral to ensure the maintenance and restoration of habitat quality and ecological functions and values for the covered species. Documenting the baseline conditions against which indicators and success criteria can be effectively evaluated will entail the tasks listed below.

- Use pre-acquisition assessments and site inventories to verify the distribution and abundance of riparian forest and scrub mapped from air photos, and to develop maps of permanent, intermittent, and ephemeral streams.
- Inventory riparian and stream corridors within or outside of the reserves to identify stream segments suitable for enhancement or restoration. Corridors outside reserves will be identified based on importance for covered species and access.

- Use data from USGS gauging stations and/or weather stations to collect information on flood processes and their effects on other hydrogeomorphic processes and riparian communities.
- Assess the connectivity of stream and riparian corridors throughout the study area and between reserves and other public lands.
- Develop a management-oriented conceptual model for streams and riparian forest and scrub (see **Figure 7-8** for an example for grasslands), and identify indicators for community function as well as any critical uncertainties that may require additional directed studies.
- Assess nonnative invasive plants (e.g., giant reed, Acacia), including maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem and hydrogeomorphic functions, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas inside and outside the reserves.
- Investigate and document historical natural disturbance regimes in streams, and document hydrologic changes that may be affecting stream and riparian systems.

Monitor Riparian Restoration Projects

Monitoring restored riparian habitat will ensure that the natural community is functioning as habitat while providing for ecological processes in the larger landscape. Prior to the initiation of restoration projects, the effects of restoration techniques tested in pilot projects[6] must be evaluated for their efficacy in restoring or duplicating the effects of ecological processes, habitat quality, native cover regeneration, and hydrogeomorphic conditions. It is from these pilot projects that indicator species will be selected and success criteria developed for large-scale restoration projects. The monitoring activities listed below will be the responsibility of the Implementing Entity[7] and will ensure that financial resources are properly allocated and greater success in restoration efforts is achieved.

- Evaluate existing programs for successful monitoring protocols that are appropriate to riparian restoration within the study area.
- Initiate a pilot project to develop restoration measures for individual sites or stream reaches. 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

[6] Although individual project proponents would not be required to carry out pilot studies, the Implementing Entity will evaluate restoration and/or creation proposal based in part, on pilot studies conducted for the Reserve System. The Implementing Entity will also consider the history of the project proponent performing successful wetland restoration elsewhere and whether the restoration or creation project is consistent with the conservation strategy of the Plan.

[7] The same riparian, stream, wetland, and pond monitoring requirements apply to all Permittees and those under their jurisdiction when aquatic restoration is proposed to offset wetland fees (see Chapter 9, Section 9.4.1).

requirements. The results of pilot projects will guide future restoration efforts.

- Determine indicator species for monitoring restoration, and develop success criteria such as the amount of Shaded Riverine Aquatic (SRA) habitat.
- Monitor the effects of active and passive restoration throughout the Reserve System in target reaches. Success criteria will be developed during Plan implementation and could include the creation of native cover and the restoration of natural hydrogeomorphic and ecological processes as well as native- or covered-species response.
- Monitor the effects of livestock access and livestock exclusion on community composition and recruitment of dominant trees and shrubs.
- Monitor mitigation sites that are beyond their establishment periods (i.e., no longer sustained by irrigation), but have not achieved their success criteria, for stress due to low soil moisture or high evapotranspiration rates. See Chapter 10 *Assurances* for remedial measures if drought occurs (*Drought*).
- Monitor SCVWD natural reservoir inflow data in the study area to determine if the seasonal inflow at the end of April indicate a dry year (near 75% of inflow). See Chapter 10 *Assurances* for remedial measures if drought occurs (*Drought*).

Evaluate Effects of Periodic Disturbance

It is necessary to monitor the responses of river and riparian communities to periodic flooding. The value of promoting a natural floodplain or allowing target areas to flood will be assessed opportunistically. The tasks listed below will be conducted by the Implementing Entity to determine the response of flooding on creating or maintaining riparian vegetation and improving channel structure.

- Develop structural diversity success criteria and compare post-treatment conditions to baseline conditions to measure the effect of flooding on natural community regeneration and succession.
- Compare results of mechanical thinning (an action which could mimic the effects of natural flooding and drought) to structural diversity success criteria and baseline conditions and measure the effectiveness of mechanical thinning on natural community regeneration and succession.

Monitor Stream Restoration Projects

Monitoring stream restoration projects will focus on the recreation of the natural hydrogeomorphic processes of confined and degraded stream channels and the restoration of ecological processes. Removal of confined channels restores floodplain connectivity, allowing for greater dispersal distances of target species that use both aquatic and upland habitats. Stabilization of degraded stream channels reduces stream impairment by anthropogenic sources of sediment. The

tasks listed below will be conducted by the Implementing Entity to evaluate the efficacy of stream restoration projects.

- Develop success criteria and monitor success of restored areas in recreating natural hydrogeomorphic and ecological processes.
- Monitor sediment levels both pre- and post-bank stabilization.
- Determine if populations of target species are being restored and/or sustained through improvements in floodplain connectivity and reduced sedimentation. Use survey data from previous monitoring activities and augment the data with additional survey efforts to characterize the seasonal distribution, abundance, and species composition of the target species communities inhabiting restored streams.
- Monitor SCVWD natural reservoir inflow data in the study area to determine if the seasonal inflow at the end of April indicate a dry year (near 75% of inflow). See Chapter 10 *Assurances* for remedial measures if drought occurs (*Drought*).

Wetland and Pond Actions

Adaptive management and monitoring of wetland and pond communities supports the conservation goal of the maintenance, enhancement, and creation or restoration of ponds and wetland habitats for the benefit of covered species and promotion of native diversity. Monitoring actions will evaluate the effectiveness of management to preserve, enhance, create and restore ponds and to preserve and enhance seasonal and perennial wetlands by increasing native vegetative cover, biomass, and structural diversity within and around the margins. At the same time, monitoring actions will be used to evaluate efforts to reduce the cover and biomass of nonnative invasive plants, access by feral and domestic mammals, and numbers of predatory wildlife and fish species. Monitoring actions will also track the response of target species (e.g., California tiger salamander, California red-legged frog, western pond turtle, tricolored blackbird) to habitat management activities. A reasonable understanding of metapopulation dynamics in the vicinity of these management actions will need to be understood in order to determine whether the actions are causing the change in population level or the population is experiencing typical population fluctuation.

Assess Condition of Natural Community

The Implementing Entity will conduct monitoring to assess the status and trends of the wetland and pond communities and to evaluate community function. The tasks listed below will be conducted to determine the baseline condition of wetland and pond communities.

- Use pre-acquisition assessments, site inventories, and other surveys to establish the distribution and abundance of ponds and wetlands within and adjacent to 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. Identify degraded stream reaches that can be used as pond creation sites.
- Identify wetlands and ponds with abundant nonnative predators or ponds where native species are affected by feral and domestic animal entry. Prioritize these sites for predatory species eradication and exclosures.
- Assess nonnative invasive plants, including maps and descriptions of their distribution and abundance; their known or potential effects on ecosystem function, native biological diversity, sensitive natural communities, and covered species; and the means and risk of their spread to other areas inside and outside the Reserve System.
- Begin pre-treatment monitoring of sites considered for enhancement, restoration, and creation and develop criteria for evaluating success. These criteria will be suitable to evaluate if habitat management increases hydrogeomorphic and ecologic functions, improves habitat value, increases landscape connectivity, and enhances the habitats' ability to support existing and new populations of covered species.
- Identify and track additional threats (e.g., disease, invasive) and manage adaptively to contain these threats.

Evaluate Habitat Enhancement, Restoration, and Creation Activities

It is necessary to monitor the effects of pond and wetland enhancement, restoration, and creation. The tasks listed below will be conducted to determine the response of these actions on increasing native vegetative cover, biomass, structural diversity, and regional connectivity for the benefit of covered species.

- Determine indicator species for monitoring enhancement, restoration, and creation and develop success criteria.
- Initiate 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 exotic wildlife such as bullfrogs); existing wildlife use; and the potential for adverse effects (e.g., disturbance and/or removal of existing pond/wetland habitat). 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, restoration, and creation. Monitor the survivorship of

planting; quantify vegetated perimeter of pond; and describe habitat quality, connectivity, and species response. Measure success based on criteria described in the monitoring component of the reserve unit management plan.

- Survey wetland and pond capacity and water duration and monitor to ensure that the ecological and hydrogeomorphic functions related to these parameters are maintained or improved.
- Determine use of artificially created ponds by covered species.
- Evaluate the use of wetland-upland complexes by covered species.

Evaluate Efforts to Reduce Impacts associated with Livestock and Nonnative Plants and Animals

It is necessary to monitor the results of efforts to reduce impacts caused by livestock and nonnative species on pond and wetland habitats. The tasks listed below will be conducted to evaluate these effects.

- Determine the effect on the vegetative community and the relative benefit to target covered species of different management treatments such as access/exclusion by livestock and feral pigs, pond draining, and predator control.
- Monitor and record populations and incursions of nonnative predators in target wetlands and ponds.
- Evaluate the success or potential adverse effects of any herbicide applications used to control nonnative plants in target areas.

7.3.3 Species-Level Actions

The Implementing Entity will conduct monitoring to assess the status of covered species and to determine the extent to which the conservation strategy described in Chapter 5 is being implemented and the extent to which biological goals and objectives for species are being met. Species-specific issues and tools are described in **Appendix J** *Monitoring Issues and Tools*. The section below summarizes the specific monitoring actions that the Implementing Entity will carry out to track environmental issues at the species level and ensure that species-level goals and objectives are being met.

Species monitoring will address the following issues relevant to the Plan.

- Status and trends of covered species and other relevant species within the Reserve System (i.e., status and trends monitoring).
- The response of covered species to HCP/NCCP species-specific conservation measures and adaptive management (i.e., effects-of-management monitoring).

- Directed studies to resolve critical management uncertainties for some covered species (i.e., directed studies).

In some cases covered species are the response variables for effects-of-management monitoring at the community level. In those cases, monitoring is described in Section 7.3.2 *Natural Community–Level Actions* above. Species have been categorized into three groups for the purposes of prioritizing monitoring and maximizing efficiencies (see Group numbers in following sections). The grouping of each species will be re-evaluated every 5 years, or if listing status changes, and species may move between the three categories during the course of Plan implementation. The target species for status and trend surveys in acquired parcels will be based on and informed by species models, CNDDB data and pre-acquisition 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. In most cases, the study area constitutes a critical portion of the species' range. Baseline surveys will be initiated within 1 year of land acquisition. Species-specific conceptual models for Group 1 species will be initiated within 1 year of implementation. Within the year, 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 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 red-legged frogs have 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 in order to reserve budget for other conservation or monitoring actions. Recommended annual monitoring is for species status monitoring only (i.e., not trends monitoring). However, monitoring frequency for species addressed in finalized USFWS Recovery Plans will not fall below the recommend frequencies in these plans. For example, at a minimum, Coyote ceanothus will be monitored every 3 years, as suggested in *The Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998).

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 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. Finally, additional threats to species survival will be identified and tracked. These monitoring actions are common for all Group 1 species within the study area. Monitoring will ensure continued species existence within the study area by tracking species population status and trends.

Group 2 species are not currently listed, but the study area constitutes a critical 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 2 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 1 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. Finally, additional threats to species survival will be identified and tracked. These monitoring actions are common for all Group 2 species within the study area. Monitoring will ensure continued species existence within the study area by tracking species population status and trends.

Species in Group 3 may or may not be listed but the study 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 5 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 5 years but up to annually, as appropriate. Success criteria and monitoring protocols will be developed to incorporate monitoring results into the adaptive management strategy. Finally, additional threats to species survival will be identified and tracked. These monitoring actions are common for all Group 3 species within the study area. Monitoring will ensure continued species existence within the study area by tracking species population status and trends.

Monitoring Partial Impact to Plant Occurrences

In addition to status and trends monitoring within the Reserve System, covered plant occurrences that may be partially adversely affected by covered activities will be monitored. The purpose of the monitoring will be 1) to assess whether the impact reduces the long-term viability of the occurrence and whether supplemental management actions are feasible and warranted, and 2) to determine whether an additional occurrence must be protected, enhanced, or created in the Reserve System to offset this partial impact (as defined by Chapter 6, Section 6.6.2, subheading *Condition 20 Avoid and Minimize Impacts to Covered Plant Occurrences*). Baseline data will be collected before the covered activity is implemented.

Covered plant occurrences that are partially permanently affected (i.e., long-term viability is not reduced below the thresholds described in Chapter 6, Condition 20) by covered activities will be monitored by the Implementing Entity unless the impact is less than 5% of the total population size as measured by the number of individuals. If the impact is less than 5% of the total occurrence size, then the impact is not considered significant with regard to long-term viability and will not require monitoring nor will it count as a permanent impact. This exception applies to all covered plant species except Coyote ceanothus.

Specific monitoring protocols and success criteria will be developed during implementation as appropriate for each covered plant species, according to the

guidelines discussed here and in Condition 20 in Chapter 6. It is possible that only a portion of the occurrence will be located on the covered activity project site. In such instances, the monitoring protocol will address this issue. Three possible monitoring approaches include the following:

1. If the landowner agrees, the Implementing Entity will obtain access to the adjacent sites on which the rest of the plant occurrence is located, and surveys will include the entire occurrence.
2. If access to adjacent site(s) is not possible, or if for some other reason it is not feasible to survey the entire occurrence, then an alternative will be developed to estimate the extent and condition of the adjacent portion of the occurrence.
3. If only a small portion of the occurrence is on adjacent properties, then only the portion of the occurrence on the project site will be monitored and assessed for viability. The determination whether this is a full impact will be made based on the results for only the accessible portion of the occurrence.

Analysis of the monitoring results for annual species will take into account annual population variation that may have affected the baseline data. For example, if the baseline year was exceptionally wet, an annual population may have been very high. Subsequent reductions in population could be partially caused by drier conditions as well as impacts from the covered activity. If extreme or unusual climate conditions affect the species, then monitoring will be extended 1 or 2 years, as appropriate to assess impacts and success.

For annual species, the minimum post-construction monitoring period will be 5 years. Monitoring will include estimates of percent cover and number of individuals. An occurrence will be assumed to retain long-term viability and will not require replacement in the reserve system if the decline in occurrence size and percent cover from pre-project conditions is less than 25% over the monitoring period, unless site-specific conditions otherwise suggest substantial declines in viability.

For perennial species, the minimum post-construction monitoring period will be 3 years. Monitoring will include estimates of percent cover, recruitment of seedlings if impacts included removing individuals, and measurements of adult plant health (e.g., signs of disease, herbivory, nutrient deficiencies, etc.). An occurrence of a perennial covered species will be assumed to retain long-term viability and will not require replacement in the reserve system if the decline in seedling recruitment and percent cover from pre-project conditions is less than 25% over the monitoring period, unless site-specific conditions otherwise suggest substantial declines in viability.

Tables 5-1c and 5-1d correlate monitoring actions with biological goals and objectives for wildlife and plant species, respectively. Species-specific monitoring actions are discussed in detail below.

Bay Checkerspot Butterfly (Group 1)

Document and Monitor Species Status

Surveys for Bay checkerspot butterfly populations will be conducted on reserve lands with modeled serpentine grassland habitat. Two types of surveys will be conducted within the Reserve System: (1) surveys of larval and adult host plants and reconnaissance level surveys for adult butterflies in suitable but unoccupied habitat, and (2) surveys of post-diapause larvae in occupied habitat. Surveys will be conducted at the frequencies discussed above (i.e., annually) during either the appropriate flowering period for larval host plants, during the late larval period (February–March), or during the peak of the flight period for adults. Surveys will be consistently conducted at the same time of year to facilitate data analysis. Additional information on survey protocols and methodologies is described in the species account for Bay checkerspot butterfly in **Appendix D**).

During implementation, previously identified (through expert opinion and habitat model, **Appendix D**) Bay checkerspot butterfly habitat within the Reserve System will be surveyed for the presence of larval host plants. This information will be used to verify the Habitat Plan's Bay checkerspot butterfly population map in the Reserve System. This will be followed by annual reconnaissance level surveys for adult butterflies during the peak of the flight period. This will generally be pedestrian surveys through modeled habitat and butterflies will be identified with the aid of binoculars (Santa Clara Valley Water District 2005; Santa Clara Valley Transportation Authority 2006; WRA Environmental Consultants 2006). These surveys will serve to detect shifts in distribution and new colonization of habitat within the Reserve System. Following colonization, a more rigorous sampling approach will be used as described below. Surveys for new populations will be focused in areas of potential habitat near the largest patches of occupied habitat (Launer and Murphy 1994).

In areas where known Bay checkerspot butterfly populations persist, surveys for post-diapause larvae will occur to gain an estimate of relative abundance of individuals. Protocols for these surveys will use the best techniques available at the time, but in general will include annual sampling at permanent plots stratified to include microclimates present as the result of changes in topography and management regime (Santa Clara Valley Transportation Authority 2006; WRA Environmental Consultants 2006). Additional techniques such as timed larval counts will also be used. This can generate numbers of larvae observed per unit time (typically 10 minutes) and gives some indication of abundance in a given area (S. Weiss pers. comm.). Initially this protocol will establish an estimate of the baseline for each population identified in **Appendix D**. Baseline numbers of individuals may be known because most of these sites are already surveyed annually. In these areas all available existing information will be used and every attempt will be made to reduce the overlap in the survey efforts for efficiency.

Monitoring protocols will be developed to assist the Implementing Entity in demonstrating compliance with species occupancy requirements described in

Chapter 5, Section 5.3.1, subheading *Acquisition of Modeled Habitat for Covered Species*.

Evaluate Covered Species Response to Habitat Enhancement and Restoration

It has been shown that without some form of grassland management (e.g., grazing, mowing, seeding, and burning), serpentine grassland quickly becomes overrun with nonnative plants, and habitat quality decreases for Bay checkerspot butterfly (Weiss 1999) to the point where the species may be extirpated from a site. Accordingly, monitoring activity is ongoing to determine Bay checkerspot butterfly population response to grassland management (Weiss 1999; Fleishman et al. 2000; Hellman 2002; Santa Clara Valley Transportation Authority 2006; WRA Environmental Consultants 2006). As management techniques are implemented within the Reserve System on unoccupied sites, the number and distribution of larval host plants will be documented to determine how habitat quality has changed under different management regimes. In areas where Bay checkerspot butterfly populations already occur, population numbers will be monitored to determine how they are responding to management techniques.

Evaluate Use of Translocation to Establish New Populations

One important biological goal of this Plan is to increase the number of Bay checkerspot butterfly populations in the study area. To this end, serpentine habitat will be acquired and managed appropriately to support the species. During years when populations are at peak numbers, some individuals may disperse to these new reserves; it is hoped that, over time, there would be reproducing populations on those sites in most years. However, if acquisition and management occur but dispersal does not, then translocation of butterflies could be used to establish populations in new reserves (Harrison 1989). A translocation program would be conducted in a controlled and repeatable fashion that allows for quantification of the number of individuals gained or lost during the experimental process. Translocation efforts will be closely coordinated with CDFG, USFWS, and other species experts. Thresholds for loss of individuals would be established beforehand. Translocation would need to be approved by the Wildlife Agencies.

These experimental translocation efforts would be monitored using the methods discussed above.

Monitor Additional Threats

Although serpentine grasslands are typically more resistant than many other vegetation types to invasion by nonnative species, if the habitat is left unmanaged nonnative plants will eventually dominate serpentine grasslands. Monitoring

how grassland species richness changes under various management techniques is essential to understanding which techniques are most effective at retaining habitat for Bay checkerspot butterfly.

A number of pollutants, especially nitrogen-based pollutants, threaten Bay checkerspot butterfly. Deposition of excess nitrogen on serpentine grasslands can alter plant composition. Deposition of nitrogen acts to fertilize the nutrient-poor serpentine soil, exacerbating the problems caused by nonnative species (Weiss 1999). Continued monitoring of nitrogen deposition on serpentine soils and the benefits of managed grazing and controlled burns in areas such as Silver Creek Hills, Tulare Hill, and Santa Teresa County Park (**Appendix E** *Draft Estimation of Contributions to Deposition of Nitrogen in Santa Clara County for the Santa Clara Valley Habitat Plan*) as well as more precisely quantifying how an increase in passenger and commercial vehicle trips and other new industrial and nonindustrial sources will degrade these habitat types will continue to be a focus under this Plan. The monitoring report prepared each year will document at least one dry season and one wet season nitrogen deposition rate from monitoring conducted by the Habitat Plan or other sources.

California Red-legged Frog (Group 1)

Document and Monitor Species Status

Early in the breeding season (November–February, depending on local population behavior), when adult California red-legged frogs typically move into breeding habitat, surveys will be conducted to determine presence/absence of potential breeding adults. Surveys during the breeding season will be conducted based on the most recent protocols adopted by USFWS and CDFG (e.g., U.S. Fish and Wildlife Service 2005)[8],coordination with the monitoring efforts of other local agencies (e.g., Santa Clara Valley Water District 2005), and best available science.

Once it is established that potential breeding adults 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 an estimate of breeding success.

Surveys of all potential breeding habitat 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. This baseline information will document the factors listed below.

- Ponds, wetlands, or stream reaches occupied by adult red-legged frogs.
- Adult, larva, and egg mass numbers.

[8] Survey protocols developed by the Wildlife Agencies often have the goal of reliably detecting presence of a species within one or two seasons, which is the time available for most project planning cycles. The goal of surveys on reserve lands will be to definitively determine presence or absence. Wildlife Agency survey protocols may or may not address this monitoring goal.

- Unoccupied breeding habitat that may have the potential to support breeding populations. This item will include an evaluation of the possible factors hindering successful breeding at that location.
- Assessment of upland habitat for potential refugia around occupied and potential breeding habitat.
- Presence of bullfrogs and nonnative, predatory fish species in occupied or potential habitat.
- Presence of other factors (threats) seemingly affecting breeding success at a given location where breeding is occurring.
- Estimate of the distance between known or potential breeding sites to help guide creation or enhancement of more robust populations.

This information will be documented in GIS layers and used to prioritize areas for enhancement and restoration. The management actions for target upland areas surrounding breeding habitat will also be described. This will aide in prioritizing potential unoccupied breeding habitat to be enhanced or restored to support breeding adults in the future.

In years following baseline data collection, visual monitoring for California red-legged frog population status will take place annually, during the breeding season, as defined by USFWS protocols. Egg mass counts and adult counts obtained during visual surveys will be used to determine the local population of California red-legged frogs and will contribute to an overall population status and trends assessment across the Reserve System.

If sufficient information is not obtained via visual monitoring—dip-netting, seining, hand catching, or other methods developed during implementation will be used to capture adults, juveniles, metamorphs, and larvae in habitat where adults have been documented during protocol-level surveys. Those more intensive methods will only be employed every 5 years to minimize impacts on local populations.

Monitoring protocols will be developed to assist the Implementing Entity in demonstrating compliance with species occupancy requirements described in Chapter 5, Section 5.3.1, subheading *Acquisition of Modeled Habitat for Covered Species*.

Evaluate Covered Species Response to Flow Regulation

Flows could also change as a result of dewatering events described in Chapter 2, *Land Use and Covered Activities*. If California red-legged frog populations are found in streams hydrologically affected by existing dams in the permit area, the Implementing Entity will monitor the effects of flow regulation on the species.

Evaluate Covered Species Response to Habitat Enhancement, Restoration, or Creation

Potential breeding habitat that is targeted for enhancement, restoration, or creation of habitat will be monitored after treatment to determine the response of breeding California red-legged frogs to habitat-management actions. The relative success of different management actions for maintaining or increasing red-legged frog populations will be assessed to guide future management efforts.

The effectiveness of enhancement and restoration management actions in occupied breeding habitat will be monitored by observing changes in the number of egg masses detected during breeding-season surveys (as defined by USFWS protocols) over time. In addition, the numbers of adults, juveniles, meta-morphs, and larvae that are observed during those surveys will be used to help determine how population levels are responding. The available breeding habitat will be quantified in acres, and population numbers will be recorded as the number of detections per acre in ponds and wetlands. In streams, breeding surveys will cover the amount of riverine habitat that a surveyor can comfortably survey during an 8-hour period. Stream surveys are based on linear miles. In order to calculate acreage the width of the wetted stream channel will be taken for every 500 feet of linear survey and an areal estimate will be calculated. This area will be quantified in acres, and the number of detections per acres will similarly be recorded. 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.

In order to initially determine the peak egg-laying month for different parts of the Reserve System additional egg mass surveys will be conducted once a week, for select sites, during the peak egg-laying period (Bobzien and DiDonato 2007). Depending on rainfall and other seasonal factors, surveys could begin up to two weeks prior to or two weeks following the peak egg-laying month. March has been noted as the peak egg-laying period for California red-legged frogs in nearby Alameda and Contra Costa Counties (Bobzien and DiDonato 2007). The peak egg-laying period for the Reserve System will be determined by surveying the potential and known breeding sites once a week starting in the beginning of January until no more new egg masses are observed, in order to determine the peak egg-laying period for individual water bodies within the Reserve System. If egg masses are detected in the first round of surveys, the following year's surveys will begin earlier (1–2 weeks) so as to establish when the onset of breeding typically occurs. Once the peak egg-laying period is determined for different parts of the Reserve System, these weekly egg-mass surveys would cease and singular egg-mass surveys would be completed at the same time as visual surveys. The overall reproductive output (i.e., number of egg masses) will be recorded during the survey period and each will be recorded with a handheld GPS unit. Newly created ponds will be monitored in the same manner.

In some instances more specific monitoring will be conducted. For example, radiotelemetry studies have been designed to determine how a local population (breeding pond) of red-legged frogs uses the upland areas around that pond during the breeding and non-breeding season (Rathbun and Murphy 1996; Bulger et al. 2003). Radiotelemetry studies may be done in the study area if the results will significantly benefit the Monitoring and Adaptive Management Program for the California red-legged frog. Radiotelemetry could be used to determine how breeding populations from several ponds or streams interact and if breeding red-legged frogs move between ponds during or between breeding seasons. Finally, there is some speculation that creating new pond habitat is a good method for increasing the red-legged frog population in a given area but that there may be little or no interaction between pond-breeding frogs and stream-breeding frogs (S. Bobzien pers. comm.). Monitoring adults using radiotelemetry would help determine whether red-legged frogs are using stream, pond, and wetland habitat within the Reserve System, or if they are more selective in their habitat use. Once conceptual models for red-legged frog have been developed, implementation of these studies will be prioritized on the basis of data gaps identified and the information needed to more effectively manage frogs in the study area.

Additional habitat enhancements, such as changes in flow regimes, could be implemented in streams that support California red-legged frog habitat. Monitoring how these changes affect habitat quality and different life stages of development will be important.

Evaluate Use of Adjacent Uplands and Nonbreeding Aquatic Habitats

Monitoring habitat condition will occur in upland areas and nonbreeding stream habitats adjacent to occupied breeding habitat. Monitoring of upland habitat will also occur adjacent to unoccupied breeding habitat that is being actively managed for California red-legged frogs. Although unoccupied breeding habitat may not be the result of deficiencies in upland habitat, problems in upland habitat may contribute to lack of breeding, and monitoring will help identify threats. Due to the importance of both breeding and upland habitat to the success of this species, this information will be used to determine what the limiting biological factors are for unoccupied breeding habitat.

In general, changes in breeding populations over time will be correlated with land management in surrounding upland areas. Monitoring for changes in breeding success will help determine how those management techniques are affecting the population. For example, if prescribed burning, or mowing to mimic burning, is instituted in uplands surrounding California red-legged frog breeding habitat, and the population increases in that breeding pool over time, then some of that success might be attributable to the upland management techniques. In addition, monitoring the response of ground squirrel colony size and burrow density to upland management techniques will be used as a proxy to determine the quality and quantity of upland habitat available for California red-legged frogs. The response of riverine populations of red-legged frogs will be

monitored with respect to changes in riparian vegetation and corridor widths as the result of enhancement or restoration activities that occur under this Plan.

Evaluate Response of Predator Control Programs

During baseline surveys to document the status of covered species populations, breeding habitat occupied by nonnative species will be identified. These data will inform management actions within the Reserve System. Subsequent surveys for bullfrogs and predatory fish will be conducted to determine the effectiveness of eradication efforts. Threat-eradication efforts for California red-legged frog will focus on reducing or eliminating bullfrogs and predatory fish as the primary threats to tadpole persistence (Lawler et al. 1999). Post-treatment surveys will also allow for an assessment of the response of native amphibian populations to invasive species eradication.

Monitor Additional Threats

Monitoring will 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.

Western Burrowing Owl (Group 1)

Document and Monitor Species Status

The Implementing Entity will carry out two separate survey efforts in support of the burrowing owl conservation strategy—nest surveys and population surveys.

Nest Surveys

Each year, the Implementing Entity will coordinate with survey efforts conducted at known nesting sites in the permit area including surveys conducted at San José International Airport, Moffett Federal Airfield, Shoreline at Mountain View, VTA Cerone bus maintenance yard, and San Jose/Santa Clara Water Pollution Control Plant buffer lands. Additional locations will be surveyed in subsequent years as new colonies are formed or discovered over the permit term. The Implementing Entity will coordinate with survey staff at the first three locations to obtain data from ongoing annual survey efforts and will provide guidance on the survey information required to inform regional data collection. The Implementing Entity will be responsible for conducting surveys at the last two locations (and any new colonies that may be discovered during the permit term) and will use the same methodology across sites to ensure consistency. All surveys will be conducted consistent with California Burrowing Owl Consortium

methodology (California Burrowing Owl Consortium 1993). Data collected from the annual survey sites will be used to track the number of adult burrowing owls and to assess reproductive status. Information will contribute to a rolling population viability analysis in the region. Collectively, the data will inform the adaptive management of this species and will help prioritize use of funds for burrowing owl conservation under the Plan. The first annual survey will occur during the first full year of Plan implementation and each year thereafter.

Population Survey

The Implementing Entity will also coordinate with other South Bay local governments, special districts, and non-profit organizations every 3 years to assess status of the burrowing owl population in the study area and the expanded study area for burrowing owl conservation. These survey efforts are aimed at identifying occupied and potential burrowing owl habitat in the four burrowing owl conservation regions. The focus of this larger survey effort is to document population expansion into new areas. This 3-year survey will help determine whether the range of nesting burrowing owls in the study area and expanded study area for burrowing owl conservation is stable and, possibly, expanding. Analysis of the survey results will encompass the areas surveyed annually, areas with historical or recent occurrences of nesting burrowing owls, and areas with highly suitable habitat that has not been occupied in the past. The initial population survey, which will occur during the first full year of implementation, will build on information collected on burrowing owl nest locations during the Habitat Plan planning process (Barclay 2008).

Evaluate Species Response to Habitat Protection and Enhancement

Monitoring the response of the western burrowing owl population to prescribed management will be difficult because population numbers are very low and the site fidelity of nesting owls is largely unknown in the study area and expanded study area. To gain a comprehensive understanding of how the population and individual nesting pairs respond to management actions, multiple approaches will be used. By establishing periodic surveys of available nesting and potential nesting habitat, a more precise estimate of the number of nesting pairs in lands protected and/or managed for burrowing owls will be made. The number of nesting pairs in the study area and expanded study area can then be tracked over time to determine whether the numbers change as more habitat is managed for burrowing owls. Where burrowing owls occur on lands managed under the Plan, the response of individual nesting pairs will be tracked to determine how management activities affect productivity. For example, if there is an area where burrowing owls are known to nest and grazing is introduced to stimulate grassland diversity, the productivity of those nesting owls will be tracked to determine if grazing has an effect on the owls' propensity to return to the site each year and the number of young produced over time.

In many cases the density and distribution of California ground squirrels and grassland height will be used as a proxy for assessing the quality and quantity of burrowing owl habitat within the burrowing owl management areas. Baseline

surveys to establish habitat condition, including the distribution and burrow density of California ground squirrels in management areas, will be conducted. The results of these surveys will be used to update the burrowing owl habitat model. An increase in the distribution of California ground squirrels in modeled habitat in response to management actions will be considered an increase in habitat availability for western burrowing owl. Overall success of efforts to promote burrowing owl will be measured by a positive growth rate in the PVA for this species (based on annual increases in the number of adults owls), and by the number of acres managed for burrowing owls.

In areas where California ground squirrels are not present and are unlikely to be reestablished, artificial burrow complexes may be installed to create nesting habitat. These installations will be monitored in accordance with accepted CDFG protocol to determine if they are supporting nesting owls.

Additional monitoring will be required if a program to increase reproductive success of burrowing owls in the South Bay are implemented (Tier 3 conservation actions, **Appendix M**). General success criteria will be defined in close coordination with the Wildlife Agencies. Criteria will be set during the Tier 2 surveys, and based on the success or failure of the program, interim checkpoints will be established to determined if/when the program should cease. Monitoring will include the evaluation of a pilot reintroduction program and a pilot study to determine other methods to increase reproduction of local burrowing owls. Success and the feasibility of replicating the reintroduction program at additional locations, as well as the effectiveness of methods to increase reproduction, will be evaluated.

Monitor Additional Threats

Rapid changes in grassland habitat, such as natural or prescribed burns, could have a temporary effect on burrow availability and prey availability for western burrowing owls. To determine how burrow availability is affected, California ground squirrel colonies will be monitored before and after natural or prescribed fires within managed areas. By monitoring the recovery period for grassland habitat, including variables such as size of the reestablished ground squirrel colony, overall habitat quality and quantity can be assessed.

California Tiger Salamander (Group 1)

Document and Monitor Species Status

During the breeding season, which begins soon after the first cool rains of late-fall and early winter, adult California tiger salamanders migrate to breeding pools. Before hatching and after larvae hatch out and are developing, the probability of detecting presence is highest. Surveys will be conducted during the breeding season using the most recent methodologies that are accepted by USFWS and CDFG. Monitoring actions that take place under the Plan will be

coordinated with those of other local agencies to ensure that unnecessary redundancies are eliminated and that data can inform both processes (e.g., Santa Clara Valley Water District 2005).

During the non-breeding season, when individuals are underground in upland refugia, this species is more difficult to detect and methods to do so are often cost prohibitive. To determine quality and quantity of upland habitat for this species, surveys for California ground squirrel colonies and pocket gopher activity will serve as a surrogate. This is discussed further below. In general, it will be assumed that if upland habitat is suitable and within the range of known dispersal distances from an observed breeding location, then the upland habitat is assumed to be occupied as well. Densities of adult salamanders using upland habitat in a given area will be extrapolated from densities of adult and larval salamanders detected in breeding habitat through seining or other methods.

Surveys of potential breeding habitat in lands acquired for the Reserve System will be conducted according to the survey schedule outlined above. Once it is established that potential breeding adults are present, a more in-depth survey during the breeding season, based on approved methodologies, will be conducted to determine an estimate of the size of the breeding population and an estimate of breeding success. Potential breeding habitat is defined as seasonal and some perennial wetlands, including stock ponds. Some riparian areas within stream corridors could also support breeding tiger salamanders if there are adjacent wetlands or large, slow water areas (e.g., side channels or scour pools) and no predatory fish species. This information will be used to document baseline levels for population monitoring during the permit term and beyond in areas where repeatable testing is appropriate. Baseline information will comprise the following.

- Ponds/wetlands occupied by tiger salamander larvae and/or breeding adults.
- Adult, larva, and egg mass numbers.
- Unoccupied breeding habitat that may have the potential to support breeding populations. This item will include an evaluation of the possible factors hindering successful breeding at that location.
- Assessment of upland habitat around occupied and potential breeding habitat.
- Presence of bullfrogs and predatory fish species in occupied or potential habitat.
- Signs suggesting presence of non-native salamander alleles (hybrid adults, paedamorphs).
- Presence of other factors (threats) that appear to affect breeding success at a given location where breeding is occurring.
- Estimate of the distance between known or potential breeding sites to help guide creation or enhancement of more robust populations.

This information will be documented in GIS layers and will be used to prioritize areas for enhancement/restoration. The management actions for target upland areas surrounding breeding habitat will also be described.

In years following baseline data collection, monitoring California tiger salamander population will take place during each breeding season at the survey frequencies described above in the introduction to Section 7.3.3 *Species-Level Actions*. Larval salamander numbers in select breeding pools will be used to determine the local population of salamanders, within the known dispersal distance from the breeding pool and will contribute to an overall population status and trends assessment across the Reserve System. The breeding pools that will be monitored within each Reserve Management Area will be outlined in its associated reserve unit management plan along with monitoring guidelines and population targets.

Additionally, upland habitat condition and use will be monitored during the breeding season within 0.5 mile of a representative sample of known breeding pools (Trenham and Shaffer 2005). Evaluation of upland habitat condition will be based on best available scientific information at the time. Changes in salamander numbers in breeding pools will be correlated with surrounding land uses. For example, if grazing is implemented as a management activity in an area where grazing previously did not occur, the impact that this has on habitat quality for tiger salamanders will be discerned by determining how it affects the breeding activity at known breeding ponds in the area.

Monitoring protocols will be developed to assist the Implementing Entity in demonstrating compliance with species occupancy requirements described in Chapter 5, Section 5.3.1, subheading *Acquisition of Modeled Habitat for Covered Species*.

Evaluate Covered Species Response to Habitat Enhancement, Restoration, or Creation

Ponds or wetlands that are targeted for restoration, enhancement, or creation will be monitored to determine the response of breeding tiger salamanders to habitat management. Management activities will be correlated with population numbers, and the relative success of different techniques on maintaining or increasing tiger salamander populations will be assessed to guide future management efforts. Newly created ponds and enhanced or restored wetlands and ponds will be monitored for target species response, including presence/absence surveys for tiger salamander larvae and breeding adults.

In addition, upland areas near created, enhanced, or restored breeding habitat will be surveyed for habitat suitability. While surveying for the presence of individuals can be cumbersome (e.g., scoping or excavating ground squirrel burrows) and time consuming, determining accessibility of upland habitat from breeding ponds and its suitability for non-breeding season use is a simpler undertaking. Surveyors will determine whether there are any barriers between breeding habitat and upland sites. Surveyors will also determine if there are sufficient underground refugia available for tiger salamanders during the non-breeding season. Changes in this upland habitat availability and suitability will be correlated with breeding population numbers. For example, if the size of a ground squirrel colony is reduced following a prescribed burn and the next year

the California tiger salamander breeding population is substantially reduced, then it might be inferred that prescribed burning had a negative effect on the tiger salamander population during this brief window.

Similarly, if the vegetative communities surrounding breeding habitat change due to restoration or enhancement (e.g., oak woodland planting, burning, grazing, tree thinning), the impacts on the breeding tiger salamander population will be tracked and its relationship with the management in these upland areas will be inferred. In select instances, directed studies might be developed to better understand how complex management issues influence tiger salamander populations over time.

Evaluate Use of Burrows

Monitoring habitat conditions will occur in upland areas adjacent to a representative sample of occupied breeding habitat. Monitoring of upland habitat will also occur adjacent to unoccupied breeding habitat that is being actively managed for California tiger salamander. Due to the importance of both breeding and upland habitat to the success of this species, this information will be used to determine what the limiting biological factors are for unoccupied breeding habitat. Monitoring the size and burrow density of ground squirrel colonies adjacent to breeding habitat will be essential. Monitoring the response of ground squirrel colony size and burrow density to upland management techniques will be used as a proxy to determine the quality and quantity of upland habitat available for California tiger salamanders.

To develop more detailed information on how California tiger salamanders use underground refugia in upland habitat, burrows and other refugia on the Reserve System can be surveyed using a burrow probe (also known as a “digiscope”). This tool provides the means to confirm or deny occupancy of burrows in upland areas, though this method is not very cost effective for a large Reserve System. Rather, this technique can be used periodically to test the assumptions about upland habitat quality characteristics. In general, it will be assumed that if breeding habitat is occupied then adjacent uplands within typical dispersal distance are being utilized as well.

Evaluate Response of Predator Control Programs

During baseline surveys to document the status of native species populations, a description of breeding habitat that is occupied by bullfrogs and predatory fish species will also be completed. These data will inform management actions within the Reserve System. Subsequent surveys for bullfrogs and predatory fish will be conducted to determine the effectiveness of eradication efforts. This will also allow for an assessment of the response of native amphibian populations to nonnative species eradication efforts.

Monitor Additional Threats

Monitoring will 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. Spread 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.

Nonnative salamanders are known to occur in the study area and are hybridizing with California tiger salamanders covered under this Plan. The degree of hybridization however, varies greatly within the Plan Area. As described in Chapter 5 and **Appendix K**, the management strategy for hybrid salamanders will be incorporated into the reserve unit management plans developed for portions of the Reserve where nonnative tiger salamanders and/or suspected hybrids are detected. Adaptive management involving close coordination with USFWS, CDFG, and other species experts will be critical in addressing this threat during Plan implementation. At a minimum, location, population size, and general condition of nonnative and suspected hybrid populations of salamanders will be documented. The response of native salamanders (e.g., outcompetition, hybridization) will also be monitored closely along with population response to any management actions that are implemented in accordance with the hybridization plan described in Chapter 5 and **Appendix K**.

Tiburon Indian Paintbrush (Group 1)

Document and Monitor Species Status

The Kirby Canyon Butterfly Trust closely monitors both known populations of Tiburon Indian paintbrush in the study area. These data will be used as baseline population data for this species. Plant surveys on acquired parcels will be conducted to document new populations.

Tiburon Indian paintbrush status will be monitored over time in relation to baseline population sizes; baseline data will serve as the standard against which future changes are measured. Monitoring will evaluate changes over time and the response of plant populations to management activities. Monitoring will include data on population size, numbers and location; age classes; seedling survival and health and vigor of populations. Location data will be collected by GPS and documented in GIS layers. In addition to annual monitoring, monitoring will always be conducted following events that may have strong effects on population size and condition (e.g., fire, severe weather, human impact). Monitoring methods will be based on up-to-date, repeatable methods of tracking population status over time.

Evaluate Covered Species Response to Habitat Enhancement

Monitoring the response of Tiburon Indian paintbrush to various grazing regimes is already occurring in the study area. This monitoring will continue under the Plan, especially if new management techniques are introduced as a result of Plan implementation. Monitoring surveys will follow appropriate protocols and occur during the flowering period for this species, which is typically April–July. In addition to acquiring data on the target population, studies may be carried out to document changes in grassland communities in and around known populations of Tiburon Indian paintbrush. Changes in plant status will be correlated to changes in the management regime to help determine whether management actions have successfully created opportunities for the population to grow.

Targeted Studies

A goal of targeted studies initiated under the Plan will be to identify any factors that are limiting population expansion of Tiburon Indian paintbrush. For example, land use patterns around known populations could be reducing habitat quality and restricting population expansion. If these land use patterns are correlated with population isolation, or if any other factors are shown to be limiting population growth, then management actions will be prescribed and implemented to change those land use patterns or factors to promote natural population expansion. Monitoring the response of plant populations to those actions will inform future management of these two very important sites.

An additional management action that is prescribed for Tiburon Indian paintbrush is experimental grazing exclusion. When such projects are implemented, appropriate monitoring protocols will be developed to study the population response.

Monitor Additional Threats

The Kirby Canyon Butterfly Trust is currently assessing the effectiveness of excluding feral pigs from areas where known Tiburon Indian paintbrush populations exist. Feral pig rooting is considered a threat to plant populations, although it is also possible that such disturbance could be beneficial if properly managed. It is uncertain if replicated experiments will be possible to determine the most effective balance of disturbance from feral pigs because Tiburon Indian paintbrush population numbers are low. However, monitoring will measure population response to pig-removal efforts, and decisions about long-term exclusion of pigs from these sites will be based on those results.

Rapid changes in grassland habitat, such as fire, could have an effect on grassland species. Tiburon Indian paintbrush populations will be monitored before and after fires, should they occur. By monitoring the post-fire recovery of grassland habitat, which might include variables such as percentage of

reestablished native versus nonnative grassland, an assessment can be made about overall quality of habitat and whether permanent changes in grassland habitat will affect the persistence of Tiburon Indian paintbrush populations.

Coyote Ceanothus (Group 1)

Document and Monitor Species Status

The location and geographic extent of the three known occurrences of coyote ceanothus are well documented within the study area from field observations and air photos (it is the only covered species visible on air photos due to its distinctive color signature). However, data on occurrence size and demography are limited because portions of all three occurrences occur on private land. These three occurrences will be added to the Reserve System and baseline occurrence assessments will be made at that time. The response of each occurrence to management under this Plan will be measured against those baseline occurrence levels. Survey protocols for the species will need to be developed. Occurrence size surveys may include complete counts for small occurrences or statistical sampling and analysis for larger occurrences. All surveys that are conducted will be coordinated with any ongoing survey efforts (e.g., Santa Clara Valley Water District 2005).

Coyote ceanothus status will be monitored over time in relation to baseline occurrence sizes; baseline data will serve as the standard against which future changes are measured. Monitoring will evaluate changes over time and the response of plant occurrences to management activities. Monitoring will include data on occurrence size, numbers and location; age classes; seedling survival and health and vigor of occurrences. Location data will be collected by GPS and documented in GIS layers. Monitoring surveys will occur at frequency intervals described above in the introduction to Section 7.3.3 *Species-Level Actions*. In addition to annual monitoring, monitoring will always be conducted following events that may have strong effects on occurrence size and condition (e.g., fire, severe weather, human impact). Monitoring methods will be based on up-to-date, repeatable methods of tracking occurrence status over time.

Evaluate Covered Species Response to Habitat Enhancement

There may be little grazing pressure on any of the three occurrences due to exclusion fencing, although native herbivores such as deer may browse seedlings. However, if different grazing regimes or other management techniques are employed in these areas, the effects of those techniques on each occurrence will be determined by conducting appropriate monitoring surveys. These surveys will include quantifying how these management regimes change natural communities that surround known occurrences. Recruitment of seedlings will be tracked to determine which management techniques are most effective at increasing occurrence levels.

Targeted Studies

A goal of monitoring under the Plan is to identify factors that limit coyote ceanothus expansion. Management actions will then be prescribed to remove or reduce those limitations; this process will be adaptively managed through follow-up occurrence surveys.

New occurrences of Coyote ceanothus will be created using field experiments to investigate suitable propagation or planting techniques and determine appropriate seed-sampling techniques from existing occurrences. These targeted studies will be experimental, and the impact that they have on known occurrences will be monitored (i.e., the effects of using existing occurrences as a seed stock for new occurrences).

All created occurrences will be monitored with appropriate protocols to measure establishment success and determine whether this technique is a viable management option. The outcomes of these targeted studies will be used in adaptive management decisions and to inform conservation actions for this species.

Additional targeted studies will be conducted to examine the effects of prescribed burns on coyote ceanothus occurrences. In the past, observers have noted increased recruitment following fires. The goal of experimental burning under this Plan is to determine the importance of fire on plant regeneration and to identify the most effective fire regime for increasing the size of occurrences. Monitoring occurrence response to experimental burning will inform future management action for this species.

Monitor Additional Threats

If any natural fires occur in areas of coyote ceanothus occurrences, then the occurrences will be monitored to study how the occurrence and species respond. Specific protocols will be developed in the context of the fire and how it has affected the plant occurrence.

Santa Clara Valley Dudleya (Group 1)

Document and Monitor Species Status

Although many occurrences of Santa Clara Valley dudleya are well documented in the study area, baseline occurrence surveys will be conducted on modeled habitat in the Reserve System to quantify or estimate the number of individuals in known occurrences and to determine if undiscovered occurrences occur on the property. Because this perennial species is readily identifiable at all times of year, surveys can be conducted at any time. Many of the known occurrences occur on private lands. If these areas are added to the Reserve System, baseline occurrence assessments will be made at that time so that the response of each

occurrence to management can be measured against those baseline occurrence levels. Baseline monitoring is currently being conducted for this species in permanent plots on Coyote Ridge on the UTC parcel (Arcadis 2008).

One key question that will be addressed early in monitoring implementation is the maximum spacing distance for individuals within the same occurrence. Santa Clara Valley dudleya individuals are patchily distributed, clustering on discrete rock outcrops. It is likely that plant interactions decrease with increasing distance from rock-outcrop patches. Occurrences are not likely to be discrete entities but rather a continuum of sub-occurrences. However, an operational "boundary" needs to be defined to delineate occurrences for monitoring and management purposes.

Monitoring will evaluate changes over time and the response of plant occurrences to management activities. Monitoring will include data on occurrence size, numbers and location; age classes; seedling survival and health and vigor of occurrences. Location data will be collected by GPS and documented in GIS layers. In addition to annual monitoring, monitoring will always be conducted following events that may have strong effects on occurrence size and condition (e.g., fire, severe weather, human impact). Monitoring methods will be based on up-to-date repeatable methods of tracking occurrence status over time.

Evaluate Covered Species Response to Habitat Enhancement

The effect of grazing regimes or other management techniques on each occurrence of Santa Clara Valley dudleya will be monitored by conducting surveys according to the same protocols established in baseline surveys. Monitoring studies may also include protocols to quantify how management techniques affect the serpentine grassland habitat that surrounds known occurrence or to assess if these techniques have an effect on Santa Clara Valley dudleya individuals or occurrence.

Targeted Studies

A goal of monitoring under the Plan is to identify factors that limit the expansion of Santa Clara Valley dudleya occurrences. Management actions will then be prescribed to remove or reduce those limitations; this process will be adaptively managed through follow-up occurrence surveys.

Monitor Additional Threats

Grazing by native species (e.g., Tule elk) and livestock is thought to be a threat to Santa Clara Valley dudleya, however the actual threat posed by grazing has not been documented. As serpentine grassland management is implemented, a

replicated experiment design will be used to determine to what extent and by what mechanism(s) livestock grazing affects known occurrences. These studies will also aim to determine the level of protection from grazers that this species needs to remain viable. Such studies will include a grazing exclusion component.

Rapid changes in grassland habitat, such as natural or prescribed burns, could have an effect on grassland species such as this. Santa Clara Valley dudleya occurrences will be monitored before and after fires occur. By monitoring the recovery period for grassland habitat, as well as other variables (e.g., percent native versus nonnative grassland that reestablishes), an assessment can be made about overall habitat quality and whether permanent changes in grassland habitat will affect the persistence of these occurrences.

Metcalf Canyon Jewelflower (Group 1)

Document and Monitor Species Status

Baseline occurrence surveys will be conducted on modeled habitats in the Reserve System to quantify or estimate the number of individuals in known occurrences and to determine if undiscovered occurrences occur on the property. Most of the known occurrences of Metcalf Canyon jewelflower occur on private lands. If these areas are added to the Reserve System, then baseline occurrence assessments will be made at the time of acquisition to assess occurrence levels. Thereafter, the response of each occurrence to management can be measured against those baseline levels. Baseline monitoring is currently being conducted for this species in permanent plots on Coyote Ridge on the UTC parcel (Arcadis 2008).

Monitoring of Metcalf Canyon jewelflower will occur during its flowering period, between April and July, and surveys will occur only when the plants are actually flowering in order to assure recognition. Monitoring will evaluate changes over time and the response of plant occurrences to management activities. Monitoring will include data on occurrence size, numbers and location; age classes; seedling survival and health and vigor of occurrences. Location data will be collected by GPS and documented in GIS layers. In addition to annual monitoring, monitoring will always be conducted following events that may have strong effects on occurrence size and condition (e.g., fire, severe weather, human impact). Monitoring methods will be based on up-to-date repeatable methods of tracking occurrence status over time.

Evaluate Covered Species Response to Habitat Enhancement

The effect of grazing regimes or other management techniques on each occurrence of Metcalf Canyon jewelflower will be monitored by conducting surveys according to the same protocols established in baseline surveys.

Monitoring studies may also include protocols to quantify how management techniques affect the serpentine rock outcrops on which the species grows and/or to assess if these techniques have an effect Metcalf Canyon jewelflower individuals or occurrences.

Targeted Studies

A goal of monitoring under the Plan is to develop studies that identify factors limiting the expansion of Metcalf Canyon jewelflower occurrences. Management actions will then be prescribed to remove or reduce those limitations; this process will be adaptively managed through follow-up surveys.

New occurrences of Metcalf Canyon jewelflower will be created using field experiments to investigate suitable propagation or planting techniques and determine appropriate seed-sampling techniques from existing occurrences. These targeted studies will be experimental, and the impact that they have on known occurrences will be monitored (i.e., the effects of using existing occurrences as a seed stock for new occurrences). The micro-habitat of this species is serpentine rock outcrops, particularly steeply cut rock faces such as those found in roadcuts, and this habitat may be experimentally created and seeded.

All created occurrences will be monitored with appropriate protocols to measure establishment success to determine whether this technique is a viable management option. The outcomes of these targeted studies will be used in adaptive management decisions and to inform conservation actions for this species.

Metcalf Canyon jewelflower is known to interbreed with its close relative, also a covered plant species—most beautiful jewelflower. There is concern that Metcalf Canyon jewelflower could eventually lose its distinct genetic integrity (Weiss and Wright 2005). Targeted studies will be undertaken to monitor this introgression and develop protocols to protect the genetic integrity of both species.

Monitor Additional Threats

Grazing by native species and livestock may to be a threat to Metcalf Canyon jewelflower. As serpentine grassland management is implemented, a replicated experimental design will be used to determine how livestock grazing affects known occurrences. These studies will also aim to determine the level of protection from grazers that this species needs to remain viable. Such studies will include a grazing-exclusion component.

Rapid changes in grassland habitat, such as natural or prescribed burns, could have an effect on Metcalf Canyon jewelflower since it generally grows in outcrops and roadcuts within a larger grassland matrix. Occurrences will be

monitored before and after prescribed burns, and after any natural fires. By monitoring the recovery period for grassland habitat, as well as other variables (e.g., percent native versus nonnative grassland that reestablishes), an assessment can be made about overall habitat quality and whether permanent changes in grassland habitat will affect the persistence of these occurrences.

Foothill Yellow-Legged Frog (Group 2)

Document and Monitor Species Status

Foothill yellow-legged frogs can be observed year-round in perennial streams. Observing adult foothill yellow-legged frogs is difficult, but possible. Surveys could be conducted throughout the breeding period (April–July), though the probability of detection is generally higher June–July.

During the breeding season, adults, juveniles, and tadpoles could be present in suitable streams, offering the greatest opportunity for detection. Surveys for adults will only be used to determine population levels if multiple surveys are conducted at a given site, all life stages have been counted, and survey coverage is near 100%. Otherwise, these visual detection surveys will only serve to determine presence/absence of the species along a given stream reach.

In most cases, the reproductive output of the population will be measured by counting egg masses in potential breeding habitat. The number of egg masses will be used to determine the relative number of breeding females in a given reach, as well as estimates of overall population health. Observing foothill yellow-legged frog adults or juveniles is difficult and could prove an inadequate method to determining relative population levels along a stream reach. However, all incidental sitings of adults, juveniles, or larvae will be recorded during each egg mass survey. Surveys for foothill yellow-legged frog egg masses will be conducted in known or assumed habitat both within the Reserve System and along stream courses that are outside of the Reserve System but where access has been granted to one of the Implementing Partners. Surveys will be conducted using the best available protocol for this species (e.g., Seltenrich and Pool 2002).

Foothill yellow-legged frogs typically lay most of their eggs during April (Bobzien and DiDonato 2007). This generally coincides with the end of the last high-water period in stream corridors. However, if large storm events occur during April, foothill yellow-legged frogs can delay egg laying to reduce mortality of egg masses from unseasonable high water (S. Bobzien pers. comm.). If there are unusually late storm events, surveys during that year will be shifted to maximize detection of egg masses.

Surveys of potential foothill yellow-legged frog habitat on land acquired for the Reserve System will be conducted according to the survey schedule outlined above. This information will be used to document baseline levels for population monitoring during the permit term and beyond. The baseline surveys will document the characteristics listed below.

- Stream reaches occupied by foothill yellow-legged frog adults.
- Unoccupied breeding habitat with the potential to support breeding populations (typically upstream or downstream of occupied habitat).
- Assessment of riparian vegetation and stream substrate along occupied and unoccupied stream reaches.
- Presence of nonnative bullfrogs, crayfish, or nonnative, predatory fish species in occupied or unoccupied habitat.
- Presence of other factors (threats) seemingly affecting breeding success at a given location.

This information will be documented in GIS layers and used to prioritize areas for protection and enhancement/restoration. This process 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 foothill yellow-legged frog breeding sites.

Monitoring protocols will be developed to assist the Implementing Entity in demonstrating compliance with species occupancy requirements described in Chapter 5, Section 5.3.1, subheading *Acquisition of Modeled Habitat for Covered Species*.

Evaluate Covered Species Response to Flow Regulation

Changes in flow downstream of dams could affect remnant populations of foothill yellow-legged frogs in the permit area. Flows could also change as a result of dewatering events described in Chapter 2 *Land Use and Covered Activities*. If yellow-legged frog populations are found in streams hydrologically affected by existing dams in the permit area, the Implementing Entity will monitor the effects of flow regulation on the species.

Evaluate Species Response to Enhancement and Restoration of Stream Habitat

Stream reaches that are targeted for restoration or enhancement will be monitored to determine the response of breeding foothill yellow-legged frogs. The relative success of different techniques for maintaining or increasing foothill yellow-legged frog populations will be assessed to guide future management efforts. Enhancement or restoration of occupied breeding habitat will be monitored by determining changes in the number of egg masses detected during surveys to establish estimates of reproductive output. Surveys will be conducted at the frequencies discussed above.

Ideally, egg mass surveys will be conducted once a week during the peak egg-laying period (Bobzien and DiDonato 2007). Peak egg-laying periods within the

study area will be determined by surveying early in the known breeding period and ending the surveys at the end of the known breeding period or after no new egg masses have been observed, whichever comes last. Survey periods must be flexible to adjust for climate-induced impacts to egg-laying period (e.g., warm, low moisture winter may delay the egg mass laying in April and move it into May.) April has been noted as the peak egg-laying period for foothill yellow-legged frogs in nearby Alameda and Contra Costa Counties (Bobzien and DiDonato 2007). The overall reproductive output (i.e., number of egg masses) will be recorded during the survey period, and each egg mass will be recorded with a handheld GPS unit. This will allow for follow-up surveys of breeding sites in subsequent years.

Additional habitat enhancements, such as changes in flow regimes, could be implemented in streams that support foothill yellow-legged frog habitat. Monitoring how these changes affect habitat quality and different life stages of development will be important.

Evaluate Management of Riparian Corridors

When enhancement or restoration activities are conducted in riparian areas, foothill yellow-legged frog populations will be monitored to determine how changes in riparian vegetation affect the local breeding population. That information will be used to inform future management actions along stream reaches that are occupied by foothill yellow-legged frogs. For example, if trees are removed to open up the canopy of a riparian corridor to promote growth in the understory for early successional songbird species, the response of the yellow-legged frog population along that reach would be of interest. Similarly, riparian restoration that promotes overstory vegetation and subsequently cools target reaches will be monitored for foothill yellow-legged frog response.

In some streams, alternate, off-stream water sources will be provided for livestock to discourage them from entering the stream. Where necessary, fencing will be installed to exclude livestock from particularly sensitive reaches. The foothill yellow-legged frog population and reproductive output will be monitored and compared to baseline conditions to determine if this method affects species response.

Evaluate Response to Nonnative Plant and Animal Control

During baseline surveys, a description of breeding habitat that is occupied by bullfrogs, crayfish, and predatory fish species will also be completed. These data will inform management actions within the Reserve System. Subsequent surveys for bullfrogs and predatory fish will be conducted to determine the effectiveness of eradication efforts. This will also allow for an assessment of the response of native amphibian populations to nonnative species eradication.

In addition, the removal of nonnative vegetation in riparian areas and reseeding with native vegetation may temporarily or permanently change the habitat adjacent to that used by foothill yellow-legged frogs. Population size will be estimated and reproductive output (i.e., number of egg masses) will be monitored along reaches that are restored or enhanced to determine if there are short-term (less than 5 years) or long-term (more than 5 years) effects. The results of this monitoring will inform vegetation management along corridors adjacent to foothill yellow-legged frog habitat.

Monitor Additional Threats

Monitoring will be conducted for diseases and the efficacy of disease control including chytrid fungus and any other harmful diseases that are discovered in the Reserve System during Plan implementation. Spread 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 surveys work to minimize the potential for cross-contamination.

Western Pond Turtle (Group 2)

Document and Monitor Species Status

Surveys of potential western pond turtle habitat in land acquired for the Reserve System will be conducted to select sites for monitoring and document baseline population levels. These sites will then be revisited and the population levels measured against the baseline to determine the effectiveness of management actions. Baseline surveys will entail an assessment of the characteristics listed below.

- Stream reaches, ponds, wetlands, or reservoirs occupied by western pond turtle adults.
- Unoccupied aquatic habitat with the potential to support populations (typically adjacent to occupied habitat).
- Basking sites that could be monitored repeatedly.
- Adjacent upland overwintering habitat for stream turtles (turtles using ponds remain in the water in winter).
- Adjacent upland nesting habitat, particularly in areas where nesting has been documented in the past.
- Presence of other factors (threats) seemingly affecting breeding success at a given location (e.g., adjacent land use).
- Observations on size structure of the population to ensure that young turtles are present and that successful reproduction is occurring.

This information will be documented in GIS layers and used to prioritize areas for enhancement and restoration. This process will be used to determine the

potential for unoccupied breeding habitat to be enhanced or restored to support western pond turtles in the future. It will also help predict how proposed restoration or enhancement of aquatic habitat and adjacent uplands might affect western pond turtle nest sites.

Western pond turtles can be observed year-round in perennial streams, ponds, and wetlands and on the fringes of reservoirs. Surveys will be conducted at times as early as March, in conjunction with surveys for stream populations of California red-legged frogs, but the highest probability of detection to determine presence of the species is during the summer months when individuals can be counted while basking during the middle of the day. Repeated annual surveys of basking sites will be used as an index for overall population numbers. This method will likely be more effective in ponds and wetlands, where aquatic habitat is well defined, than in streams or lakes where individuals are able to move greater distances through the water.

In many cases, it could be beneficial to install artificial basking sites in ponds or wetlands that would be monitored every year. This would facilitate monitoring in areas where there are no basking sites or where sites are submerged during high-water periods. In streams and along reservoir margins, existing information on species distribution and baseline survey data of suitable basking sites will provide an inventory of future survey sites. Once identified, these basking sites will be monitored at the frequencies described above in the introduction to Section 7.3.3 *Species-Level Actions* to determine the number of individuals present. These results will be used to determine the population level in the area and will allow for some analysis of population response to management actions.

Monitoring protocols will be developed to assist the Implementing Entity in demonstrating compliance with species occupancy requirements described in Chapter 5, Section 5.3.1, subheading *Acquisition of Modeled Habitat for Covered Species*.

Evaluate Covered Species Response to Flow Regulation

Flows could also change as a result of dewatering events described in Chapter 2 *Land Use and Covered Activities*. If western pond turtle populations are found in streams hydrologically affected by existing dams in the permit area, the Implementing Entity will monitor the effects of flow regulation on the species. Monitoring how these changes affect habitat quality and different life stages of development will be important.

Evaluate Species Response to Enhancement and Restoration of Aquatic Habitat

Stream reaches, ponds, and wetlands that are targeted for restoration or enhancement will be monitored to determine the response of western pond turtle populations to those activities. The relative success of different techniques for

maintaining or increasing western pond turtle populations will be assessed to guide future management efforts. Enhancement or restoration of occupied habitat will be monitored by determining changes in the average number of individuals observed during basking site surveys. This method will only be useful at monitoring long-term trends, but it will give some sense of the population response to the change in habitat.

In areas where nesting is known to occur, the number of nesting attempts or the success rate of nests will be monitored to determine how site-specific management prescription are affecting turtles during the nesting period. The opportunities to conduct this type of monitoring may be limited due to the number of known nesting areas and the difficult nature of monitoring nesting turtles without disturbing important nesting areas. The Implementing Entity will determine the best approach for monitoring western pond turtle once reserves are acquired and reserve unit management plans are being developed. Trapping or observations can provide information on the relative abundance of young (small) turtles as an index to reproductive success.

In some streams, 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. Western pond turtle populations will be monitored and compared to baseline conditions to determine if these methods improve habitat quality and increase numbers of turtles.

Additional habitat enhancements, such as changes in flow regimes, may be implemented in streams that support western pond turtle habitat. Monitoring by the Implementing Entity regarding how these flows affect habitat quality will be important. Changes to riverine systems to conditions that are more natural will inherently benefit western pond turtles in the study area.

Monitor Additional Threats

Nesting sites and nest success are thought to be the limiting factor for this species in the study area. Identifying known or potential nest sites in the Reserve System and along target streams will provide valuable information that informs efforts to conserve the species. Studies have shown that while western pond turtle populations can seem relatively stable due to the presence of adults, there may be minimal recruitment of juveniles into the population (Reese 1996). Focusing on aquatic habitats is important, but extending that focus to include adjacent uplands, where nesting could occur, is critical to guaranteeing the long-term stability of the populations.

Other Covered Plants (Group 2)

There are 6 other rare plant species covered by this Plan. Their monitoring actions will be comparable and are described below. These plant species include the following:

- Mount Hamilton thistle
- Fragrant fritillary
- Loma Prieta hoita
- Smooth lessingia
- Most beautiful jewelflower

Document and Monitor Species Status

Baseline surveys will be conducted on parcels that are added to the Reserve System to determine or estimate the number of individuals in known occurrences of covered plants and whether undiscovered occurrences occur on the property. Surveys will be conducted at the appropriate blooming period for each species (see **Appendix D** for blooming periods). Survey protocols will be developed for each species. When feasible and efficient to do so, surveys for serpentine plants will be included with the above-described surveys for Bay checkerspot butterfly. Surveys may entail counts for small sub-occurrences or statistical sampling and analysis for larger occurrences. Baseline monitoring is currently being conducted for fragrant fritillary, most beautiful jewelflower, smooth lessingia, and Mount Hamilton thistle in permanent plots on Coyote Ridge on the UTC parcel (Arcadis 2008).

Species status will be monitored over time in relation to baseline occurrence sizes; baseline data will serve as the standard against which future changes are measured. Monitoring will evaluate changes over time and the response of plant occurrences to management activities. At a minimum, monitoring will include data on occurrence size, numbers and location; age classes; seedling survival; health and vigor of occurrences, threats, and adjacent land uses. Location data will be collected by GPS and documented in GIS layers.

For some species, it may be important to separate individuals into stages (e.g., seedlings, adults, reproductive adults) to assess occurrence dynamics. In addition to the specified monitoring, monitoring will always be conducted following events that may have strong effects on occurrence size and condition (e.g., fire, severe weather, human impact). Monitoring methods will be based on up-to-date repeatable methods of tracking occurrence status over time.

Evaluate Species Response to Habitat Enhancement

Several land management actions will be implemented under this Plan. In many areas these management activities are already occurring. For example, grazing is

an important part of grassland management in the study area. However, the manner in which reserve lands are grazed may change as the result of prescriptive management outlined in reserve unit management plans. In some areas, grazing may be reduced in favor of other management techniques such as prescribed fire.

In all such cases the impact of changes in management on covered plant occurrences will be tracked through occurrence monitoring. Management at the natural community level will be informed by information that is gathered during species-specific monitoring. Monitoring will be designed to facilitate quantification of how these management regimes change the number of individuals in an occurrence and/or the total number of occurrences. Additional data that could be collected to inform management decisions include the recruitment of seedlings in covered plant occurrences and changes in the species richness of natural communities surrounding covered plant occurrences. Ultimately, the findings of these monitoring activities should determine which management techniques are most effective at increasing covered plant occurrence levels in the Reserve System.

Targeted Studies

A goal of monitoring under the Plan is to identify factors that limit the expansions of covered plant occurrences. Management actions will then be prescribed to remove or reduce those limitations; this process will be adaptively managed through follow-up surveys.

For some species, targeted studies will be conducted to evaluate the efficacy of establishing new occurrences by transplanting individuals from known occurrences or by seed collection and propagation. These created occurrences will be monitored and their success, as well as any impact that transplantation or seed collection has on known occurrences, will be recorded and incorporated into adaptive management decisions. In addition, the success rate of establishing individuals in new locations will be tracked to determine if this is a viable management option. The outcomes of these studies will be used to inform conservation actions for these species.

The Plan also prescribes some management actions for specific species, such as conducting experimental grazing exclusion for a small suite of plants. In all cases of specific management action implementation, appropriate monitoring protocols will be developed and carried out.

Monitor Additional Threats

While fire is likely necessary for the propagation of some species, the effect of fire on covered species is not well understood at this time. Accordingly, covered plant occurrences will be monitored after fires. By monitoring the recovery period for natural communities that burn, as well as other variables such as

percent native versus nonnative species that reestablish, an assessment can be made of overall habitat quality and whether permanent changes in available habitat will affect the persistence of covered plant occurrences.

Mt. Hamilton thistle may face threats from the release of biological control agents (e.g., insect herbivores) that target related invasive thistles. If such releases are conducted in the study area, occurrences of Mt. Hamilton thistle on the Reserve System need to be monitored closely to determine whether there are any adverse effects on this covered species. However, initial monitoring does not show a significant effect on recruitment from biocontrol agents (Hillman 2007).

Additional monitoring may be necessary for covered plants (e.g., Loma Prieta hoita) that may be susceptible to feral pig rooting or damage by other invasive species. Covered plant occurrences near recreational trails will be monitored periodically for trampling or illegal collecting.

San Joaquin Kit Fox (Group 3)

Document and Monitor Species Status

Although state and federally listed, the San Joaquin kit fox is included in Group 3 because the study area is not considered a critical component of the species' range. Monitoring for San Joaquin kit fox will be difficult due to the very low numbers of individuals in the study area (or their absence in many years) and also to their presence primarily on private property. While some monitoring for kit fox will be conducted, as described below, most monitoring for this species will be conducted at the natural community level. For example, monitoring of grasslands, described above in the introduction to Section 7.3.3 *Species-Level Actions* will reveal how grassland communities are responding to grassland management under this Plan. Facilitating a net increase in native grassland communities within the Reserve System will provide more and better habitat for kit fox by increasing the prey base. Further, monitoring the connectivity of habitats within the study area through study of other more abundant species with similar long-distance dispersal behavior (e.g., coyote, bobcat, badger) will ultimately determine if the goal of increased habitat connectivity for kit fox has been achieved.

The San Joaquin kit fox *Level B Strategy* of the *Recovery Plan for Upland Species of the San Joaquin* identified a number of research needs to refine viability models and land-use optimization model (U.S. Fish and Wildlife Service 1998). In accordance with these research needs, a baseline survey of potential den sites will be conducted for modeled San Joaquin kit fox habitat (**Appendix D**) in the Reserve System. Potential den sites will be assessed for occupancy, and a schedule for follow-up monitoring will be established. Further, to assess how San Joaquin kit fox and other terrestrial species move across SR 152 (the most prominent barrier within the modeled San Joaquin kit fox habitat), a combination of trail cameras or track boards will be used at assumed crossing locations (e.g., bridges, culverts) to quantify wildlife corridor use. A

methods testing study will be conducted to identify methods for quantifying use of crossings by native species.

Evaluate Species Response to Habitat Enhancement

It is assumed that monitoring efforts aimed at quantifying grassland community enhancement and connectivity will be suitable to assess kit fox habitat quality. For example, if grassland enhancement efforts are deemed successful at increasing the amount of grassland and overall connectivity in the Reserve System, then those efforts will be similarly successful for grassland-dependent species such as San Joaquin kit fox. The density and distribution of California ground squirrels in the Reserve System will also be used as a proxy for habitat quality and quantity for San Joaquin kit fox within the modeled range of the species. Baseline surveys to establish the distribution and burrow density of California ground squirrels in the Reserve System will be conducted, and that information will be used to refine the habitat model. Changes in distribution of California ground squirrels in response to grassland management will be considered changes in habitat availability for San Joaquin kit fox in areas modeled as San Joaquin kit fox range.

The Implementing Entity will also monitor the success of conservation actions focusing on removing fences, roads, and/or small culverts to increase habitat linkage for the kit fox by tracking more common indicator species. Indicator species will also be monitored to track the efficacy of fencing installed to direct movement toward linkages that are created or enhanced through Plan implementation.

Monitor Additional Threats

Additional threats within the study area include SR 152, which bisects potential San Joaquin kit fox habitat. Other terrestrial mammals will be examined to evaluate how this and other roadways might be affecting habitat connectivity in the study area, because kit fox numbers are likely too low to reveal meaningful trends. How and where species move across these barriers and how those movement patterns change in response to crossing enhancement or roadway modifications will be assessed.

In addition, predation of nonnative red fox on San Joaquin kit fox will be examined as a threat.

Rapid changes in grassland habitat, such as natural or prescribed burns, could have a temporary effect on prey availability and cover for San Joaquin kit fox. To determine how the prey base is affected, California ground squirrel colonies will be monitored before and after fires occur. By monitoring the recovery period for grassland habitat, including ecosystem variables such as size of the reestablished ground squirrel colony, an assessment can be made of overall

habitat quality and whether permanent changes in grassland habitat will affect the occurrence or persistence of a San Joaquin kit fox population.

Least Bell's Vireo (Group 3)

Document and Monitor Species Status

Although state and federally listed, least Bell's vireo is included in Group 3 because the study area is not considered a critical component of the species' range. Surveys of riparian woodland within the Reserve System will be conducted. Initially, the Implementing Entity will document any nesting activity in the study area. Because least Bell's vireos have only been documented twice in the recent past (once nesting, once foraging), other songbird species (e.g., song sparrow, common yellowthroat, Wilson's warbler, black headed grosbeak) that nest in the understory of riparian woodland could be used as indicators of habitat quality until least Bell's vireos are documented nesting in the study area. The focus areas for least Bell's vireo will initially be the species' modeled habitat (**Appendix D**) within the Reserve System and on other public lands. Surveys along these stream reaches will characterize the songbird communities (also part of natural community monitoring) and detect any least Bell's vireos present during the nesting season. Species status will be based on presence in the Reserve System and other public lands. Monitoring will also occur at least every 5 years in targeted sites outside the vireo's modeled habitat in the study area to determine if it is expanding (in particular, in the northern portion of the County). These surveys would be done by the Implementing Entity. Through adaptive management, the vireo model would change in the future due to new information.

Surveys will consist of either standard point count or area search methods (Ralph et al. 1993) depending on the terrain and size of the reach. The nesting season for riparian songbirds is typically April 15–July 31 in the study area. The period with the highest potential to detect breeding least Bell's vireo is mid- to late May (Santa Clara Valley Audubon Society 2005). Locations of all singing males will be recorded using a GPS receiver, as will any nests or other evidence of breeding activity. During baseline surveys, the species habitat model will be modified to reflect riparian habitat quality and actual nesting habitat within the Reserve System. Subsequent surveys will be focused on those areas to monitor changes in the population.

Evaluate Species Response to Habitat Enhancement and Restoration

Additional surveys conducted by the Implementing Entity will be focused along riparian corridors where changes in land use or stream flow, or stream or riparian restoration activities, are expected to occur. For example, stream flow below the two south County reservoirs may be altered to improve habitat for covered aquatic species in Uvas Creek. Those alterations could change the riparian vegetation in Uvas or Llagas Creek, making it more or less suitable for breeding

least Bell's vireo. The actual effects will be determined by monitoring breeding least Bell's vireo populations along these stream reaches, should they be present or, in their absence, by monitoring breeding populations of other riparian understory obligates. Some modifications to land use, such as excluding livestock from stream corridors or stabilizing sources of sediment, could also change the vegetative structure along stream reaches. Monitoring least Bell's vireo and other riparian obligate songbird species will offer insight into how these changes affect the function of the riparian community.

In an extreme case, restoring engineered channels to a more natural condition will change the songbird community using the drainages during the nesting season. In such an instance it will be important to collect at least 1 year of baseline data along the engineered channel against which to compare the restored channel. However, few such scenarios are anticipated in potential least Bell's vireo habitat within the Reserve System (one example is Upper Llagas Creek within Morgan Hill).

Monitor Additional Threats

Currently there are limited threats to least Bell's vireo within the study area because populations are absent or very low. It is assumed that the distribution of the local population will continue to expand northward as it has in the recent past. Once a least Bell's vireo population is established in the study area, there could be additional threats to nests and adults. Studies to determine nest success will be conducted annually once nesting is detected in the study area. In addition to documenting nest success, these studies will document reasons for nest failure and incidence of brown-headed cowbird parasitism (a major threat in established populations in southern California). The results of these studies will inform management decisions to increase nest success in the study area. Potential management actions are listed below.

- Brown-headed cowbird control program.
- Feral cat removal or relocation.
- Native and/or nonnative predator control (e.g., red fox, raccoon, skunk).
- Restricted public access to important breeding areas during the nesting season.

Tricolored Blackbird (Group 3)

Document and Monitor Species Status

All suitable freshwater wetland or pond habitat within the Reserve System will be surveyed in accordance with the survey schedule described in the introduction to Section 7.3.3 *Species-Level Actions* to document the baseline estimate of the population size within the Reserve System. Because tricolored blackbird populations are rare in the study area, other potential wetland sites on other

public lands will be surveyed to document the species in the region. Baseline information for the species will comprise the components listed below.

- Location of occupied wetlands.
- Estimate of number of birds in colony.
- Assessment of nesting habitat quantity and quality (e.g., percent of native and nonnative plants).
- Assessment of any additional nearby threats (e.g., heron rookeries, sources of noise or other disturbance).

This information will be documented in GIS layers and used to prioritize areas for protection and enhancement or restoration/creation.

Once baseline data are collected, monitoring for tricolored blackbird colonies will be conducted during the breeding season. The population size of established colonies will be monitored, as will unoccupied wetlands in the study area. Tricolored blackbirds typically nest from early April through early June. Because the probability of detecting nesting colonies is highest during May, surveys will be conducted during or near the month of May. It is suggested that each colony be visited twice during the breeding season, preferably 10–14 days apart, to determine a range of breeding individuals at the colony, by at least two observers on the same day. The mean number of birds estimated by the two observers can be used to determine the size of the breeding colony. During the survey, the colony will be observed through binoculars or a spotting scope at a distance that will not change the behavior of the nesting birds. These proposed monitoring guidelines will be revised if better methodologies based on the best available scientific information are developed during implementation.

Once baseline data have been collected on breeding habitat availability in the Reserve System and existing breeding colonies have been documented, that information will be used to determine breeding habitat connectivity within the study area. This will identify areas where "new" breeding habitat will be created or acquired to ensure habitat connectivity for this species. Information will be collected on where new colonies become established, and identifying the surrounding land use patterns (e.g., agriculture, irrigated pasture) that provide foraging habitat for breeding tricolored blackbirds. Areas where this relationship can be preserved or created within the Reserve System will be identified and evaluated for future restoration or creation of habitat.

Evaluate Species Response to Habitat Enhancement, Restoration, or Creation

Enhanced or restored wetland areas and suitable created ponds will be monitored twice from April to June to determine if a tricolored blackbird nesting colony is present or, if one is already established, to document its current size. In wetlands or ponds where there are existing tricolored blackbird colonies, all enhancement or restoration activities will be conducted outside the nesting season. Following

those management actions, the tricolored blackbird colony size will be monitored to determine the population response to the management actions. In target areas where tricolored blackbirds were not observed prior to management actions, subsequent surveys will document whether new colonies establish in the area.

Monitor Additional Threats

In instances where tricolored blackbirds are nesting in nonnative plants (e.g., Himalayan blackberry), there is the risk that nonnative species control could result in the loss of nesting habitat. Accordingly, the removal of nonnative plant species will be weighed against the loss of important nesting habitat for this species. There should be attempts to transition the nonnative habitat to native habitat that will also support nesting tricolored blackbirds. The colony response to those actions will be monitored and the result will inform future management prescriptions for colony sites with nonnative plants.

In general it is difficult to monitor nest success of tricolored blackbird because while nesting they are very susceptible to disturbance. Some information about colony success can be gained through annual monitoring of colony size, but this approach often fails to identify specific stressors. There are assumptions that some species (e.g., feral cats) can have a deleterious effect on colonies. For colonies that are near urban areas, feral cat removal programs could increase the success of nesting tricolored blackbirds. Similarly, robust populations of nonnative red foxes or even native skunks and raccoons can have significant impacts on nesting birds. In general, control programs will not address native species. However, targeted programs could be initiated in response to observations of individuals taking nests, eggs, or nestlings.

7.4 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 Implementing Entity staff, decision makers, scientific advisors, Wildlife Agencies, other interested government agencies including the Corps and Regional Boards, 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 *Plan Implementation*. The reporting requirements for monitoring include the following (also found in Chapter 8):

- A description of the landscape-, natural community–, and species-level monitoring undertaken during the reporting period and a summary of monitoring results, including species status and trends.
- A description of the adaptive management process utilized during the reporting period (e.g., consultation with science advisors, convening of the Independent Conservation Assessment Team).

- A summary of the recommendations or advice provided by the Wildlife Agencies, science advisors, and the Independent Conservation Assessment Team (if applicable) regarding adaptive management and monitoring.
- A summary of the monitoring program objectives, techniques, and protocols including monitoring locations, variables measured, sampling frequency, timing, and duration, analysis methods, and who performed the analyses.
- An assessment of the efficacy of the monitoring and research program and recommended changes to the program based on interpretation of monitoring results and research findings.
- An assessment of the efficacy of habitat restoration and creation methods in achieving performance objectives and recommended changes to improve the efficacy of the methods.
- A description of all Habitat Plan directed studies undertaken during the reporting period; a summary of study results; and a description of integration with monitoring, assessment, and compliance elements.
- An assessment of the appropriateness of performance indicators and objectives (see **Table 7-2** for examples) based on the results of effectiveness monitoring, and recommended changes to performance indicators and objectives.
- A description of any actions taken or expected regarding changed circumstances, including remedial actions.
- A description of any unforeseen circumstances that arose and responses taken.

Table 7-1. Schedule of Monitoring Tasks over the Permit Term

Monitoring Type/ Phase	Summary Tasks
Years 0–5	
Compliance	Set up tracking databases for impacts, acquisition, and restoration to land cover, and covered-plant populations.
Inventory	Initiate inventories in the Reserve System.
	Assess landscape linkages using aerial photos and ground surveys and initiate data – collection program on wildlife movement.
	Submit reserve unit management plans for Wildlife Agencies review and approval within 5 years of the first acquisition for each reserve unit. Each plan will contain a detailed monitoring and adaptive management plan; including the development of indicators, monitoring protocols, and success criteria for management actions.
	Prioritize conservation actions within the Plan area.
Targeted Studies	Develop ecological models for Group 1 species.
	Initiate methods testing for key management actions (e.g., restoration).
	Prioritize and initiate pilot projects.
	Prioritize and initiate directed studies.
Long-Term Monitoring	Develop experimental design for long-term management activities such as restoration and include as part of reserve unit management plans.
Years 6-15	
Compliance	Continue tracking impacts, acquisition and restoration. Ensure that mitigation stays ahead of impacts.
Inventory	Continue baseline inventories as sites are added to the Reserve System.
Targeted Studies	Complete methods testing and pilot projects.
	Continue directed studies.
Long-Term Monitoring	Update GIS layer (every 5 years) and assess trends.
	Monitor covered-species response to management actions.
	Monitor covered species in accordance with the schedule developed in the Habitat Plan and the final detailed monitoring and adaptive management plan.
	Monitor success of restoration sites against success criteria.
	Review existing literature and scientific knowledge and make changes to monitoring and management based on new information.
Years 16–25	
Compliance	Continue tracking impacts, acquisition, and restoration. Ensure that mitigation stays ahead of impacts.
Inventory	Continue baseline inventories as additional parcels are acquired.
Targeted Studies	Complete targeted studies.

Monitoring Type/ Phase	Summary Tasks
Long-Term Monitoring	Continue to assess status and trends of natural communities (aerial surveys) and species.
	Adapt management actions based on monitoring results of species response and success criteria for restoration and other management efforts.
	Continue to monitor covered species and adaptively manage species in response to monitoring results.
	Evaluate efficacy of monitoring protocols using results of pilot projects.
Years 25+	
Compliance	Finalize impact tracking. Maintain database of any active ongoing mitigation.
Inventory	Finalize baseline inventories of parcels acquired after Year 25.
Long-Term Monitoring	Continue to assess status and trends of natural communities (aerial surveys) and species.
	Based on 25 years of implementation, develop reduced monitoring protocols for target species and/or communities.
	Promote directed studies in the reserve system that benefit covered species and natural communities.

Table 7-2. Example Success Criteria for Monitoring Effectiveness of Selected Management Actions[a]

Management Action	Performance Period[1]	Example Success Criteria	
		Example Minimum Value[3]	Example Target Value[4]
Enhance Wetlands and Ponds: ponds and perennial wetlands	__ years following acquisition of ponds and perennial wetlands	*Nonnative predators:* • Maintain __% of all ponds and permanent wetlands free of nonnative fish (except mosquitofish) and bullfrogs in any given year	*Nonnative predators:* • Maintain all ponds and permanent wetlands free of nonnative fish (except mosquitofish) and bullfrogs annually
		Emergent vegetation cover-margins: • Maintain native emergent vegetation along at least __% of pond and perennial wetland edges	*Emergent vegetation cover-margins:* • Maintain native emergent vegetation along at least __% of pond and perennial wetland edges
		Emergent vegetation cover-pond surface: • For ponds designed to support tricolored blackbird breeding: Maintain native emergent vegetation over at least __% of pond surface area	*Emergent vegetation cover-pond surface:* • For ponds designed to support tricolored blackbird breeding: Maintain native emergent vegetation over at least __% of pond surface area
		Hydrology: • Maintain wetlands year-round in normal rainfall years[6] • Maintain ponded surface water until October 1 in normal rainfall years[6]	*Hydrology:* • Maintain wetlands year-round in dry rainfall years[6] • Maintain ponded surface water until October 1 in normal rainfall years[6]
Pond creation	__ years following pond creation	*Extent created:* • __ acres[5]	*Extent created:* • __ acres[5]
		Emergent vegetation cover: • __% of ponds will support native emergent vegetation > 5 feet tall (e.g., cattail or tules) over at least __% of surface area (for Tricolored Blackbird) • __% of ponds will support emergent vegetation over at least __% but no more than __% of the surface area (for California red-legged frog)	*Emergent vegetation cover:* • __% of ponds will support native emergent vegetation > 5 feet tall (e.g., cattail or tules) over at least __% of surface area (for Tricolored Blackbird) • __% of ponds will support emergent vegetation over at least 30% but no more than __% of the surface area (for California red-legged frog)

Table 7-2. Continued

Management Action	Performance Period[1]	Example Success Criteria	
		Example Minimum Value[3]	Example Target Value[4]
		% emergent vegetation cover-margins: • Maintain native emergent vegetation along at least __% of each pond margin	*% emergent vegetation cover-margins:* • Maintain native emergent vegetation along at least __% of each pond margin
		Nonnative predators: • Maintain __% of all ponds of free of nonnative fish (except mosquitofish) and bullfrogs in any given year	*Nonnative predators:* • Maintain all ponds free of nonnative fish (except mosquitofish) and bullfrogs annually
Enhance Grassland	__ years following implementation of preserve-wide management of grasslands (and after pilot study complete)	*% native forb cover:* • Demonstrate an upward trend in __% native forb cover relative to existing conditions	*% native forb cover:* • Increase native forb cover by __% relative to condition at time of acquisition
		% native grass cover: • Demonstrate an upward trend in % native grass cover (annual or perennial) relative to condition at time of acquisition	*% native grass cover:* • Increase native grass cover by __% relative to condition at time of acquisition
		Native plant diversity: • Demonstrate an upward trend in native plant diversity	*Native plant diversity:* • Demonstrate an upward trend in native plant diversity
Increase Natural Burrow Availability and Prey Base in Grasslands	__ years following implementation of measure	*Abundance of burrows:* • Demonstrate and upward trend in burrow density and distribution within the Reserve System	*Abundance of burrows:* • Increase the density of burrows by __% and total acreage of burrow complexes by __% within the Reserve System
Enhance Oak Woodland	Implement measures to increase oak tree establishment and densities within __ years of detecting a decline in canopy cover	*Absolute oak tree canopy cover:* • Maintain the existing __% absolute oak tree canopy cover in oak woodlands on Reserve lands	*Absolute oak tree canopy cover:* • Maintain the existing __% absolute oak tree canopy cover in oak savanna and woodlands on Reserve lands

Table 7-2. Continued

Management Action	Performance Period[1]	Example Success Criteria	
		Example Minimum Value[3]	Example Target Value[4]
Restore Valley Oak Woodland	__ years following initial plantings of oak trees	*Extent restored:* • __ acres[5]	*Extent restored:* • __ acres[5]
		% oak-tree canopy cover: __% tree canopy cover equal to or up to __% greater than the percent canopy cover in valley oak stands removed by covered activities	*% oak- tree canopy cover:* __% tree canopy cover equal to or up to __% greater than the percent canopy cover in valley oak woodlands removed by covered activities
	__ years following initial plantings of oak trees	*Understory native plant cover:* • Develop an understory with native plant cover within __% of existing conditions	*Understory native plant cover:* • Develop an understory with native plant cover equal to or greater than that of existing conditions
		Understory native plant diversity: • Develop an understory with native plant diversity at least __% of existing conditions	*Understory native plant diversity:* • Develop an understory with native plant diversity equal to or greater than existing conditions
Enhance Chaparral and Northern Coastal Scrub	__ years following initial treatments	*Canopy gaps:* • Develop a gap frequency of __% in stands of chaparral and northern coastal scrub	*Canopy gaps:* • Develop a gap frequency of __% in stands of chaparral and northern coastal scrub
		Chaparral plant regeneration: • Demonstrate a steady or upward trend in native chaparral and northern coastal species numbers and/or density	*Chaparral plant regeneration:* • Increase the existing relative native chaparral and northern coastal species numbers and/or density (where appropriate)by at least __%
Enhance Conifer Woodlands	__ years following initial treatments	*Species density:* • Maintain the existing species density	*Species density:* • Develop a species density of __%
		Species composition: • Maintain the existing native species composition	*Species composition:* • Maintain the existing native species composition
		Species regeneration: • Demonstrate the existing species composition is maintained post-treatment	*Species regeneration:* • Demonstrate the existing species composition is maintained post-treatment

Table 7-2. Continued

Management Action	Performance Period[1]	Example Success Criteria	
		Example Minimum Value[3]	Example Target Value[4]
Enhance Riparian Woodland/Scrub	__ years following initial treatments	*Relative native tree canopy cover:* • Demonstrate an upward trend in native plant diversity	*Relative native tree canopy cover:* • Increase the existing relative native tree canopy cover by at least __%
		Relative native shrub canopy cover: • Demonstrate an upward trend in native plant diversity	*Relative native shrub canopy cover:* • Increase the existing relative native shrub canopy cover by at least __%
Restore Streams and Riparian Woodland/Scrub to Compensate for Habitat Loss and to Increase Biodiversity	__ years following restoration planting	*Extent restored:* • __ acres[5]	*Extent restored:* • __ acres[5]
		Relative native tree canopy cover: • Establish a relative native tree canopy cover of at least __%	*Relative native tree canopy cover:* • Establish a relative native tree canopy cover of at least __%
		Relative native shrub canopy cover: • Establish a relative native shrub canopy cover of at least __%	*Relative native shrub canopy cover:* • Establish a relative native shrub canopy cover of at least __ acres

Notes:

[a] This table provides a framework for evaluating the success of certain conservation measures. The Implementing Entity will develop values for assessing success during the Inventory and Targeted Studies phases of implementation

[1] The estimated period following enhancement/creation/restoration of a natural community at a site during which performance standards should be achieved.

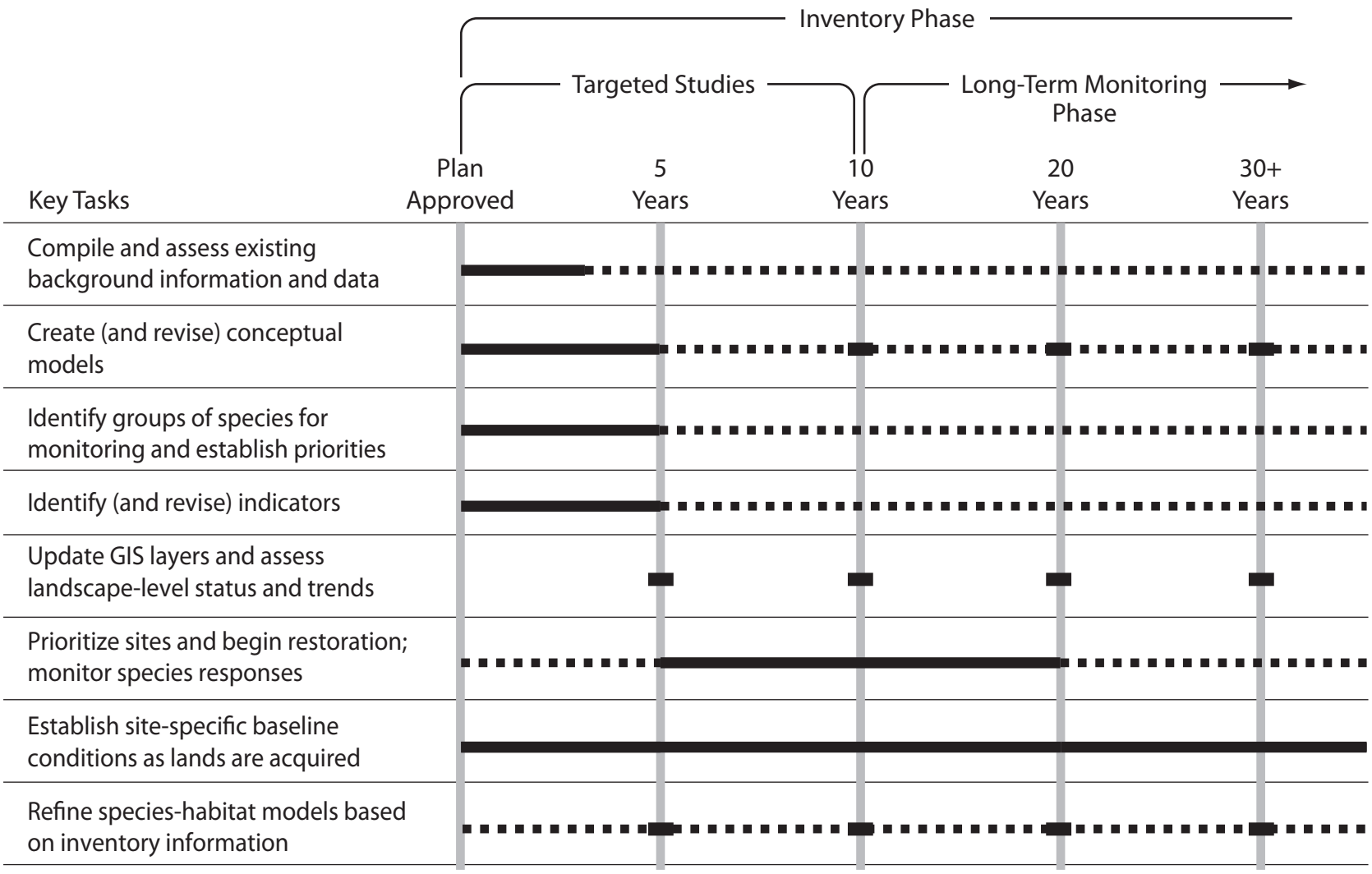
[2] Success criteria are shown in italics.

[3] The example minimum value is the minimum measured value for each success criterion that must be achieved during the performance period.

[4] The example target value represents the optimal desired value for each performance indicator and the design and management objectives for enhanced/created/restored natural communities. If performance objectives are not achieved, adaptive management actions may be triggered.

[5] Acres restored are estimates based on the impact analysis. Actual restoration performance standard/target may vary depending on actual field-verified impacts.

[6] Normal rainfall years are defined as within 1 standard deviation of the annual average rainfall as measured at the California Irrigation Management Information System (CIMIS) __ rain gauge over the hydrologic record of the gauge (October–September). Dry years are defined as less than 1 standard deviation from the annual mean.



Note: Density of line indicates intensity of work.

Adapted from Atkinson et al. 2004.

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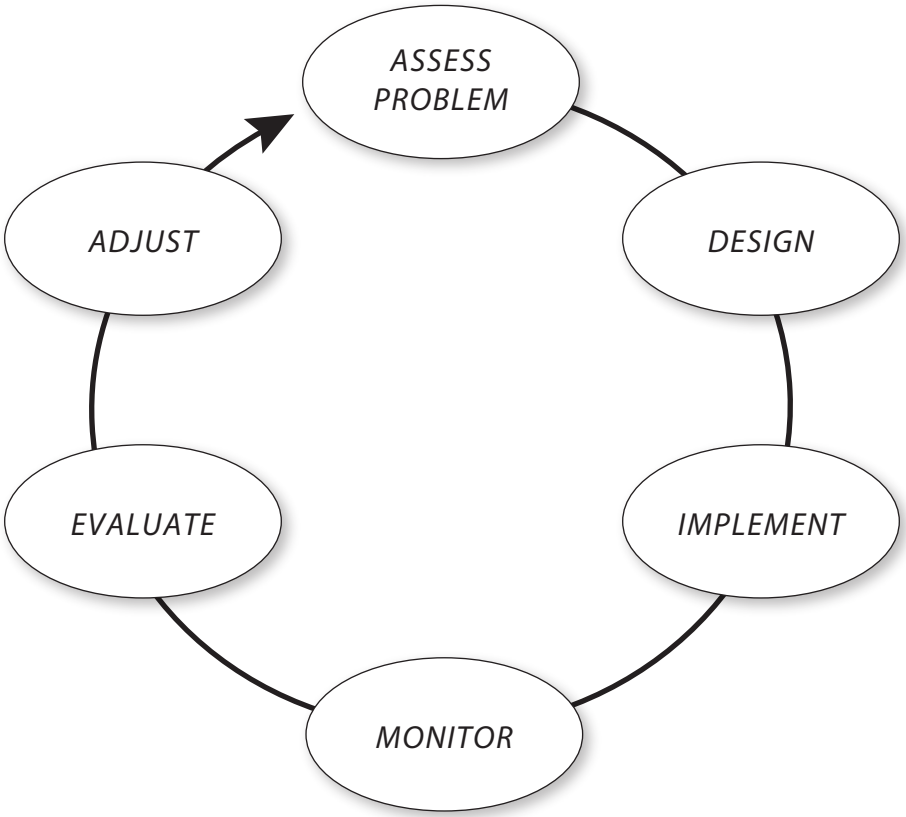
Figure 7-1
Timing of Monitoring Phases

Adaptive Management Process



Adapted from William et al. 2007.

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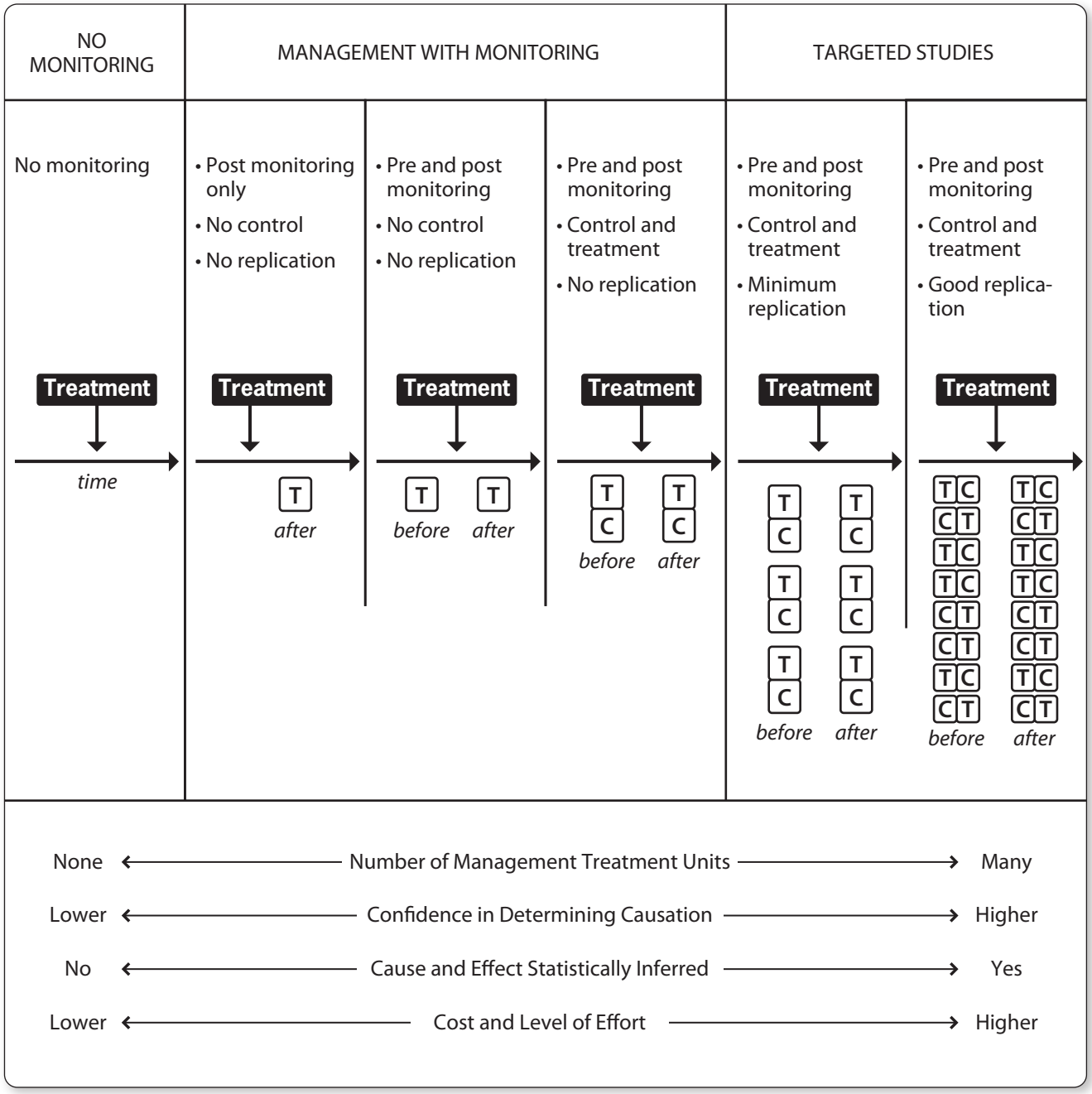
Figure 7-2
Adaptive Management Process



Adapted from Elzinga et al. 1998.

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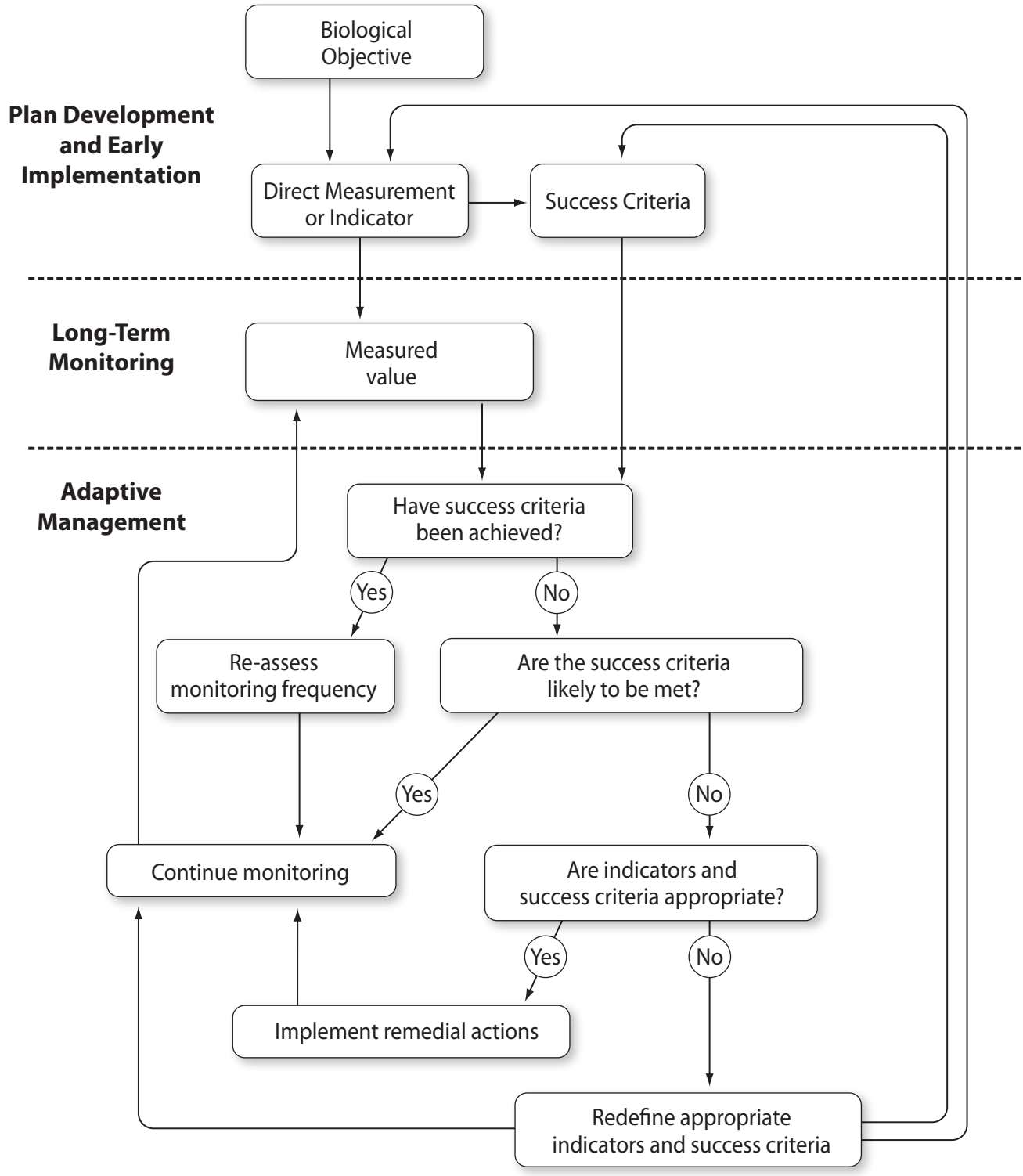
Figure 7-3
Continuum of Experimental Management



Adapted from Draft Guadalupe River Project, Downtown San Jose, California, Mitigation Monitoring Report (Jones & Stokes 2002)

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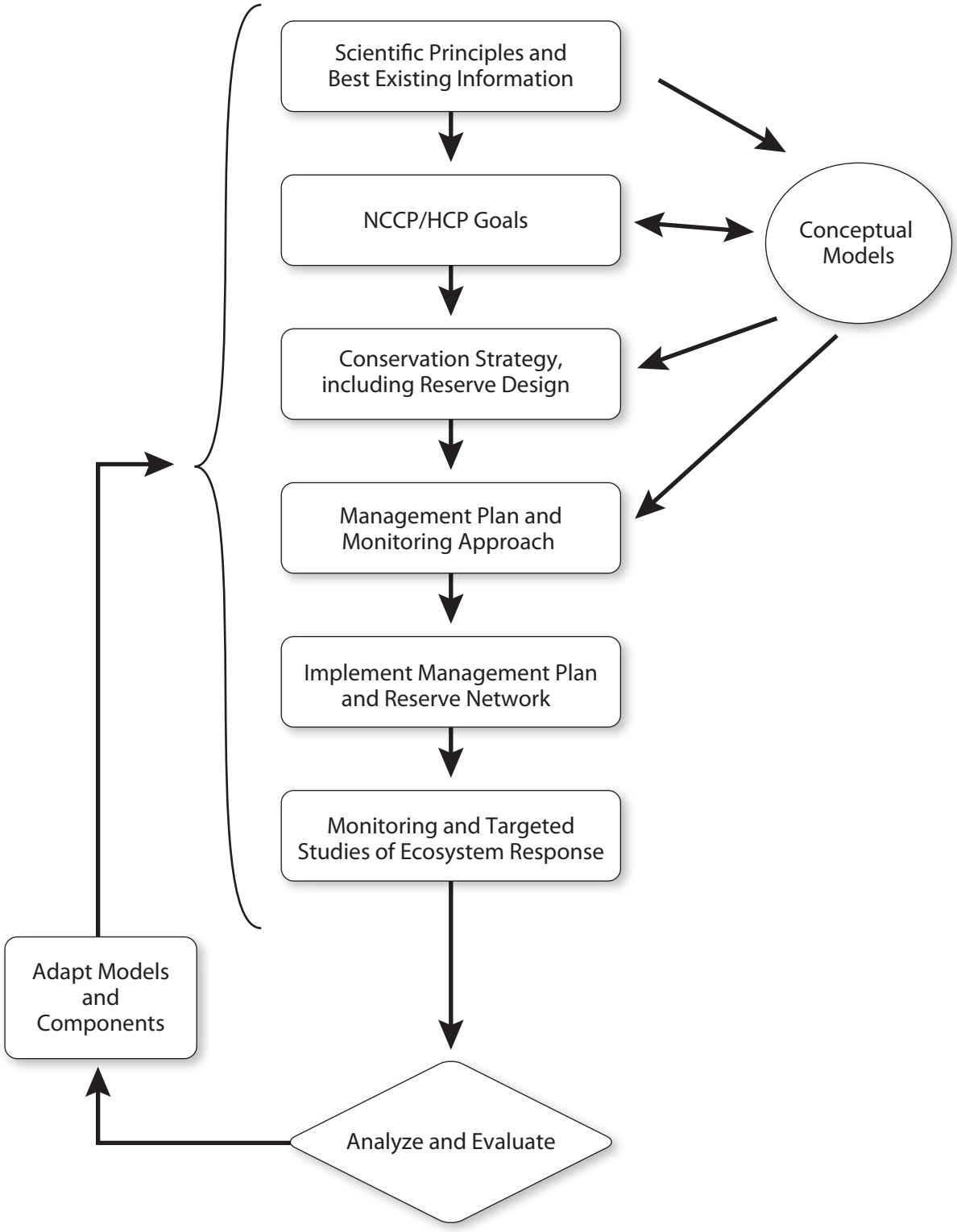
Figure 7-4
Flowchart of the Adaptive Management Process



Excerpted from Atkinson et al. 2004.

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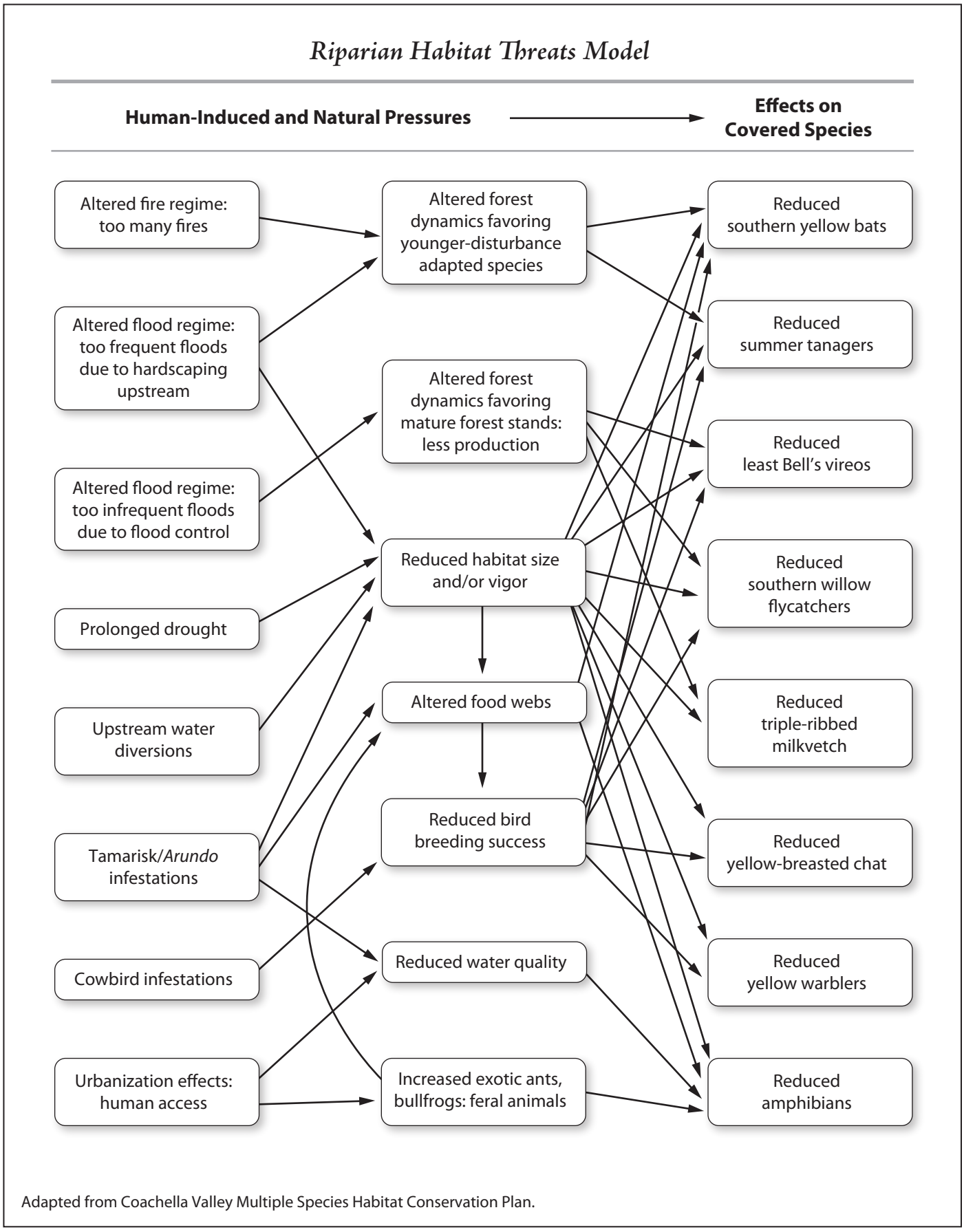
Figure 7-5
Adaptive Management Feedback Loop



Adapted from Coachella Valley Multiple Species Habitat Conservation Plan.

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Figure 7-6
Example Stress-Response Model 1

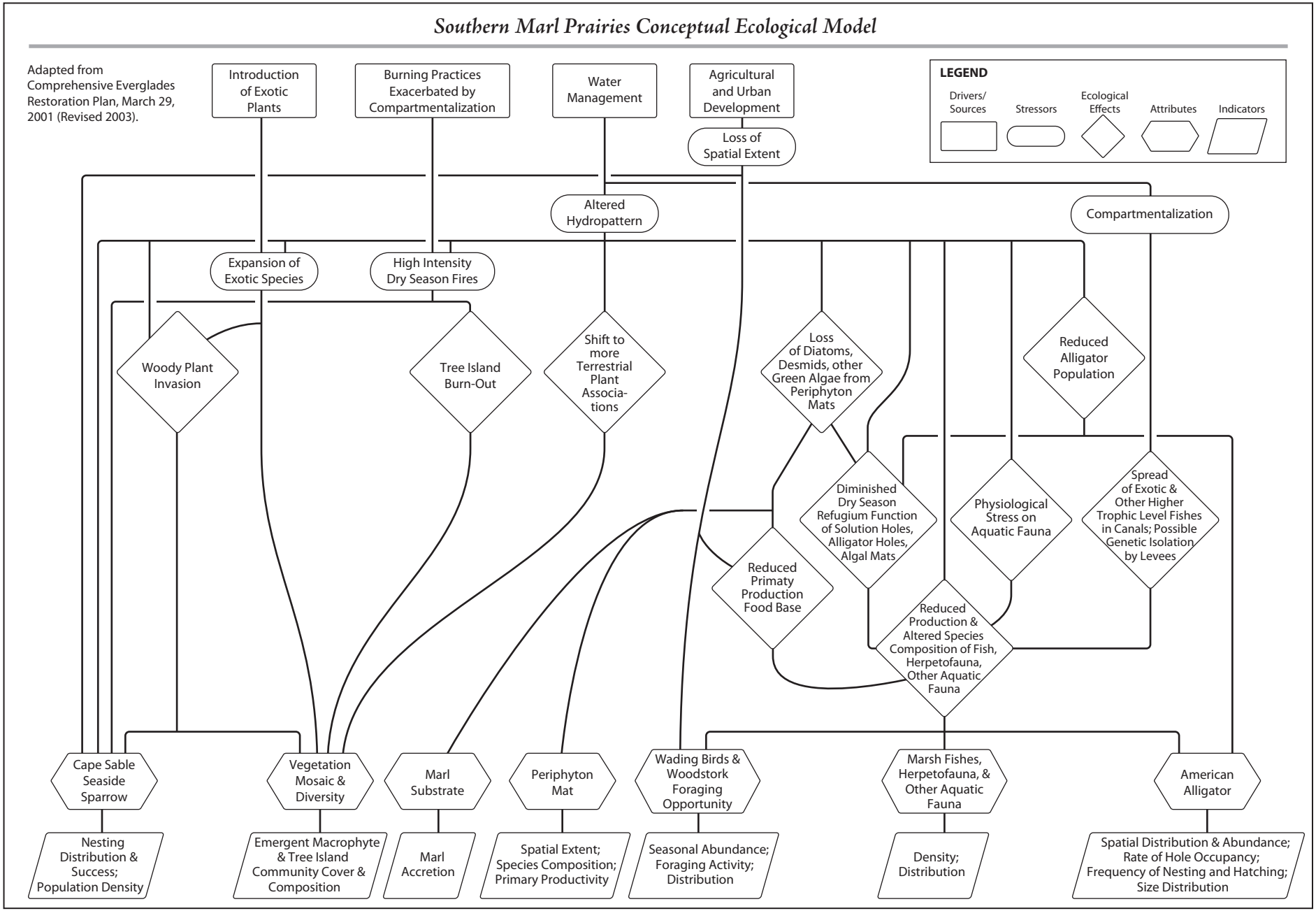

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Figure 7-7
Example Stress Response Model 2

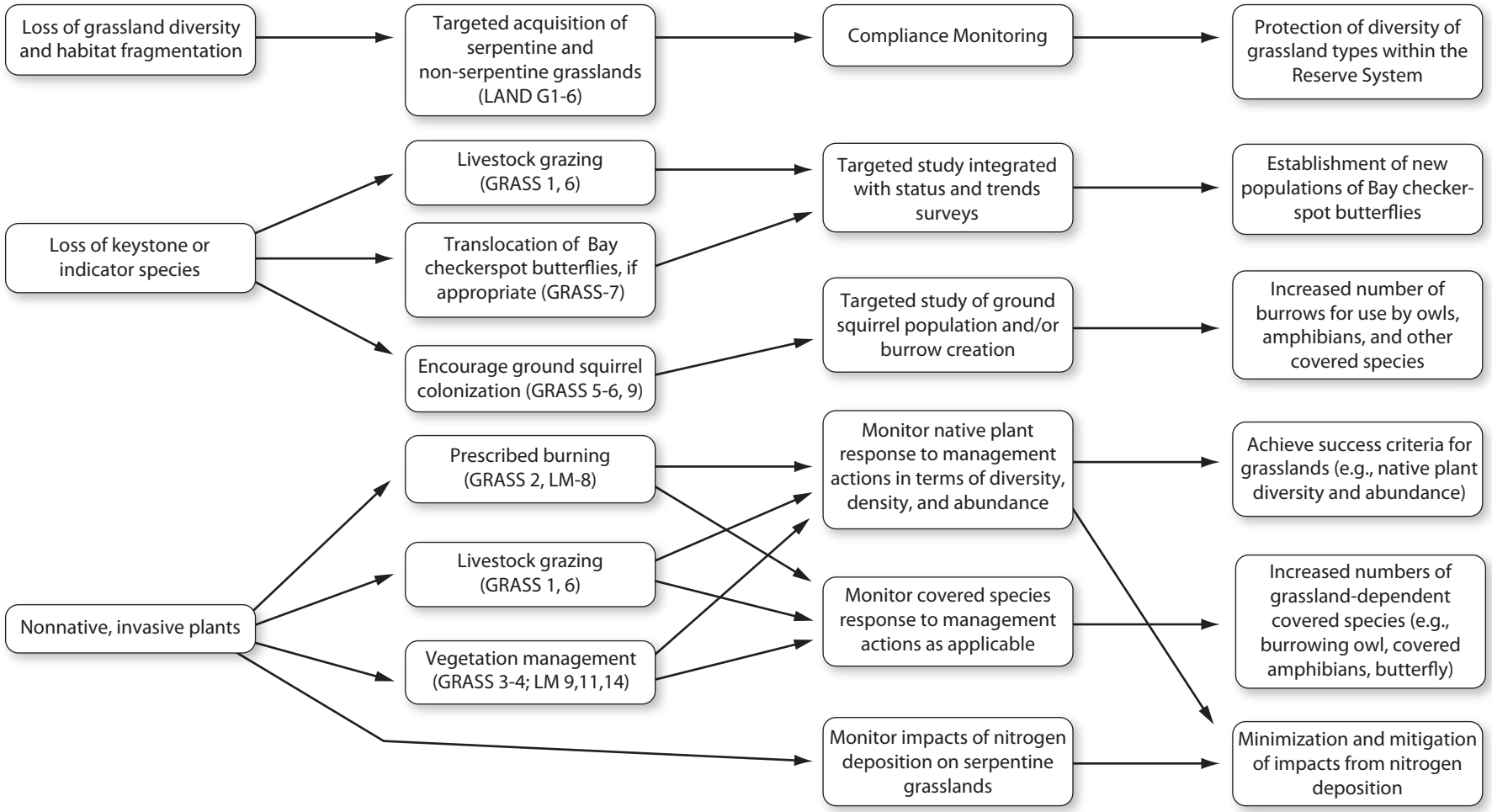

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Figure 7-8
Adaptive Management and Monitoring Conceptual Model for Grassland

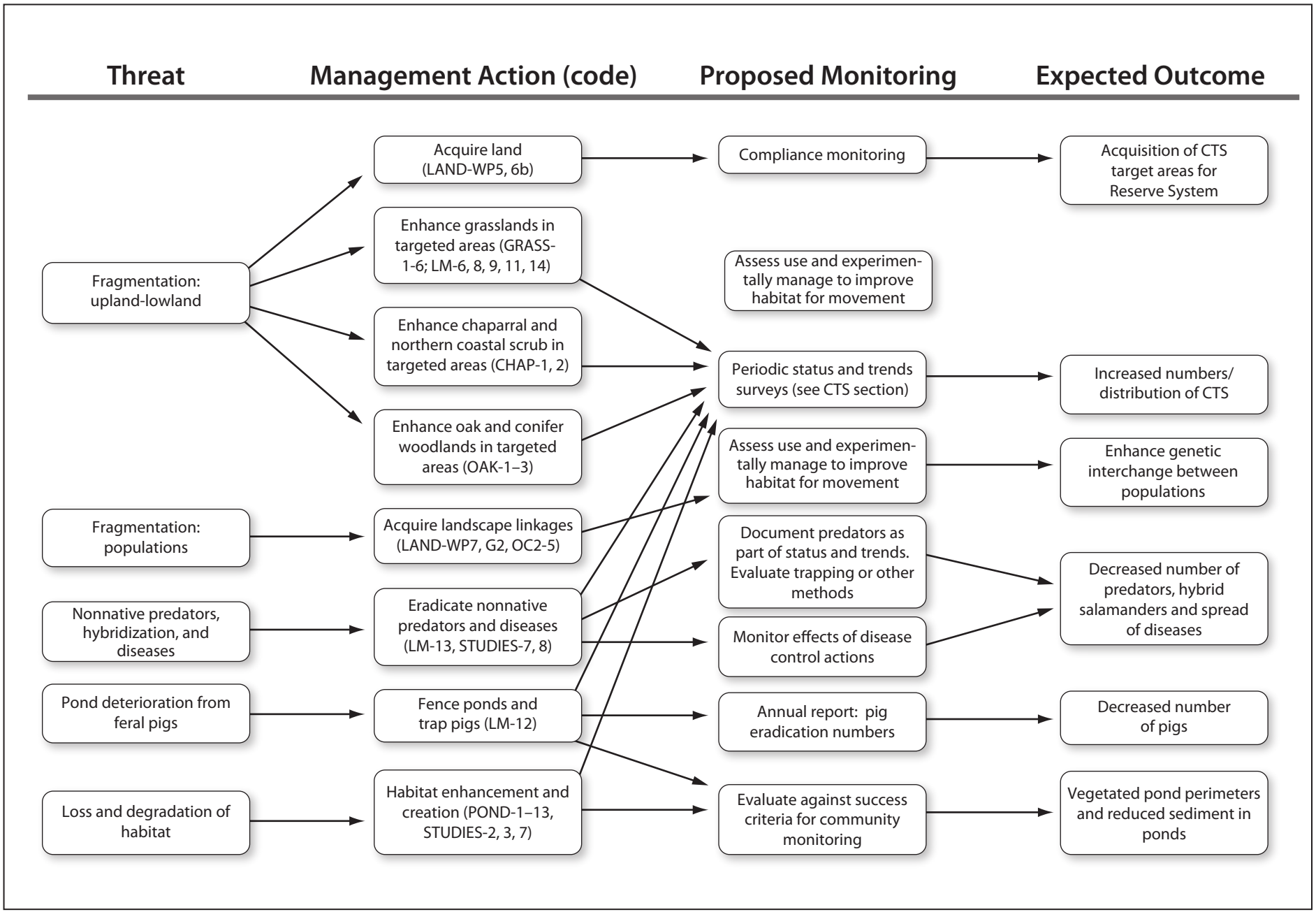

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Figure 7-9
Adaptive Monitoring and Management Conceptual Model for California Tiger Salamander