Appendix J

Monitoring Issues and Tools

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Monitoring is conducted in three phases (described in Chapter 7, Section 7.2.2 *Program Phases*) and at three levels (described below). Level was a guiding principle of the conservation strategy, and goals and objectives were developed at the landscape, natural community, and species levels. This section provides an overview of what monitoring at each level involves, the issues or topics related to the three levels, and the general monitoring tools or approaches that will be used. Specific monitoring actions for each of the three levels are identified and discussed in Chapter 7, Section 7.3 *Monitoring and Management Actions*.

J.1 Landscape Monitoring Issues and Tools

Landscape-level monitoring is directed at geographically large areas (e.g., the entire Reserve System or large portions of the Reserve System) that maintain essential ecological processes. Functioning landscapes encompass multiple ecosystems and natural communities and the movement of nutrients or materials between those units. Landscape-level monitoring addresses the following issues relevant to the Plan.

- The amount of land cover types in the Reserve System and their relationship to each other (e.g., succession or conversion from one community type to another, transitions zones between communities).
- Status and trends in the amount and quality of land cover types, natural communities, and other landscape features.
- The integrity and quality of landscape linkages and their potential role as dispersal and movement routes and corridors to preserve or maintain connectivity throughout the study area.
- The delineation of watersheds and maintenance of the general hydrologic function of those watersheds in and out of the Reserve System.
- The location, distribution, and range of invasive plants, nonnative wildlife species, and disease in the study area.
- The frequency, intensity, and geographic scope of disturbance events such as fires and floods.

The purpose of monitoring changes in the extent of land cover types within the planning area is to track long-term, landscape-level changes and, by inference, changes to the habitats and natural communities contained therein. Long-term changes can indicate local, regional, or global problems such as unanticipated impacts of covered activities, influence of invasive species, and effects of climate change. Monitoring long-term changes will also track the contribution of the HCP/NCCP toward maintaining or improving the extent, distribution, and continuity of natural land cover types. Changes in land cover type will result from management actions (e.g., conversion of unvegetated streams to riparian woodland/forest; see Chapter 5). If landscape-level changes differ from the expected outcomes due to management actions, the Implementing Entity will attempt to identify reasons for the differences and address them through the adaptive management program as appropriate.

J.1.1 Landscape Monitoring Issues

Following is a brief description of concepts and issues that are addressed under the topic of landscape-level monitoring. Broad issues relevant to landscape-level monitoring are discussed in this appendix. Specific monitoring actions are addressed by phase in Chapter 7, Section 7.3 *Monitoring and Management Actions*.

Habitat Fragmentation

Since reduction of available habitat and fragmentation at a landscape level are among the principle causes of species decline, identifying and preserving key linkages is a primary objective of this Plan. The term *landscape linkage* is used in this Plan to refer to contiguous areas of habitat that connect larger areas of habitat and facilitate genetic exchange within a population or between subpopulations by allowing for movement within or between habitat patches. (For discussion on key landscape linkages and a description of acquisition targets in the study area, see Chapter 5, Section 5.3.1 *Land Acquisition and Restoration Actions*, **Table 5-6**, and **Figure 5-6**.)

In order to understand the level of stress that habitat fragmentation puts on populations of covered species it is important to understand how the existing linkages function and whether they are effective at supporting metapopulations in the Reserve System. There are two important components of monitoring landscape linkages (Bennet 2003). First, it is important to gain a basic understanding of the key linkages that occur within the study area and the representative species that utilize those linkages (status and trends monitoring). These species can serve as indicator species when determining which linkages will be protected and managed and whether they are functioning properly. It will not be possible to gain baseline information on every potential linkage, but linkages that contain landcover features representative of important types in the Reserve System (e.g., riparian corridor, grasslands, conifer woodland) will be studied. Second, it is important to monitor the effectiveness of linkages to determine whether they are achieving their goals (effects monitoring). Again, it may not be possible to monitor every linkage within the Reserve System, but representative examples will be surveyed. In general, monitoring these linkages can take several forms.

- Regular monitoring of the occurrence and status of the plants and animals within linkages (either living there or passing through) to provide information on how the link is being used and the species for which it facilitates connectivity.
- Monitoring of individual animals within the linked system (e.g., by radiotelemetry) to obtain data on the extent, frequency, direction, and type of movement made through particular linkages.
- Monitoring the status of populations and communities in habitat connected by linkages to assess response to changes in connectivity.

Effectiveness monitoring will likely include all three of these methods at some point during the permit term. The effectiveness of linkages for wildlife species will be determined by monitoring indicator species, such as tiger salamander, bobcat, Tule elk, American badger, black-tailed deer, and mountain lion. Sampling methods will be determined upon implementation but generally will include track plates, motion-activated cameras, and transect surveys that could reveal scat or other visual evidence for terrestrial wildlife. The methods will be implemented both within linkages and in core habitat areas on either side of identified linkages.

These surveys will aid in determining whether linkages are functionally allowing passage between two points or whether enhancement of the area between two known habitat areas is necessary. Sometimes linkages will be monitored at natural pinch points, such as riparian corridors, or unnatural pinch points, such as culverts or bridges. In other cases, more rigorous monitoring could be used to determine how a given species uses the landscape. For example, radio-telemetry studies of Tule elk or American badger might be conducted. These species are grassland specialists but can range widely on the landscape, providing some insight into the overall “connectedness” of the Reserve System. There is already some general monitoring of wildlife movements occurring in the study area. These are track surveys and camera monitoring stations near underpass crossing points along U.S. 101. It is generally thought that U.S. 101 is a significant hindrance to any major wildlife movement east-west through the study area, but these recent observations are showing that movement of all sizes of mammals is occurring (T. Diamond pers. comm.) There are proposals to expand this work in scope and rigor to better understand how various species are moving through the study area and what the limiting factors are for larger carnivores (e.g., mountain lions) to persist.

Invasive Plants and Animals

Invasive species control is a serious regional issue and must be evaluated at that level as well as at the site-specific level. For example, exotic plants that occur in the study area must be identified and prioritized regionally for eradication or control. To ensure Plan success, efforts to eradicate or control existing invasive species and to prevent new invasions in the Reserve System will be coordinated with other land management agencies and private landowners in the region, as described in Chapter 5, Section 5.3.2 *Landscape Conservation and Management*.

The monitoring program will track the success of eradication and minimization efforts for invasive species through status and trends monitoring as well as through the development and execution of directed studies that evaluate the efficacy of different techniques. Depending on the resource issue and the level of the monitoring effort, this monitoring might occur at varying frequencies. For example, site-specific monitoring of nonnative plant species might be conducted annually, while a watershed-wide inventory might only occur every 5–10 years. The Implementing Entity and their consultants will take measures to reduce the spread of invasives during monitoring

Feral Pigs

In some cases monitoring exotic species can be best accomplished by documenting the impact of those species on natural landscapes. It would be difficult to census the number of feral pigs within the Reserve System without an extensive effort. However, rooting disturbance can be monitored. Pig population will be controlled until rooting disturbance reaches an acceptable level. .

Bullfrogs and Nonnative Predatory Fish

Following a baseline inventory of nonnative predators (e.g., fish and bullfrogs) in ponds and perennial wetlands within the Reserve System, a systematic eradication program will be implemented. Threats will be prioritized, and the progress of this program will be monitored on an annual basis by repeating the inventory on ponds that have been treated for nonnative animals and ponds that did not support nonnative animals during the initial inventory. This procedure will allow the Implementing Entity to evaluate the success of the eradication program, to detect the spread of these species to unaffected parts of the Reserve System, and to eradicate them as new invasions are identified. Ideally, sites that do not receive treatments (i.e., control sites) will be used to improve understanding of the effectiveness of eradication efforts. However, in the case of serious new infestations or highly invasive species, the management goal may be complete eradication; in such cases, control sites may not be feasible.

Similar inventory and survey efforts will occur in designated sections of riverine and riparian habitat. It is more difficult to eradicate nonnative bullfrogs and fish in riverine systems or along riparian corridors than in isolated aquatic habitats (e.g., ponds) unless the entire length of the system is treated. Monitoring nonnative animals in these habitats will focus on determining population levels. Population control efforts will reduce populations of nonnative animals to levels that facilitate the successful implementation of the conservation strategy described in Chapter 5 of this Plan and maintain those levels in designated reaches of high ecological value (e.g., critical habitat, modeled habitat, known covered species occurrences). Monitoring the effectiveness of population control methods will entail surveys and inventory of nonnative animals but will also involve surveys of selected native species to determine the net benefit of these conservation actions. For example, population levels of native amphibians might be monitored along a reach of stream where bullfrog control has been implemented.

Non-Native Mussels and Snails

Due to the recent discovery of the non-native zebra mussel in northern California reservoirs, a monitoring program has been enacted to determine the local source of the invasions and to identify solutions. The California Department of Fish and Game, the Department of Water Resources, and the Santa Clara Valley Water District have taken the lead on the monitoring effort. The Santa Clara Valley Water District has scheduled a visual inspection of the San Felipe Division intakes in San Luis Reservoir. This subsurface inspection will be conducted with the help of a remotely operated vehicle. The district is also working on performing subsurface inspections of other reservoirs in the study area. The goals of the monitoring are to determine if zebra mussels are present in any SCVWD reservoirs. Test plates will be installed at Calero and Anderson reservoirs and at the San Felipe Division intakes. The test plates are a Plexiglas substrate that is commonly used to detect colonies of zebra or quagga mussels. The plates will remain in the reservoirs for at least a month.

The SCVWD has formed a task force with the Alameda County Water District (ACWD) and the Zone 7 Water District in Livermore to coordinate monitoring efforts. The SCVWD has also set up an internal task force to manage the threats of both zebra and quagga mussels.

Similar efforts will need to be taken to monitor the spread of New Zealand mud snails.

Disturbance

Within the context of this Plan, a disturbance is a temporary or intermittent change in environmental conditions that causes a pronounced change in an ecosystem. Ecological disturbances include natural events such as fire, drought, and flooding as well as nonnatural or anthropogenic events such as habitat fragmentation through development or the introduction and spread of nonnative species (Dale et al. 2001).

Monitoring will record the frequency, intensity and location of natural disturbance events, and these results will be compared to historic incidence of disturbance in an attempt to foster natural disturbance, as feasible. In general, flooding will be allowed within the Reserve System and in identified natural areas outside the Reserve System. (See the *Natural Flood Protection* section in Chapter 5.) A more detailed description of the fire-containment policy and in instances where fires will be allowed to burn is found in Chapter 5 (*Minimum Impact Fire Suppression Techniques*).

Disease

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

Disease must be carefully monitored in the Reserve System. Measures to reduce the spread of disease during monitoring activities will be taken by the Implementing Entity or its contractors. Monitoring includes identifying serious outbreaks, quantifying changes in infection rate or target diseases, and determining the impact on plant and wildlife populations, when applicable. Diseases must be identified and prioritized regionally for eradication or control when possible. Efforts to eradicate or control existing infected species and to prevent the spread of pathogens in the Reserve System will be coordinated with other land and resource management agencies in the study area and the region. In particular, monitoring diseases that affect covered and other native species will be coordinated with the Santa Clara County Division of Agriculture, the agency that monitors animals that serve as human disease vectors in the County. When feasible, large private landowners adjacent to the Reserve System will also be involved. Coordination could include sharing costs, staff, and equipment and conducting joint monitoring programs to address the regional problem of disease.

Sudden oak death (SOD), caused by the pathogen *Phytophthora ramorum*, is a serious threat to oak woodlands and mixed evergreen forests in northern California and an example of one of the diseases that will be monitored within the study area. Several species of trees in the study area have been identified as hosts to this pathogen: coast live oak, California black oak, California bay laurel, madrone, California buckeye, and big-leaf maple (Davidson et al. 2003). In addition, there are several instances of confirmed SOD near or at the border of the study area. SOD appears to be widespread along the northwestern portion of the Santa Clara County border, just outside the study area[1]. There is also a confirmed incidence of SOD at the border of the Almaden Quicksilver County Park. Trees near the Almaden occurrence will be monitored frequently.

Several consortiums and organizations have been formed to manage and monitor this critical issue. The California Oak Mortality Task Force—a coalition of research/educational institutions, public agencies, nonprofit organizations, and private interests including agencies such as the USDA Forest Service, the National Park Service, the California Department of Forestry, and the University of California—is focused on establishing appropriate monitoring regimes for the disease. The University of California's Center for the Assessment and Monitoring of Forest and Environmental Resources (CAMFER) is working with

[1] See recent maps at: <http://nature.berkeley.edu/comtf/html/comtf_organization.html>.

the California Oak Mortality Task Force and is implementing monitoring strategies at various levels. At a regional level, these organizations are combining aerial surveys with ground sampling[2]. At the landscape level, they are using remotely sensed data to determine the condition and pattern of trees with SOD, and at a local level, they have established research plots in various areas in Northern California that are examined every 2–3 months for various types of damage (Kelly and McPherson 2001). Monitoring efforts in the study area will be consistent with the methods used by these organizations.

Hydrologic Function

Maintaining the hydrologic function of the study area is a primary objective of this Plan (**Objectives 1a.1, 1a.2, and 1b.1** in **Table 5-1a**). Aquatic ecosystems—including streams, rivers, ponds, and wetlands—are structured by hydrological processes operating at multiple levels.

Hydrologic function can be broadly defined as the flow of water through a landscape and the processes controlled or influenced by those flows. Hydrologic functions are driven by precipitation and include infiltration, runoff, groundwater recharge, and the quality and quantity of water within channel networks and other water bodies.

The Plan has committed to maintaining and, where feasible, improving hydrologic function within the study area, as described in detail in Chapter 5, *Conservation Strategy*. To that end, the Plan will incorporate Water District data (e.g., water level, water temperature, turbidity, stream flow, impervious surfaces, groundwater) and augment when necessary with limited additional sampling stations to be identified in the first year of implementation and functioning within two years of implementation. Water quality monitoring requirements associated with development (*Condition 3. Maintain Hydrologic Conditions and Protect Water Quality*) will also be reviewed annually by the implementing entity to ensure that the goals of the Water Quality Condition are being met and that the condition is effective.

Impacts of Recreation

Recreation within the Reserve System will be monitored to determine if uses are having adverse effects on covered species that may be sensitive to human disturbance (e.g., San Joaquin kit fox, western pond turtle, covered plant species [**Table 4-1**]).

Monitoring will distinguish between different types of uses (e.g., hiking, horseback riding) that can have varying levels of impacts on covered species.

[2] They are also using the OakMapper website <http://kellylab.berkeley.edu/SODmonitoring/OakMapper.htm> to submit new incidents of infection.

Monitoring will also be designed to help inform if and when seasonal or other restrictions on recreational uses will be imposed in sensitive areas (e.g., in sensitive vegetation, near ponds that support covered amphibians and reptiles).

J.1.2 Landscape Monitoring Tools

Because most effectiveness monitoring takes place at the natural community and species levels, monitoring at the landscape level focuses on detecting changes in natural process that cannot be detected on smaller scales, such as community or species. This type of monitoring will ensure that impacts, as specified by the Plan, on biological resources are not exceeded; that preservation/enhancement, restoration and creation requirements are being implemented and met; that threats are being targeted and reduced; and that any large-scale issues affecting resources regionally are identified early and addressed. Following is a description of some of the tools that will be used to monitor status and trends at the landscape level.

Pre-Acquisition Assessments

Information on landscape features will be collected through pre-acquisition assessment and other field surveys that provide information on the extent and distribution of land cover types in the Reserve System. These data will be used to refine currently existing species habitat models. Additionally, this information will be combined with other 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). Results of pre-acquisition assessment will be merged with the results of other fieldwork to determine baseline conditions and to evaluate future changes against that baseline.

Remote Sensing

At the landscape level, the Implementing Entity will monitor, using aerial photos or satellite imagery, the extent and distribution of Plan land cover types within the study area every 5 years. Land cover mapping will be verified in the field at sites where air photo interpretation is difficult. Current species models (**Appendix D**) reflect the landscape-level data available at the time of the writing of this Plan (December 2006). Species models will be improved as new data become available.

Additionally, landscape-level information generated through pre-acquisition assessments and other surveys will be crosschecked against periodic updates to the land cover map from aerial photos or satellite imagery described above. The Implementing Entity will coordinate landscape-level monitoring with future regional mapping efforts that may be conducted by others within the study area (e.g., The Nature Conservancy, CDFG).

Mapping of Invasive Plants

The goals of the Invasive Plant Control Program described in Chapter 5 are to control the spread of noxious weeds (as defined by the California Department of Food and Agriculture) and invasive exotic plants listed by the California Invasive Plant Council (California Invasive Plant Council 2007 or latest list) into new areas and to control infestations of noxious and serious weeds, where practicable. Within the Reserve System, the Implementing Entity will map occurrences of noxious weeds and invasive exotic plants as they are identified (by planning and other surveys) and periodically monitor these occurrences. The Implementing Entity will also prioritize control and removal efforts. The frequency of monitoring will depend on the threat that species pose to native biological diversity. For example, invasive plants that occur within the reserves and have the ability to spread rapidly will be monitored more frequently (e.g., several times per year). Species that spread slowly will be monitored less frequently (e.g., every 1–5 years). Additionally, Implementing Entity field staff will look for occurrences of new invasive plants that require immediate eradication or control actions within the Reserve System. Field workers will follow proper decontamination procedures prior to entering and exiting an area they are working in to stop spread of weeds, seeds, or disease between areas.

J.2 Natural Community Monitoring Issues and Tools

The Implementing Entity will conduct monitoring to assess ecosystem and natural community function. Natural community–level monitoring focuses on local resources and threats to communities and habitats as well as the response of each natural community to management actions (especially restoration and enhancement). Natural community monitoring includes, but is not limited to, the following issues relevant to the Plan.

- The extent and quality of natural communities and the relationships between their constituent elements.
- Natural community function including the ability of these communities to withstand natural and anthropogenic stressors and threats.
- The effectiveness of the conservation measures in enhancing, creating, or restoring natural communities and their associated features (e.g., ponds, riparian woodland) and the ability of these areas to provide their intended ecological functions and values.
- The response of keystone species (i.e., species such as California ground squirrels that affect the community in greater proportion than their relative abundance) to management actions.

- Community dynamics such as grassland burrow systems.

J.2.1 Natural Community Monitoring Issues

Following is a brief description of broad concepts and issues that are germane to natural-community-level monitoring. Specific monitoring actions are addressed by phase for each natural community in Section 7.3.2 *Natural Community–Level Actions*.

Removal or Disturbance of Keystone Species

A keystone species is one that affects its environment disproportionately more than its abundance or biomass would suggest (Paine 1969; Power et al. 1996). An important component of natural community monitoring is the identification of any keystone species that strongly influence relationships within that community. An example of a keystone species in the study area is California ground squirrel. This species' burrows provide nesting habitat for western burrowing owl and upland refugia for California red-legged frog and California tiger salamander. In addition, California ground squirrel is an important prey item for many grassland-associated species, including the San Joaquin kit fox, which is a covered species. Accordingly, California ground squirrel is recognized as a keystone species for grasslands and will be monitored in grasslands as a measure of the effectiveness of that natural community to support the covered species that depend on ground squirrels. The effect of coyotes on red fox, as well as the effect of mountain lions on deer herbivory and raccoons on red-legged frogs and pond turtles, could also be considered keystone species. Other keystone species will be identified as the conceptual models are developed.

Predation by Nonnative Species

Predation plays a pivotal role within many natural communities, and the presence or absence of predators can strongly influence community dynamics. While predation is often defined to include herbivory, for the purposes of this Plan, grazing is described separately below. Predation has an ecological role at the community level. Primarily, predation regulates prey populations, which in turn affects community structure. In short, the absence of natural predators can cause abnormal levels of prey populations, thereby affecting the structure and composition of the plant community. An intermediate intensity of predation is associated with high prey diversity by promoting the competitive exclusion of some prey species (Begon et al. 1996). The presence of invasive or nonnative predators can severely disrupt native prey populations that have not evolved defense mechanisms in response to those predators.

Examples of predation and its potential effect on natural communities include feral cats that affect wildlife relationships in riparian and grassland natural communities by altering the nest success of native songbirds and reducing populations of native rodents, which in turn suppresses the prey base for many native raptors and carnivores (Begon et al. 1996). In grasslands, nonnative red foxes outcompete native foxes (e.g., San Joaquin kit fox) by reducing the prey base of native rodents (Hall 1983; Berry et al. 1987; Ralls and White 1995), which also affects native raptors. Within the study area, a potentially significant cause of red-legged frog decline is predation by nonnative bullfrogs (Lawler et al. 1999).

Nonnative species (e.g., red fox, bullfrogs and some nonnative fish) will be controlled if data indicate that the impacts from predation and/or competition on covered species or natural communities preclude the successful implementation of the conservation strategy described in Chapter 5 of this Plan. The patterns of predation between species will be examined for each natural community.

Altered Fire Frequency

Fire is an important form of disturbance with particular relevance to chaparral, grassland, and oak woodland communities (see description of fire and its role in natural communities in Chapter 3). It is unclear how fire patterns in the study area have changed over time, and additional study is required to attempt mimicry of historic fire regimes (if feasible). In southern California the frequency of fire in shrublands is thought to be as frequent or more frequent in the twentieth century than it was in the nineteenth century (prior to fire suppression activities), partly because fire suppression activities have been ineffective at reducing fire frequency in shrublands (Keeley et al. 1999; Keeley and Fotheringham 2001). The frequency of severe weather conditions (i.e., low humidity, high winds, and drought) and the number of people with access to stands (providing an ignition source) appear to play much more important roles than do vegetation conditions in determining fire risk. Fire management is discussed in detail in Chapter 5, *Conservation Strategy*, and fire history in the study area is depicted in **Figure 10-1**.

Prescribed burning is an important tool to restore the historic patterns of fire in natural communities in the study area. It will be necessary to monitor the impacts of unplanned and prescription burns on native and nonnative vegetation within the Reserve System. Vegetation sampling to document a baseline condition for comparison will precede prescribed burning. The result of this monitoring will inform the effectiveness of burning as a tool to regenerate grassland, chaparral, and oak woodland natural communities. The purpose of burning is to reduce the biomass of nonnative vegetation while encouraging regeneration of fire-adapted native species.

Livestock Grazing

Much of the flora of the study area evolved under the influence of prehistoric herbivores—large herds of deer (primarily a browser on shrubs and trees), elk, antelope, and other grazing animals. Grassland and in particular serpentine grassland communities can be greatly influenced by the intensity, timing, and type of grazing (for further description see Chapter 3). At present, livestock grazing utilizing cattle, sheep, or goats is an essential vegetation management tool to maintain and improve habitat conditions for some native plants and animals and to reduce fuel loads for wildfires (see Chapter 3).

Grazing in certain native grassland communities, however, may be inappropriate or may need to be reduced to maintain or enhance these communities. Accordingly, the response of native plant populations to grazing regimes in grasslands, shrublands, or other rangelands will be monitored. Further, the response of nonnative vegetation will also be monitored to determine which grazing rotation or which combination of rotations is most effective at reducing nonnative vegetation to an acceptable level. These surveys can be supplemented with other evaluation of other natural community metrics such as percent of native shrub cover and overall species richness. Grassland songbirds can be monitored during the breeding season to measure species diversity and richness relative to each grazing regime. They can also be monitored as an effective surrogate to measuring overall grassland structure (e.g., percentage of ground cover, height of vegetation). In some grassland communities the presence of particular songbird species could be used as a surrogate for grassland health. These techniques will be explored during the targeted studies phase of implementation. Compliance monitoring will ensure that the livestock are grazing at the HCP-required levels.

Altered Stream Flow

The diversity and abundance of aquatic organisms are shaped by six primary factors: flow regime (the pattern of water quantity over time); water quality; physical habitat (e.g., the morphology of a stream channel); food-web productivity; interactions with other species; and the connectivity between habitats, both longitudinal (upstream–downstream) and lateral (channel–floodplain). The flow regime has been called the “master variable” because it can strongly influence all the other factors (Poff et al. 1997). For example, the physical structure of a stream channel is shaped during floods as high-energy flows erode the channel and floodplain in some locations and simultaneously deposit sediment in other locations.

The flow regime is a function of watershed-level patterns of precipitation and runoff, which are strongly influenced by vegetation cover, underlying geology, and land use. For example, impervious surfaces can lead to a “flashier” runoff regime—higher peak flows and lower base flows—by reducing the amount of precipitation that infiltrates the ground. Thus, more precipitation rapidly reaches the channel network and less infiltrates into shallow groundwater to support baseflows during periods of low or no precipitation. Changes in flow regime strongly affect the quality of habitat for covered species within the aquatic and riparian land cover types and influence the structure and composition of the riverine and riparian natural communities. Because of their importance, the hydrological variables listed below will be monitored within the study area.

- **Baseflows.** Monitoring of baseflows over the entire year will ensure that sufficient water exists during critical stages of the lifecycle of target organisms (e.g., rearing of juveniles, upstream and downstream passage). SCVWD monitors stream flow releases at its reservoirs and at other stream flow gauges
- **Flooding and droughts.** In target areas, managed flooding or drybacks or processes that mimic flooding and drought will be implemented to create scour or tree mortality and to promote a variety of successional stages of riparian forest and scrub.
- **Temperature.** This important ecological variable is strongly influenced by the flow regime and impacted by changes to runoff associated with land clearing and development. Temperature measurements are already taken by SCVWD and will be supplemented by the Implementing Entity, as described earlier under *Hydrologic Function*. .

J.2.2 Natural Community Monitoring Tools

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

Conceptual Ecological Models

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

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

- by providing a basis from which to test assumptions about the relative importance of certain processes,
- by helping to identify threats or stressors that require monitoring,
- by identifying species or other attributes that function as indicators,
- and by serving as a repository of the changing understanding of the system as more data become available.

Conceptual models can also be used to communicate understanding of the system to other scientists and the public and to facilitate review by outside experts. Numerous studies have confirmed that the use of conceptual models greatly assists the development of monitoring and adaptive management programs (Elzinga et al. 2001).

Models can be either narrative or diagrammatic. In most cases, diagrams show the hypothesized relationships that characterize the ecosystem and are supplemented by written materials. Several types of models can be used, including stress-response models and habitat models (e.g., those developed for species accounts **Appendix D**). In one stress-response model (**Figure 7-6**), stressors and threats are aligned along the left tier of the model, the central tier displays habitat responses, and the right tier shows hypothesized responses of covered species. An example of a more complex stress-response model is shown in **Figure 7-7**.

A conceptual ecological model was developed for the Grassland habitat type (**Figure 7-8**). It provides guidance for the development of additional models and shows how that modeling process can help to elucidate assumptions and directly inform monitoring. In the inventory phase, the Implementing Entity will develop conceptual models for each natural community type. A critical task in the development of these models is the identification of uncertainties and threats or stressors. The identification of uncertainties provides a springboard for additional targeted studies. The models will also incorporate the anticipated effect of management actions on natural communities.

Natural Community Inventory Protocols

Once a parcel for the Reserve System has been acquired, a thorough vegetation and wildlife community inventory will be conducted. The inventory will build on the results of the pre-acquisition assessment. This inventory will draw as much as possible from accepted protocols for typing vegetation communities and wildlife habitats. These typing protocols include the California Native Plant Society "Vegetation Rapid Assessment Protocol" (California Native Plant Society 2002) and "Releve Protocol" (California Native Plant Society 2003) for plants. Another option is DFG's Keeler-Wolf "protocols." Protocols are updated frequently and the most recent or most appropriate protocols at the time of assessment will be used. Vegetation associations and alliances will be classified and mapped in more detail than the regional land cover classification used in this Plan to provide more accurate mapping and finer units to monitor over time. Streams will be mapped and included as one of the land-cover types addressed in the inventory protocols.

Similarly, acquired parcels will be surveyed for natural communities (including covered species habitats), invasive species, and other potential disturbances. Survey protocols will be developed by the Implementing Entity during the initial phase of implementation and additional details provided in the system-wide monitoring plan. These protocols will evolve through time. Where up-to-date protocols exist for a particular species, those will be used. Such protocols will include protocols in use by any of the wildlife agencies or those developed by scientific processes (as in the protocols developed for burrowing owls for the Burrowing Owl Consortium). Other specific protocols that may be used for wildlife include live trapping, vocalizations/recordings, mist netting, observation scans, search transects or plots, infrared camera stations, and identification and mapping of tracks and scat.

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

Monitoring Community Function

Conserving, restoring, and managing ecosystem function is a requirement of the NCCP Act[3]. Often, biotic or abiotic indictors are used to assess function. In this Plan conceptual models will be used to identify attributes selected for monitoring. For example, songbirds may be monitored across terrestrial habitat types as a guide to measuring overall natural community structure and function. Bay checkerspot butterfly may provide important information regarding the health of remnant native grasslands and serpentine plant communities (Launer and Murphy 1994). This information will be used in conjunction with an understanding of drought situations and a balance with water-supply needs. Measuring vegetation, benthic invertebrates, or arthropod species diversity may also be indicators of community function. It is important to recognize that covered species monitoring is not the metric by which communities are evaluated under the Plan and that the conceptual models will guide development of monitoring for community function.

Evaluating Creation, Enhancement, and Restoration

One of the main components of natural community monitoring will be the assessment of natural community enhancement, restoration, and creation actions. Monitoring of enhanced, created, or restored habitat will focus on the community or habitat response and, where applicable, species response. Because natural communities are likely to occur in different stable states, determining the desired restoration goals is a complex but necessary first step (Hobbs and Norton 1996). The targeted studies phase will establish a range of measures or success criteria to evaluate restoration efforts for each natural community. This monitoring will ensure that the restored natural communities are functioning as habitat for particular covered species or suites of species associated with the subject communities. **Table 7-1** lists examples of standards and objectives that may be

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

the basis for assessing success of natural community enhancement, creation, and restoration conservation actions.

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

1. Identify processes leading to decline (relevant to restoration projects).
2. Develop methods to ameliorate degradation or decline (relevant to restoration projects).
3. Determine realistic goals for functional ecosystems that still result in the creation of an ecosystem with similar ecological values to local equivalents.
4. Develop relevant, easily observable success criteria.
5. Develop practical techniques for implementing these goals and ensure that they are commensurate with the problem.
6. Document and communicate these techniques.
7. Adaptively manage the system.

The Plan has accounted for the financial costs of the monitoring program and the Implementing Entity will maximize efficiencies to determine where conservation dollars are best spent. This Plan provides example success criteria for the restoration/enhancement of each natural community type (**Table 7-1**). These recommendations are preliminary and are intended to guide future efforts and provide a tangible idea of the nature of the desired criteria. More permanent criteria will be established during the first five years of Plan implementation. It is beyond the scope of this Chapter 7, *Monitoring*, and this appendix to establish the final criteria for successful management and restoration. Moreover, other conservation planning efforts that have provided too much detail too early in the process have resulted in criteria that were ill-considered and inadequate and that needed to be amended during plan implementation (B. Johnson pers. comm.). The approach used in developing this Plan strives to provide the necessary guidance for developing rigorous and defensible criteria while providing flexibility for Plan implementation and the additional work, including pilot projects that will be conducted during the early phases of the Plan.

J.3 Species Monitoring Issues and Tools

The Implementing Entity will conduct monitoring to assess the status of covered species and to determine the extent to which the biological goals and objectives for species are being met. Species monitoring will address the following issues relevant to the Plan.

- The response of covered species to Plan conservation actions and adaptive management.
- Status and trends of covered species and other relevant species on reserve lands and in streams.

- Trends in abundance for selected indicator species over the term of the Plan.
- The response of plant populations to impacts resulting from covered activities (Condition 22).

J.3.1 Species-Specific Monitoring Tools

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

Surrogate Species

It may be difficult to detect individuals of certain species due to small body size, rarity, or behavior. In such cases, other species can be used as surrogates for covered species that are difficult to monitor. The Implementing Entity will document the rationale for using surrogates. A more general discussion on indicator species is provided in Section 7.2.4 *Guidelines for Monitoring*.

Focal Covered Species

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

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

Habitat Indicators for Species

Selecting the best attributes by which to measure the population status of covered species increases the effectiveness of monitoring. Monitoring adult abundance and distribution of covered species is often the most appropriate, direct measure of status. However, in many cases monitoring protocols for certain species yield variable and imprecise results or require a prohibitively expensive sampling effort. In these cases key habitat variables may be used—in conjunction with other information—to evaluate species status. This method requires targeted studies to verify the relationship between the habitat attribute and the species status and will be periodically retested to ensure that the relationship between the indirect indicator and the condition of the species does not change. See *Indicators* in Section 7.2.4 *Guidelines for Monitoring* for additional information on selection of biotic and abiotic variables. An effective monitoring program balances efficiency and cost effectiveness with the reliability of the information obtained.

Species Models

Species-Habitat Models

Parameters for the existing species-habitat models (**Appendix D**) will be refined and revised throughout Plan implementation as more information becomes available. At a minimum, models will incorporate any new land cover information that becomes available as part of the periodic update of GIS layer with aerial photographs or satellite imagery (every five years). Models will also be updated when new scientific or on-the-ground information that influences model outcome becomes available. If possible, species-habitat models will be developed for those species that did not have models developed for this Plan.

These species-habitat models document the best current understanding of the biological and physical parameters that influence each species and, in this way, are species-specific conceptual models. Species-habitat models were developed for most covered species using GIS to hypothesize a relationship between land cover type and other habitat associations and the distribution of covered species. These models (**Appendix D**) have served as the basis for estimating impacts and prioritizing land acquisition. Information from the pre-acquisition assessment and post-acquisition inventories will further refine these models such that they can be used to help predict distribution and occupancy and to assess population trends. Species occurrence information on Reserve Lands will also be used to update species models.

Species Conceptual Models

As described above, conceptual models are an important component of the Monitoring and Adaptive Management Program. In addition to ecological models, conceptual models will be developed for covered species as well. The priority of model development for each species group is defined in Section 7.3.3 *Species-Level Actions*. An example species conceptual model was developed for the California tiger salamander (**Figure 7-9**). It provides guidance for the development of additional models and shows how the modeling process can help to elucidate assumptions and directly inform monitoring. In the inventory phase, the Implementing Entity will develop conceptual models for Group 1 species. A critical task in the development of these models is the identification of uncertainties and threats or stressors. The identification of uncertainties provides a springboard for additional targeted studies. The models will also incorporate the anticipated effect of management actions on covered species.

J.4 References Cited

J.4.1 Printed References

Atkinson, A. J., P. C. Trenham, R. N. Fisher, S. A. Hathaway, B. S. Johnson, S. G. Torres, and Y. C. Moore. 2004. *Designing Monitoring Programs in an Adaptive Management Context for Multiple Species Conservation Plans*. (U.S. Geological Survey Technical Report.) Sacramento, CA: U.S. Geological Survey Western Ecological Research Center.

Begon, M., J. L. Harper, and C. R. Townsend. 1996. *Ecology: Individual, Populations and Communities.* Malden, MA: Blackwell Sciences.

Bennet, A. F. 2003. *Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation.* IUCN, Gland, Switzerland and Cambridge, UK. Pp. 254.

Berry, W. H., J. H. Scrivner, T. P. O’Farrell, C. E. Harris, R. T. Kato, and P. M. McCue. 1987. *Sources and Rates of Mortality of the San Joaquin Kit Fox, Naval Petroleum Reserve #1, Kern County, California, 1980–1986.* (U.S. Dept. of Energy Topical Report, EG&G/EM Santa Barbara Operations Report No. EGG 10282-2145.)

California Invasive Plant Council. 2007. Cal-IPC Invasive Plant Inventory (on-line database). Available: < http://portal.cal-ipc.org/weedlist>.

California Native Plant Society. 2002. Relevé Protocol CNPS Vegetation Committee. Last revised: February 5, 2003. Available: <http://www.cnps.org/archives/forms/releve.pdf>.

California Native Plant Society. 2003. Vegetation *Rapid Assessment Protocol CNPS Vegetation Committee.* Last revised: February 5, 2003. Available: <http://www.cnps.org/vegetation/rapid_assessment_protocol.pdf>.

Dale V.H., Joyce L.A., McNulty S, Neilson R.P., Ayres M.P., Flannigan M.D., Hanson P.J., Irland L.C., Lugo A.E., Peterson C.J., Simberloff D., Swanson

F.J., Stocks B.J., Wotton M.B. 2001. Climate change and forest disturbance. *BioScience*; 51: 723–734.

Davidson, J. M., S. Werres, M. Garbelotto, E. M. Hansen, and D. M. Rizzo. 2003. *Sudden Oak Death and Associated Diseases Caused by* Phytophthora ramorum. Plant Health Progress doi:10.1094/PHP-2003-0707-01-DG. Available: <http://www.suddenoakdeath.org/>/.

Elzinga, C.L, D.W. Salzer, J.W. Willoughby, and J.P. Gibbs. 2001. *Monitoring Plant and Animal Populations*. Blackwell Science, Inc., MaIden, MA.

Hall Jr., F. A. 1983. *Status of the San Joaquin Kit Fox*, Vulpes macrotis mutica, *at the Bethany Wind Turbine Generating Project Site, Alameda County, California.* California Department of Fish and Game.

Hobbs, R. J., and D. A. Norton. 1996. Towards a Conceptual Framework for Restoration Ecology. *Restoration Ecology* 4(2): 93–110.

Keeley, J. E., and C. J. Fotheringham. 2001. Historic Fire Regime in Southern California Shrublands. *Conservation Biology* 15:1536–1548.

Keeley, J. E., C. J. Fotheringham, and M. Morais. 1999. Reexamining Fire Suppression Impacts on Brushland Fire Regimes. *Science* 284:1829–1832.

Kelly, M. and B. A. McPherson. 2001. Multi-Scale Approaches Taken to SOD Monitoring. *California Agriculture* 55:15–16

Lambeck, R.J. 1997. Focal Species: A Multi-species Umbrella for Nature Conservation. *Conservation Biology* 11(4):849-856.

Launer, A.E., and D. D.Murphy. 1994. Umbrella species and the conservation of habitat fragments: a case of a threatened butterfly and a vanishing grassland ecosystem. *Biological Conservation* 69:145–153.

Lawler, S.P., D.D. Dritz, T. Strange, and M. Holyoak. 1999. Effects of Introduced Mosquitofish and Bullfrogs on Threatened California Red-legged Frog. *Conservation Biology*. 13(3): 613-622.

Mayer, K.E. and W.F. Laudenslayer, Jr, eds. 1988. A Guide to Wildlife Habitats of California. State of California Resources Agency, Department of Fish and Game. Sacramento, CA. 166 pp.

Paine, R.T. 1969. A Note on Trophic Complexity and Community Stability. *The American Naturalist*. 103(929):91–93.

Poff, N L., J.D. Allan, M.B. Bain, J.R. Carr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, J.C. Stromberg. 1997. The Natural Flow Regime: A Paradigm for River Conservation and Restoration. *BioScience* 47(11).

Power, M.E., D. Tilman, J.A. Estes, B.A. Menge, W.J. Bond, L.S. Mills, G. Daily, J.C. Castilla, J. Lubchenco, and R.T. Paine. 1996. Challenges in the quest for keystones. *Bioscience* 46: 609–620.

Ralls, K., and P.J. White. 1995. Predation on San Joaquin Kit Foxes by Larger Canids. *Journal of Mammalogy* 76:723–729.

Williams, B.K., C. Szaro, and D. Shapiro. 2007. *Adaptive Management: The U.S. Department of the Interior Technical Guide.* Adaptive Management Working Group, U.S. Washington, DC: Department of the Interior.

J.4.2 Personal Communications

Diamond, Tanya. Biologist. California Department of Fish and Game. Summer–Fall 2007—various email exchanges with Troy Rahmig, Jones and Stokes.

Johnson, Brenda. California Department of Fish and Game; Habitat Conservation Planning. December 14, 2007.