7.0 SECTION CONTENTS

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7.0 MONITORING AND ADAPTIVE MANAGEMENT

7.1 OVERVIEW

The purpose of the Monitoring and Adaptive Management section is to describe the framework for monitoring and how the anticipated results will direct management on the Solano HCP reserve system. The overall goals of the Monitoring and Adaptive Management Program for the Solano HCP are:

- To preserve, protect, and enhance natural communities within the Solano HCP reserve system for the benefit of Covered Species, Special Management Species and other native plants and animals.
- Minimize the uncertainty associated with managing Covered Species and natural communities where there are gaps in the available scientific information on their biological requirements.
- Incorporate new information on the life history or ecology of Covered Species and natural communities generated through continuing research.

7.1.1 Adaptive Management

Adaptive management provides a framework for confronting uncertainty in natural resources issues (Holling 1978, Walters 1986). An adaptive management approach, acknowledges that managed resources will always change as a result of human intervention, that surprises are inevitable, and that new uncertainties will emerge. Uncertainties do not paralyze management actions nor are they ignored. Instead, uncertainties are dealt with via an active learning approach (i.e., policies are experiments).

Since its development in the early 1970s, adaptive management has been defined in various ways. Different people and organizations continue to have somewhat differing views of the best definition. The California NCCP Act of 2002 defines adaptive management as the use of results of new information gathered through the monitoring program of the plan and from other sources to adjust management strategies and practices to assist in providing for the conservation of Covered Species. USFWS (1996) and the Five-point Addendum (USFWS 2000) defines adaptive management as a method for examining alternative strategies for meeting measurable biological goals and objectives, and then, if necessary adjusting future management actions according to what is learned. The USFWS further argues that the key component in making the adaptive process meaningful includes careful planning through identification of uncertainties, incorporating a range of alternatives, implementing a sufficient monitoring program to determine success of the alternatives, and a feedback loop from the results of the monitoring program that allows for change in the management strategies. Figure 7-1 presents a conceptual model of the adaptive management feedback loop. The purpose of the adaptive management feedback loop is to ensure that the conservation goals and objectives for Covered Species and natural communities are being met.

Although the adaptive management strategy anticipates future modifications to implementing the Conservation Program, the alternative conservation strategies are subject to the same limits as other provisions of the Solano HCP consistent with the FWS's "No Surprises" policy. That is, conservation measures and management schemes may be modified or new measures substituted as long as the new measures are of roughly equivalent cost and are consistent with approved take assumptions. Procedures for modifications and amendments to the Section 10(a) permit are described in Section 10.10.

7.1.2 Monitoring

Monitoring is mandated under the ESA (USFWS 1996, USFWS 2000) to demonstrate compliance with the respective incidental take conditions and to provide "feed-back" information for adaptive management actions implemented under the HCP. The two main components of monitoring are: compliance monitoring and effectiveness monitoring. Compliance monitoring is verifying that the terms of the HCP, permit, and IA are being carried out. In other words, compliance monitoring tracks the status of HCP implementation, ensuring that planned actions (e.g., conservation measures) are being properly executed as written in the Plan (see Section 10.6). Effectiveness monitoring evaluates the effectiveness of the operating Conservation Program of the HCP and whether the assumptions and predictions made during the development of the Plan hold true (USFWS 2000). Based on the U.S. Fish and Wildlife Service's "5-Point Policy" for Habitat Conservation Plans there are several components to effectiveness monitoring, including the evaluation of incidental take. However, this section of the HCP deals with effectiveness monitoring associated with achieving the biological goals and objectives. In this Plan, this component of effectiveness monitoring is referred to as Biological Effectiveness Monitoring.

Biological Effectiveness Monitoring is the measurement of variables that allow the program to assess the success of the HCP in meeting its stated biological goals and objectives. Biological effectiveness monitoring evaluates the effects of the planned actions, by measuring biologically meaningful variables, and determining whether the operating Conservation Program of the HCP (i.e., implementation of the avoidance and minimization measures, conservation measures and preserve management) are successfully achieving the biological objectives. The assumption made in the Conservation Program is that if the conservation measures are proper implemented these actions will collectively achieve the stated biological goals and objectives. The purpose of Biological Effectiveness Monitoring is to track the validity of this assumption (USFWS 2000).

7.1.3 Scientific Principles

Monitoring is an important tool in an adaptive management approach and should be designed in a way that ensures data will be properly collected, analyzed and used to adjust conservation and management strategies. The Five Point Policy Guidance (USFWS 2000) states: "In order to obtain meaningful information, the applicant and the Services should structure the monitoring and standards so that the results from one reporting period to another period or compare different areas, and the monitoring protocol responds to the question(s) asked." In addition, it states that, "The monitoring program will be based on sound science." To ensure that the monitoring program will be based on sound science, specific monitoring protocols developed will employ a set of scientific principles.

These principles will establish the standard for collection, analysis and interpretation of data generated from the program. These principles include:

1. Define monitoring objectives as specific hypotheses or questions.
2. Further define hypotheses using conceptual, statistical, or other types of models. This will ensure that the assumptions in the hypotheses are stated *a priori* to data collection.
3. Whenever possible, use power[1] analyses and probability-based sampling techniques to select the number and location of sampling units. This will ensure sufficient rigor in the monitoring protocols and targeted studies so that the results may be able to robustly address the question(s) asked.
4. Replicate in space and time, the number of sites surveyed during monitoring and those receiving a treatment/management action and avoid psuedoreplication[2].
5. Explicitly describe the methods and the assumptions of the methods used to collect and analyze data.
6. Adjust the sensitivity of the data to reflect true changes in the resources being sampled. For example, adjust count data or measurements of occupancy with an estimate of detection probability.

Employing the use of sound science in the monitoring program is critical for ensuring the success of adaptive management because monitoring and targeted studies are integral tools when employing an adaptive approach.

7.2 STRUCTURE OF MONITORING AND ADAPTIVE MANAGEMENT FOR THE SOLANO HCP RESERVE SYSTEM

Implementation of the Monitoring and Adaptive Management Program for the Solano HCP will be administered at two levels: over the entire Plan Area and on individual reserves (Figure 7-2). A Plan wide Biological Effectiveness Monitoring Program will be administered by the SCWA (See Section 7.0), encompass all three levels of monitoring (landscape, natural community and species), and will be funded through user fees. Section 7.4 provides the basic framework, objectives, and methodology for this Program.

Management of reserves, baseline surveys of mitigation areas, and any additional monitoring, such as invasive species monitoring and post-construction maintenance and performance monitoring for restored wetlands, will be administered by individual mitigation banks and/or private-project specific mitigation lands (See Sections 7.3 and 10.5: Figure 7-2). In order to maintain consistency of management on reserves and preserves, all reserves and preserves established under the Solano HCP will be required to have a Resource Management Plan and if applicable a Restoration and Enhancement Plan approved by the SCWA (See also Sections 10.5). The SCWA will develop a more specific template for these Plans.

[1] A power analysis determines the power of a statistical test to reject the null hypothesis when the specified alternative is true. Power for a specified alternative hypothesis is defined as 1-β, where β is the probability of making a type II error (Underwood 1997).

[2] Psuedoreplication is defined as the use of inferential statistics to test for treatment effects with data from experiments where either treatments are not replicated (though samples may be) or replicates, are not statistically independent (Hurlbert 1984).

7.2.1 Framework for Adaptive Management on Reserves

All existing mitigation banks in the County are required to include funding in their endowments to modify management activities in response to new information (e.g., adaptive management). The types of potential modifications that are anticipated and funded for established reserves include, but are not limited to:

- changes in stocking rates or livestock,
- modification of grazing seasons,
- elimination of grazing, and
- increased weed abatement or changes in control methods.

The adaptive management funding for the existing banks, however, is generally insufficient to test management hypotheses across the full spectrum of resources at the individual banks. As a result, the Solano HCP provides the basic framework and approach for the adaptive management program. SCWA will oversee and implement the Biological Effectiveness Monitoring Program which will be focused on the success of the reserve system in meeting the biological goals and objectives with funding provided through user fees (see Section 11.1.3). SCWA will further provide guidance to participating mitigation banks and private reserves/mitigation sites regarding changes in the management plans that need to be implemented to maximize conservation values. Funding for existing banks and reserves is currently held by other third parties (generally either the CDFG or Solano Land Trust). In the future, SCWA may seek to acquire and administer the endowment funds from CDFG in order to pool the funds with reserves and mitigation sites under the HCP administration. This would allow for more efficient implementation of adaptive management on established reserves.

Other changes in management activities that may be required to address potential broader, regional issues such as disease and predation will be directed by SCWA and funded through user fee funds (see Section 11.2 for further discussion of applicable HCP programs and funding commitments).

7.3 INDIVIDUAL RESERVE MONITORING AND ADAPTIVE MANAGEMENT

Management of individual reserves as well as baseline surveys of mitigation areas, and any additional monitoring, such as invasive species monitoring and post-construction maintenance and performance monitoring for restored wetlands, will be administered by individual mitigation banks and/or private-project specific mitigation lands (see Section 10.5: Figure 7-2). In order to maintain consistency of management on reserves and preserves, all reserves and preserved established under the Solano HCP will be required to have a Resource Management Plan and if applicable a Restoration and Enhancement Plan approved by the SCWA (see also Sections 10.5.3 and 10.5.4). The SCWA will develop a more specific template for these Plans. There are standard requirements for the Resource Management Plans and the Restoration and Enhancement Plans for all reserves established under the HCP (see Section 7.3.1 and 7.3.2). Additional management and monitoring requirements for individual reserves will also depend which Avoidance and Minimization Measures or Conservation Measures were applicable in the reserves establishment (e.g., is the reserve a riparian buffer area or does it provide Swainson's hawk foraging habitat mitigation?) (Table 7-1). In general, monitoring of all habitat features established on reserves (restored wetlands, riparian plantings, Swainson's hawk

nest trees, artificial burrows for burrowing owls or burrow densities, etc.), effectiveness monitoring associated with Avoidance and Minimization Measures and Conservation Measures (e.g., effectiveness of buffers in maintaining natural hydrology), and additional Covered Species monitoring on reserves will be the responsibility of individual mitigation banks and/or private-project specific mitigation lands.

7.3.1 Resource Management Plans

Each reserve shall have a Resource Management Plan that includes the following minimum criteria:

1. Prepared by a qualified person(s) experienced in the development and implementation of restoration, mitigation, and management plans for the respective communities.
2. List and prioritize all potential threats to the natural communities present within the preserve/reserve.
3. Control measures and programs for highly invasive exotic and noxious weeds. These programs shall be conducted in perpetuity and shall include annual surveys to visually assess and identify weed infestations and identify annual control measures.
4. Control measures for invasive and destructive nonnative animal species (e.g., wild pigs and bullfrog). These programs shall be conducted in perpetuity and shall include annual surveys to visually assess and identify new infestations and appropriate control measures.
5. Resource management plans for sites in annual grasslands shall include measures for removal of thatch and standards for reducing or controlling annual grass heights, particularly in valley floor and vernal pool grassland areas. Livestock grazing is the generally preferred method for control. Grazing requirements shall specify stocking rates, desired grass maximum heights by season, end of grazing season residual dry matter requirements, and applicable grazing seasons. In smaller urban reserves, reserve fencing requirements shall be sufficient to exclude dogs from accessing reserves (to minimize harassment/harm to livestock). Where livestock grazing may not be practicable, provisions and funding for regular mowing of vegetation shall be required. In general, mowing shall be conducted 2 to 3 times per year: at the end of the rainy season (to reduce thatch and reduce wild fire fuel build up) and once to twice during the growing season to maintain grass heights between 2 and 6 inches in order to promote forb emergence and conditions preferred by burrowing owls).
6. Restrictions on rodent control to the maximum extent practicable. Natural habitat reserves and preserves[3] shall set aside zones for no rodent control. Control activities shall be limited to reserve/preserve edges where ground squirrels and other rodents could conflict with adjacent land uses. The recommended control zone width shall be no more than 450 feet[4], unless approved by SCWA in consultation with the Resource Agencies. If these distances are reduced, resource management plans shall include additional control efforts to confine rodent activity to the reserve as part of a good neighbor policy.

[3] Irrigated agricultural land preserves for Swainson's hawk and burrowing owl habitat mitigation are exempt from the rodent control restrictions.

[4] The 450-foot control zone is based on a review of literature that indicates the home range for a California ground squirrel rarely exceeds 450 feet of a burrow, with an typical home range 150 feet radius of a burrow system.

7. Installation, maintenance, and monitoring of artificial burrowing owl burrows/nest boxes shall be identified in the Resource Management Plan and funded as a line item of the management endowment.
8. Management and restoration plans need to incorporate measures to protect extant populations of Covered Species on the sites. Reserve and preserve managers are also encouraged to incorporate establishment of other Covered Species native to the habitats on the sites as part of any restoration and enhancement actions.
9. A management endowment that is acceptable to the long-term management entity and of sufficient amount to manage the property in perpetuity consistent with the approved management plan.
10. Management plans shall include provisions and funding for implementing adaptive management on the established reserves (see Section 10.5.5).
11. The management plan shall specify maintenance requirements and the responsibility for implementation, long-term ownership and/or management responsibility, annual reporting requirements, and a funding mechanism consistent with the HCP reserve design and management standards.

7.3.2 Restoration and Enhancement Plans

Mitigation banks and/or private-project specific mitigation lands that will involve habitat restoration and/or enhancement to fulfill Solano HCP Conservation Measure requirements shall also be required to submit restoration and enhancement plans to SCWA for review and approval (see Section 10.5.4). In general, acceptable habitat restoration and enhancement plans shall meet the following guidelines:

1. Restoration/enhancement shall occur in similar soil types or in soil types typically associated with the applicable community (e.g., vernal pool habitats should not be constructed in upland soil types unless it can be demonstrated that wetlands would naturally occur in such conditions).
2. The sizes, shapes, and depths of the target community (e.g., wetlands/vernal pools) or vegetation shall be of similar size, shape and relative density as natural communities on the same or similar soil types.
3. Construction activities for restoration and enhancement shall be avoided in areas of high habitat quality and relatively natural topography, construction activities shall be limited to areas where the natural community structure has been eliminated or severely disturbed/altered by past disturbances.
4. Revegetation activities shall be limited to native or wide-spread, non-invasive naturalized plant species common to the region.
5. Restoration and Enhancement Plans will include specific, measurable criteria (i.e., performance criteria) to assess success of the restoration/enhancement in meeting the goals and objectives of the Solano HCP Conservation Strategy. Any salvage, recovery, or restoration efforts shall incorporate the performance criteria outlined by the SCWA and have clearly defined goals and monitoring objectives consistent with the goals and objective of the Solano HCP.
6. Monitoring to assess performance shall occur for a minimum of 5 years or until fifth year/final performance criteria have been met for a minimum of 2 years without significant human

intervention (e.g., irrigation, replanting, regrading). The monitoring program shall include provision for remedial action as needed to correct deficiencies.

7. Monitoring reports will be submitted annually to SCWA for review and approval and annual reporting to the Resource Agencies.

7.3.3 Valley Floor Grassland and Vernal Pool

The reserve system for the Valley Floor Grassland and Vernal Pool Natural Community will consist of between 10,500 and 11,500 acres of habitat within High Value Vernal Pool Conservation Areas (Figure 4-9) and/or priority areas for future protection identified in Figure 4-27. The majority of this, between 8,700 acres and 9,700 acres, will be located within Subarea 1A or other potential vernal pool reserve areas outlined in Figures 4-8 and 4-27. A substantial component will also occur in areas in close proximity to urban development: 380 - 400 acres in Subarea 1B, 700 - 760 acres in Subarea 1C, 60 acres in Subarea 1D, 170 acres in Subarea 1E, 120 acres in Subarea 1G, and a minimum of 350 acres in Subarea 1F. These smaller areas will encompass the majority of the Contra Costa goldfield reserves. In addition to habitat preservation, a large component of the Conservation Strategy will consist of restoring between 270 to 400 acres of vernal pool wetlands within High and Medium Value Vernal Pool Conservation Areas. Given the range of conservation activities and reserve locations within the overall reserve system for this natural community, each reserve will have slightly different monitoring and management goals.

7.3.3.1 Adaptive Management. The primary management goal of the adaptive management program is to protect and/or enhance the biological values of the Valley Floor Grassland and Vernal Pool Natural Community by maintaining habitats that support native plants and animals associated with this Natural Community. Specific management goals intended to achieve this primary goal are: minimizing the accumulation of thatch from annual grasses, reducing the occurrence of noxious weeds, maintaining and enhancing hydrological integrity of preserved and restored wetlands and preventing accelerated erosion, and expanding the population levels of Covered Species and other native plants and animals on the site. The management prescriptions that will be implemented to achieve these goals are livestock grazing, weed control (herbicides, manual removal and mowing), and possibly prescribed burning.

Resource management plans for sites in annual grasslands shall include measures for removal of thatch and standards for reducing or controlling annual grass height. Livestock grazing is the generally preferred method for control. Grazing requirements shall specify stocking rates, desired grass maximum heights by season, end of grazing season residual dry matter requirements, and applicable grazing seasons. In smaller urban reserves, reserve fencing requirements shall be sufficient to exclude dogs from accessing reserves (to minimize harassment/harm to livestock). Where livestock grazing may not be practicable, provisions and funding for regular mowing of vegetation shall be required. In general, mowing shall be conducted 2 to 3 times per year: at the end of the rainy season (to reduce thatch and reduce wild fire fuel build up) and once to twice during the growing season to maintain grass heights between 2 and 6 inches in order to promote forb emergence and conditions preferred by burrowing owls).

Establishing patches of tall and dense nesting cover. Typical nest cover includes fairly tall (2 to 4 feet) and dense grass, weeds, marshy vegetation, or shrubs.

- In Valley Floor and Vernal Pool Grassland and California Red-legged Frog/Callippe Silverspot Conservation Areas, suitable areas within reserves for consideration of allowing nesting cover to establish include: old homesteads, corrals, or barn areas; ditches, streams, stock ponds, or marshy areas; or other waste areas which are separated from high value vernal pools, Callippe silverspot larval host plant stands, or native grassland habitats. Potential nesting habitat should be fenced to exclude regular livestock access, but may be grazed periodically to promote new vegetation growth and to control invasive exotic vegetation.

- In Irrigated Agricultural Reserves for Swainson's hawk, 10 percent of the set-aside lands specified in Conservation Measure SH 3 should be allowed to establish in dense nesting cover. Dense shrubby cover established for the tricolored blackbird nesting habitat under Conservation Measure RSM 14 may also satisfy this cover need.

Implementing grazing schemes that result is a patchwork of ungrazed, lightly, and moderately grazed pastures. In most valley floor grassland and vernal pool and California red-legged frog/callippe silverspot butterfly reserves, moderate grazing levels are desired for maximizing habitat values for Covered Species. Periodically ungrazed or lightly grazed pastures may be appropriate on larger reserves to promote higher vole populations where multiple pastures are present and where limited grazing would not degrade habitat conditions for vernal pool associated Covered Species or Callippe silverspot butterfly breeding and larval habitat. Potential opportunities for reduced grazing include riparian pastures, vernal pool and seasonal wetland restoration areas where Covered Species are not established/present, wet or alkali meadows, or pastures lacking significant presence of vernal pools. As a general guideline, no more than 20 percent of a reserve shall be within the ungrazed to lightly grazed phase in any given year.

7.3.3.2 Effectiveness Monitoring.

Avoidance Monitoring. Reserve areas for this natural community may be established as a result of Avoidance and Minimization Measures VPG 2 and 3 (i.e., site design standards and buffer criteria). All avoided habitat areas and associated buffers must be preserved and managed in perpetuity. The Resource Management Plans of these preserved areas shall include and fund provisions for monitoring the hydrology of avoided wetlands to ensure that no significant adverse changes in water quality or timing and duration of inundation have occurred for a minimum of ten years. In addition to water quality and hydroperiod, vegetation monitoring will be conducted for a minimum of ten years to show no significant changes in species composition as a result of the adjacent development. If buffers are unsuccessful in achieving these standards and avoided areas are greater than 250 feet from the edge of the development, additional mitigation shall be required to mitigate indirect effects at the ratios outlined in Conservation Measure VPG 3.

Restored Wetlands. A large component of the Valley Floor Grassland and Vernal Pool Conservation Strategy involves the restoration of between 270 to 400 acres of vernal pool wetlands (Objective VPG 1.2 and Conservation Measure VPG 3). All restoration activities and subsequent monitoring (at

minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan. This also includes the monitoring of created California tiger salamander breeding habitat (Conservation Measure VPG 8). Following this initial monitoring period, long-term monitoring of a subset of these restored wetlands will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA (See Section 7.4.5).

Contra Cost Goldfield Reestablishment. The other restoration component that will occur on vernal pool reserves is the reestablishment of 100 acres of new, self-reproducing Contra Costa goldfield populations within known or potential habitat areas (Objective VPG 2.2). Monitoring of reestablished populations will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plans. Re-established populations will be considered self reproducing when plants reestablish annually for a minimum of 5 years with no human intervention, such as supplemental seeding, with an occupied area and flower density comparable to existing occupied wetlands that are similar in type (see Conservation Measure VPG 4). If these criteria are not achieved within 10 years of when the original project impacts occurred, the applicant shall increase the preserved wetland reestablishment acreage requirement by 50 percent (see Conservation Measure VPG 6).

7.3.4 California Red-Legged Frog

The reserve system for California red-legged frogs will consist of approximately 3,300 acres of inner coast range upland, riparian and aquatic habitats within the California Red-legged Frog Conservation Area. Implementation of the Conservation Measures will result in the construction and restoration of additional breeding habitat that will be managed for the benefit of California red-legged frogs. Conservation Measures to control of invasive species include measures to passively control them, by preventing the creation of new permanent water features and the "perennialization" of intermittent creeks and other existing aquatic features, and actively control them through control programs established as part of the Resource Management Plans of the reserves.

7.3.4.1 Adaptive Management. The primary goal of the adaptive management program is to protect existing populations of California red-legged frogs by reducing threats and expanding populations through the restoration and creation of habitat. Specific management goals intended to achieve this primary goal are: eradicating invasive exotic species, such as bullfrogs and introduced predatory fish from breeding habitat; reducing the occurrence of noxious weeds; maintaining and enhancing hydrological integrity of preserved and restored wetlands and preventing accelerated erosion; and expanding the population levels. The management prescriptions that will be implemented to achieve these goals are predator eradication programs, livestock grazing, selectively excluding cattle from sensitive riparian areas, weed control (herbicides, manual removal, and mowing), and the creation of additional breeding habitat.

7.3.4.2 Effectiveness Monitoring.

Hydrology Monitoring. The Conservation Program of the HCP will passively control the spread of invasive aquatic species by preventing the creation of new permanent water features and the

"perennialization" of existing aquatic features, such as avoided ponds and intermittent creeks (Avoidance and Minimization Measure RLF 1 and Conservation Measure RLF 6). The hydrology of avoided aquatic habitat features will be monitored annually in perpetuity to ensure no changes in hydrology occur. Hydrology monitoring of some second order streams supporting riparian vegetation, third, fourth, and higher order streams, will be conducted by SCWA as part of the Biological Effectiveness Monitoring Program (Section 7.4.6). The hydrology of first order streams, second order streams currently lacking riparian vegetation, and all other preexisting aquatic features will be monitored as part of the Resource Management Plan of individual reserves and preserves. In addition to existing aquatic features, the hydrology of detention basins and other storm water features shall be monitored to ensure that they do not become perennial. These features shall also be monitored for the presence of non-native species.

Invasive Species Monitoring. The largest management component for reserves established for California red-legged frogs is the control of invasive species. Based on Conservation Measure RLF 7, reserves established in the California Red-legged Frog Conservation Area shall implement and fund, in perpetuity, programs designed to control nonnative species such as bullfrog, crayfish, and warm water fish. If nonnative predators are present, control activities will be conducted annually until they have been locally eradicated from the breeding habitat and absent for three consecutive years. Once nonnative predators have been successfully eliminated from individual aquatic habitat areas, long-term monitoring will occur annually in perpetuity to prevent the reestablishment of these species. Aquatic breeding habitat will be surveyed during the early summer through the fall for the presence of bullfrogs and exotic fish species.

Constructed Breeding Habitat. A large component of the California Red-legged Frog Conservation Strategy involves the construction of new breeding habitat (Objective RLF 1.2 and Conservation Measure RLF 3). The initial restoration activities and subsequent monitoring (at minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan.

7.3.5 Callippe Silverspot Butterfly

The reserve system for the callippe silverspot butterfly will consist of approximately 3,500 acres of inner coast range habitat within the Callippe Silverspot Butterfly Conservation Area. The primary conservation actions for this species involve protecting existing breeding habitat and corridors for dispersal of adults, enhancing stands of the adult nectar plant, and, if possible, restore additional areas of the larval host plant.

7.3.5.1 Adaptive Management. The primary management goal of the adaptive management program is to protect and expand existing callippe silverspot butterfly populations on existing and future reserves/preserves within the Plan Area. Specific management goals intended to achieve this primary goal is to enhance callippe silverspot butterfly habitat by increasing the distribution and abundance of the larval host plant (Johnny jump-up) and adult nectar plants. This will be accomplished through minimizing the accumulation of thatch from annual grasses and reducing the occurrence of noxious weeds both of which may out compete Johnny jump-up and adult nectar plants. The management prescriptions that will be implemented to achieve this goal are livestock grazing, weed control (herbicides, manual removal, and mowing), and possibly prescribed burning.

7.3.5.2 Effectiveness Monitoring.

Avoidance Monitoring. Reserve areas containing core breeding habitat for the species will likely be established as a result of Avoidance and Minimization Measures CSB 1 (site design standards) and Conservation Measure CSB 2. All avoided habitat areas and associated buffers must be preserved and managed in perpetuity. The Resource Management Plans of these preserved areas shall include and fund provisions for monitoring the distribution and density of Johnny jump annually, for a minimum of ten years, to ensure no significant adverse changes have occurred to the core breeding area.

Restoration of Johnny Jump-up and Adult Nectar Plants. Conservation Measure CSB 3 requires restoration/enhancement of stands of Johnny jump-up and nectar plants for direct and indirect impacts to existing stands. Monitoring of restored stands will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan. Restoration will be considered successful when plants reestablish annually for a minimum of 5 years with no human intervention, such as supplemental seeding, with an occupied area and flower density comparable to adjacent core breeding areas or that meet the criteria for being considered core breeding habitat (i.e., at minimum a 1 acre block of habitat with a Johnny jump-up density of at least 10 percent)..

7.3.6 Riparian, Stream, and Freshwater Marsh

The primary goal of the Riparian, Stream, and Freshwater Marsh Natural Community is to Maintain and enhance the natural hydro-geomorphic processes; essential ecological processes, functions, and values; species diversity; and habitat heterogeneity of riparian, stream, and freshwater marsh habitat within the Plan Area. The three main conservation activities to be conducted on reserves for this Natural Community are preservation, restoration and enhancement. Resource Management Plans and Restoration and Enhancement Plans for this Natural Community will focus monitoring and adaptive management on demonstrating the effectiveness of these conservation actions.

7.3.6.1 Adaptive Management. The primary adaptive management goal is to balance the natural hydro-geomorphic and ecological functions of riparian, stream and freshwater marsh habitats with the need to maintain channel capacity for flood control. The control and management of invasive plant and animal species is also a key management consideration.

7.3.6.2 Effectiveness Monitoring. A large component of the Riparian, Stream, and Freshwater Marsh Conservation Strategy involves the restoration and enhancement of riparian and in stream habitat, preferably within priority drainages (Objective RSM 1.1, 1.5 and 2.2; see Table 7-1 for Conservation Measures). Individual mitigation banks and/or private-project specific mitigation lands are responsible for all initial restoration activities and subsequent monitoring (at minimum the first five years) as part of their Restoration and Enhancement Plan. The long-term monitoring of a subset of these restored riparian areas will then be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA (see Section 7.4). In addition to the minimum requirements for Restoration and Enhancement Plans, Plans within for riparian, stream, and freshwater marsh habitats shall:

1. clearly defined restoration goals that focus on vegetation, fishery, wildlife, and channel stability issues, and
2. provide detailed specifications for vegetation, site preparation, exotic species removal, site grading, erosion control, channel stabilization, preservation methods, fishery enhancement, and reevegetation.

7.3.7 Giant Garter Snake

The reserve system for giant garter snakes will encompass approximately 175 acres of restored and enhanced aquatic and 121 acres of associated upland habitat. These reserve areas will be managed for the benefit of giant garter snakes.

7.3.7.1 Adaptive Management. The primary management objective for giant garter snakes within reserve areas is to provide for the essential habitat requirements of the species. These habitat features include:

1. an abundance of emergent, herbaceous wetland vegetation (e.g., cattails and bulrushes) to provide escape cover and foraging habitat during the active season;
2. adjacent upland habitat for basking, shelter, and retreat sites;
3. adjacent upland habitat (levees or banks) high enough to provide refuge from winter floodwaters;
4. a suitable prey base (fish and/or frogs); and
5. adequate water during the giant garter snake active period (i.e., April through October).

7.3.7.2 Effectiveness Monitoring. The main conservation activity for this species is the restoration of aquatic habitat plus restoration of upland habitat adjacent to the restored aquatic habitat. Restoration and Enhancement Plans for giant garter snake reserves shall comply with the minimum requirements listed in Section 7.3.2, the requirements for the Riparian, Stream, and Freshwater Marsh Natural Community, and have specific performance criteria for the key habitat requirements for giant garter snakes listed in Section 7.3.7.1.

7.3.8 Coastal Marsh

The Coastal Marsh Natural Community Conservation Strategy involves a mixture of conservation actions designed to maintain the water and sediment quality standards, hydrology and ecological functions of the natural community, contribute to the restoration of tidally-influenced coastal marsh habitat, contribute to the conservation and recovery of associated Covered Species and promote habitat connectivity. The primary conservation actions include preservation (primarily through avoidance), restoration, invasive species control, and maintenance of water quality and hydro-geomorphic processes through the implementation of avoidance and minimization measures and Best Management Practices.

7.3.8.1 Adaptive Management. Because multiple agencies are actively involved in management of Suisun Marsh and are currently developing a Habitat Management, Preservation and Restoration Plan, the primary goal of the costal marsh Adaptive Management Program for the Solano HCP is to support and compliment existing management activities. Specific management goals intended to achieve this primary goal are: the adoption of an invasive species control program as a regular part of the ongoing operations and maintenance activities associated with public facilities (flood control facilities, parks, trails, bike paths, and linear parks, etc.) within the Natural Community; annually fund a grant program for invasive plant and animal control in coastal marsh habitats within the County; and developing and implementing public education programs that addresses the effects of non-native predators and domestic and feral pets on salt marsh wildlife species.

7.3.8.2 Effectiveness Monitoring.

Avoidance Monitoring. The primary mechanism for preservation of marsh habitat under the HCP is avoidance. Development projects that result in avoided marsh habitat must also implement enhancement and restoration plans and provide funding for the long-term management of these areas consistent with the HCP reserve design and management standards (see also Section 10.5). The quality of avoided marsh habitat will be monitored for a minimum of five years to ensure that the established buffers are sufficiently precluding changes to water and soil salinity and the flood/inundation regime in the marsh (Avoidance and Minimization Measure CM 3).

Soft Bird's-beak and Suisun Thistle. All populations of soft bird's-beak or Suisun thistle that were avoided and preserved as part of an individual project shall be monitored every year for the first five years. Long-term monitoring of these populations will be conducted every 3 years in perpetuity. This monitoring is primarily to show the effectiveness of Avoidance and Minimization Measure CM 4.

7.3.9 Swainson's Hawk

The reserve system for the Swainson's hawks will consist of 5,700 acres of agricultural foraging habitat within the Swainson's Hawk Irrigated Agriculture Potential Reserve Areas, 4,300 acres of valley floor grassland habitat, and 1,000 acres of additional foraging habitat within either: the Swainson's hawk Irrigated Agriculture, Valley Floor Grassland, or Inner Coast Range Potential Reserve Areas. The reserve system for Swainson's hawks will also provide sufficient nesting habitat in proximity to suitable foraging habitat through the planting of new potential nest trees on reserves. HCP reserve system

7.3.9.1 Adaptive Management. The conservation strategy is based on intensive studies of Swainson's hawks in California and their well-documented reliance on having a diversity of irrigated agricultural crops for foraging and numerous small, isolated groups of trees or woody riparian habitat zones for nesting. Each agricultural reserve established for Swainson's hawks under the Solano HCP shall implement the following additional management requirements:

1. Five percent of the reserve system shall be set aside and established in permanent, naturalized herbaceous and woody/shrub cover. The locations of these set aside areas shall be designed on a reserve-specific basis to maximize distribution through the reserve while not significantly

interfering with agricultural operations and may also be used for preserving/planting nest trees (Conservation Measure SH 6), for establishment of burrowing owl artificial nest burrows (Conservation Measure BO 3), tricolored blackbird nesting habitat (Conservation Measure RSM 14), nesting habitat for other Special Management Species (Section 6.11), and for providing vegetated filter strips for water quality enhancement.

2. At least 50 percent of cultivated lands in the reserve system shall be planted and managed in any given year for alfalfa or other irrigated hay crops with similar management requirements (e.g., regular irrigation and harvesting through the Swainson's hawk nesting season). The remaining 50 percent of the cultivated land may be planted in any annual or biennial crop type that provides an acceptable crop rotation typical of or suitable for alfalfa production in this region.

In order to allow for long term flexibility, SCWA will establish a program that would allow for crop type credits to be traded between individual reserves as long as the minimum 50 percent criteria for alfalfa (or other irrigated hay crops with similar management requirements) is met in the overall irrigated agriculture reserve system in any given year (see Section 10.5 for further information).

7.3.9.2 Effectiveness Monitoring. Each reserve established for Swainson's hawks within the Irrigated Agriculture Conservation Area shall show annual compliance with the reserve design standards outlined in Conservation Measure SH 3. Under Conservation Measure SH 6, each Swainson's hawk reserve within the Irrigated Agriculture Conservation Area is required to provide a minimum of 1 suitable nest tree/grove per 40 acres of reserve. Reserve management plans shall incorporate monitoring and funding to maintain reserve-specific established nest tree numbers and replace potential nest tress in perpetuity.

7.3.10 Burrowing Owl

Burrowing owls use a variety of natural, uncultivated, and agricultural habitats, any of which can support owls depending on the availability of burrows for cover and nesting and the presence of prey. As such, the Monitoring and Adaptive Management Program for burrowing owls is applicable to all lands within the irrigated agriculture region of the county, the Valley Floor Grassland and Vernal Pool Natural Community and the grasslands and oak savanna habitat within the Inner Coast Range. However, monitoring efforts will focus on the irrigated agriculture and Valley Floor Grassland and Vernal Pool Conservation Areas designated for Swainson's hawks (Figure 4-22) because the majority of the owl population within the Plan Area occurs within these areas.

7.3.10.1 Adaptive Management. The following management actions shall be required for reserves established for burrowing owls:

Grassland Reserve Criteria.

1. **Vegetation Height:** Management measures shall be implemented and adequately funded to maintain average effective vegetation height[5] at 6 inches or less over 80 percent of the reserve

[5] Height at which 90% of a white board is obscured by vegetation when viewed 1 m from the ground at a distance of 10 m (Green and Anthony 1989).

from February 1–April 15, when owls typically select mates and nest burrows. To achieve this, average effective height of residual vegetation at the end of the dry season (September–October) shall not exceed 4 inches. In addition, tree and shrub canopy cover shall be maintained at less than 30 percent in perpetuity;

2. **Restrictions on Rodent Control:** Reserves in grassland habitats shall contain a large core area (minimum 25 percent of site) where ground squirrel control is prohibited. Ground squirrel control may only occur along existing irrigation canals and drains and within perimeter zones (maximum 250 feet in width[6]) of the reserve as necessary to prevent ground squirrels from increasing population levels on adjacent properties (see Sections 7.3 and 10.5.3); and
3. **Burrow Density:** Reserves in valley floor and vernal pool grasslands shall provide a minimum 28 suitable burrowing owl burrows per 280 acres of valley floor and vernal pool grassland preserves. Where natural burrows do not provide the required density, a minimum of three artificial nest burrow complexes per 280 acres shall be installed monitored, and maintained until the natural burrow density is achieved. Artificial burrow complexes shall include at a minimum rate of 1 multi-entrance, nest burrow/chamber and 9 temporary burrows per 280 acres until suitable, natural burrow densities reach a minimum 28 burrows per 280 acres.

Agricultural Reserves Criteria.

1. **Suitable Burrow and Cover Habitat:** A minimum of 2 acres of habitat per 80 acres of reserve land shall be permanently taken out of production to provide suitable nesting and cover habitat for burrowing owls. This 2-acre unit shall consist of one continuous block of habitat and shall not be adjacent to a County road or highway.
2. **Artificial Burrows:** A minimum of 2 burrow complexes (3 burrows per complex) shall be installed and maintained in perpetuity within the 2 acres of habitat set aside for burrowing owls.
3. **Vegetation Height:** Within the 2 acre of habitat set aside from agricultural production for burrowing owls, management measures shall be implemented and adequately funded to maintain average effective vegetation height at 6 inches or less from February 1–April 15, when owls typically select mates and nest burrows. In addition, the 2-acre set aside area must be kept free of tree and shrub canopy cover in perpetuity.

7.3.10.2 Effectiveness Monitoring. Artificial burrows and burrow density on grassland reserves will be monitored annually for the first ten years and every three years in perpetuity. Annual monitoring will include the collection of data pertaining to the ability for artificial and burrows to provide suitable breeding habitat for burrowing owls. The average effective vegetation height will be measured around all artificial burrow complexes established on a reserve or five natural potential nest burrows. Vegetation will be sampled along four 50-m transects radiating from each burrow. The transects will be spaced 90 degrees apart with the first direction selected randomly. Effective height will be measured at 40 quadrats distributed every 5 m along the transects. Habitat information will be collected from June–September of each monitoring year to allow for the collection of additional observations of burrowing owl baseline habitat use. Additional biological information on the number of breeding pairs, number of fledged juveniles, and number of wintering owls will be collected on reserves. If the reserve is established as a commercial or institutional mitigation bank, failure to

[6] The 250-foot control zone is based on a review of literature that indicates the typical home range for a California ground squirrel is a 150 feet radius of a burrow system.

document use may result in removal of the site from the approved mitigation reserve system (e.g., the purchase of credits from an unapproved site would not fulfill the incidental take mitigation requirements). Failure to document use and/or declining population statistics may require amendment to the management plans for the individual reserves.

7.3.11 Special Management Species

Special Management Species (Appendix C) will receive substantial conservation benefit associated with the habitat preservation and restoration, water quality protection, invasive species control, and reserve management associated with the basic Natural Community and many of the associated Covered Species-specific Conservation Measures. However, several of the species in this group require implementation of additional or special management on reserves in order to maximize their conservation benefits. Reserve Managers shall evaluate the additional management actions specified in the following subsections for inclusion into the required Reserve Management Plans (see also Section 10.5.3). These special management actions shall be implemented on each reserve as appropriate and to the extent they do not significantly conflict with the management requirements for Covered Species.

7.3.11.1 Northern Harrier and Short-eared Owl. Both the northern harrier and short-eared owl are widespread in the County and are associated with multiple natural communities, including Vernal Pool and Valley Floor Grassland, Agricultural lands, Coastal Marsh, and Inner Costa Range Natural Communities. Both species benefit from maintaining a habitat mosaic that includes agricultural crops with suitable prey species, lush ungrazed to lightly grazed grasslands, and weedy fields (Shuford and Gardali eds. 2008). Both species are ground nesters and typically nest in areas of fairly tall and dense grass, weeds, marshy vegetation, or shrubs. Meadow voles (Microtus sp.), which are a primary food source for these two raptors, also thrive in wet, ungrazed to lightly grazed grasslands (Fehmi and Bartolome 2002). Voles are also a main food source for Swainson's hawks and the management requirements for establishing 50 percent of the Swainson's hawk reserve system in alfalfa (or similar crop, Conservation Measure SH 3) will greatly benefit these species. Standard management requirements for Valley Floor Grassland and Vernal Pool Natural Community associated Covered Species typically focus on having moderate grazing levels in order to reduce annual grass herbaceous cover in order to promote native vegetation growth (see Natural Community Model in Appendix B). In grassland and agricultural communities, the availability of nesting cover is likely the primary factor limiting the populations of both species.

The following special management actions shall be incorporated into required reserve management plans (see Sections 7.3 and 10.5.3) to increase habitat values for northern harrier and short-eared owl:

Establishing patches of tall and dense nesting cover. Typical nest cover includes fairly tall (2 to 4 feet) and dense grass, weeds, marshy vegetation, or shrubs.

- In Valley Floor and Vernal Pool Grassland and California Red-legged Frog/Callippe Silverspot Conservation Areas, suitable areas within reserves for consideration of allowing nesting cover to establish include: old homesteads, corrals, or barn areas; ditches, streams, stock ponds, or marshy areas; or other waste areas which are separated from high value vernal pools, Callippe silverspot larval host plant stands, or native grassland habitats. Potential nesting habitat should be fenced to

exclude regular livestock access, but may be grazed periodically to promote new vegetation growth and to control invasive exotic vegetation.

- In Irrigated Agricultural Reserves for Swainson's hawk, 10 percent of the set-aside lands specified in Conservation Measure SH 3 should be allowed to establish in dense nesting cover. Dense shrubby cover established for the tricolored blackbird nesting habitat under Conservation Measure RSM 14 may also satisfy this cover need.

Implementing grazing schemes that result in a patchwork of ungrazed, lightly, and moderately grazed pastures. In most valley floor grassland and vernal pool and California red-legged frog/callippe silverspot butterfly reserves, moderate grazing levels are desired for maximizing habitat values for Covered Species. Periodically ungrazed or lightly grazed pastures may be appropriate on larger reserves to promote higher vole populations where multiple pastures are present and where limited grazing would not degrade habitat conditions for vernal pool associated Covered Species or Callippe silverspot butterfly breeding and larval habitat. Potential opportunities for reduced grazing include riparian pastures, vernal pool and seasonal wetland restoration areas where Covered Species are not established/present, wet or alkali meadows, or pastures lacking significant presence of vernal pools. As a general guideline, no more than 20 percent of a reserve shall be within the ungrazed to lightly grazed phase in any given year.

7.3.11.2 Loggerhead Shrike. Loggerhead shrikes use grasslands and agricultural areas for foraging and breeding, but generally select microhabitats such as riparian corridors and edges and other areas of trees and shrubs (often planted along roads or fence lines in agricultural areas) preferentially, and travel between habitat patches via these sheltered corridors. Areas of open agricultural or grassland habitats without a tree or shrub corridor to provide connectivity to other habitat experience reduced shrike use and dispersal (Haas 1995). Special management requirements for loggerhead shrike primarily involve establishing shrubby nesting cover:

Establish shrub nest cover. Typical nest cover includes small trees and shrubs.

- In valley floor grassland and vernal pool and California red-legged frog/callippe silverspot butterfly reserves, nesting cover for loggerhead shrikes will be established in suitable areas. Suitable areas for consideration of planting/establishing nesting cover include: old homesteads, corrals, or barn areas; edges of ditches, streams, stock ponds, or marshy areas; or other waste areas.
- In irrigated agricultural reserves for Swainson's hawk, shrubs should be established in association with tree planting areas in portions of the set-aside lands specified in Conservation Measures SH 3 and 6. Shrub plantings shall not occur in areas reserved for burrowing owl habitat (Conservation Measure BO 3). Dense shrubby cover established for the tricolored blackbird nesting habitat under Conservation Measure RSM 14 would also provide suitable nesting habitat for loggerhead shrike.

7.3.11.3 Grasshopper Sparrow. Grasshopper sparrows prefer breeding habitat comprised of open grasslands, preferably with bunch grass (versus sod-type) as the predominant cover, although through much of California, non-native annual grasslands and fallow agricultural fields are used in the

absence of native bunch-grass ecosystems. Grasslands with more open structure allow the birds freedom to forage and move about, whereas sod-type grasses presumably hinder these activities (Whitmore 1981). Proximity to woodland areas has been negatively correlated with grasshopper sparrow use, possibly as a result of increased predation and nest parasitism (Thogmartin 2006). Grasshopper sparrows are also considered to be area-sensitive, meaning that they appear to preferentially select the interior portions of larger habitat areas which have a high interior-to-edge ratio (Renfrew 2005; Davis, 2004).

The primary habitat for grasshopper sparrows is present in the larger tracts of grassland within the Valley Floor Grassland and Vernal Pool and Inner Coast Range Natural Communities. Specific information on optimal grazing regimes is limited (Shuford and Gardali, eds. 2008); however, available life history information data indicates that light grazing which results in a patchy environment that includes some bare ground, scattered shrubs, and some denser residual grass cover for nesting is desirable.

Grazing management which results in a patchwork of ungrazed, lightly, and moderately grazed pastures as recommended for northern harrier and short-eared owl, in Section 7.3.11.1, would also be applicable for the grasshopper sparrow.

7.3.11.4 Native Perennial Grassland. Native perennial grassland is limited to small stands of relict native perennial grasses. Generally, researchers have used 10 percent relative cover of native grasses to classify an area as being a sensitive natural community. Native grass stands are threatened by habitat loss and fragmentation, and invasion/competition by non-native annual plants caused by urbanization, crop cultivation, disking and tilling, improper livestock grazing, rodent control, and climate change. However, moderate grazing can sometimes be beneficial in controlling non-native annual grasses. Proposed reserves in Valley Floor Grassland and Vernal Pool and California Red-legged Frog/Callippe Silverspot Butterfly Conservation Areas shall identify locations where native grasses and associated native forbs comprise at least 10 percent of the cover. As part of the required reserve management plan, realistic management objectives shall be established and applicable management implemented to promote preservation and expansion of the native grass and forb stands.

7.4 BIOLOGICAL EFFECTIVENESS MONITORING PROGRAM ADMINISTERED BY SCWA

Effectiveness monitoring evaluates the effectiveness of the operating conservation program of the HCP and whether the assumptions and predictions made during the development of the Plan hold true (USFWS 2000). Based on the U.S. Fish and Wildlife Service's "5-Point Policy" for Habitat Conservation Plans there are several components to effectiveness monitoring, including the evaluation of incidental take. However, this section deals primarily with effectiveness monitoring associated with achieving the biological goals and objectives. This component of effectiveness monitoring in this Plan is referred to as biological effectiveness monitoring.

Biological effectiveness monitoring evaluates the effects of the planned actions, by measuring biologically meaningful variables, and determining whether the operating conservation program of the HCP (i.e., implementation of the conservation measures and preserve management) are successfully achieving the biological objectives. The assumption made in the Conservation Strategy is

that if the conservation measures are proper implemented these actions will collectively achieve the stated biological goals and objectives. The purpose of Biological Effectiveness Monitoring is to track the validity of this assumption (USFWS 2000). This section outlines the Biological Effectiveness Monitoring Program to be administered by the SCWA.

7.4.1 Implementation Schedule

A recent USGS publication (Atkinson et al. 2004) identifies three phases in the development of a monitoring program in an adaptive management context. These phases, include Phase 1 - identifying relationships and inventorying resources, Phase 2 - pilot testing of long-term monitoring and resolving critical management uncertainties and Phase 3 - implementing long-term management and monitoring (Atkinson et al. 2004; Table 7-4). The Solano HCP has adopted this implementation schedule for the Biological Effectiveness Monitoring Program; however, the phases are referred to as Phase 1 –Developing and Testing Monitoring Protocols, Phase 2 – Refining Monitoring Protocols, Establishing Baseline Data, and Significant Threshold Levels and Phase 3 – Long-term Monitoring. In addition to these three phases, a programmatic review of the current monitoring and management practices is embedded in the implementation schedule every five years for the duration of the Permit and every ten years in perpetuity (Table 7-4). Management will be conducted on reserves during all three phases and will be directed from the results of the biological effectiveness monitoring (Table 7-4).

7.4.1.1 Phase 1 – Developing and Testing Monitoring Protocols. During Phase 1 – Developing and Testing Monitoring Protocols, the proposed monitoring techniques for each natural community and Covered Species will be further developed and tested in the field at least once. During this phase of refining the monitoring protocols statistical methods to be used to analyze the monitoring data will also be developed and key statistical parameters, such as detection probabilities, will be identified and estimated.

7.4.1.2 Phase 2 – Refining Monitoring protocols, establishing baseline data, and significant threshold levels. The second phase in the Monitoring and Adaptive Management Program involves an intensive monitoring period in which, the biological effectiveness monitoring is conducted every year for the first 10 years. The purpose of a more intensive monitoring period is to further test and evaluate the effectiveness of survey protocols and to begin to establish statistically valid baseline data (e.g., population estimate or population index value) for the development of biologically meaningful significance thresholds. Since, the reserve system will continue to grow throughout Plan implementation, not all areas within the reserve system will be included in this intensive monitoring phase. The intent of the data collected during this period is not designed to be reserve specific, but to inform the nature of variation within the biological system (e.g., population levels of Covered Species or composition of the natural community) intended to be preserved and managed. The 10 year time frame of intense monitoring should also allow sufficient time to experience a range of climatic conditions, typically one drought and one wet rainy season cycle, plus variations in timing and duration. This should provide a reasonable assessment of the annual population fluctuations for Covered Species and Natural Community level variables to develop more biologically meaningful management thresholds and comparisons to interpret data during the long-term monitoring phase.

7.4.1.3 Phase 3- Long-Term Monitoring. This phase involves implementation of the long-term monitoring program, which consists of a continuation of the monitoring protocols developed during Phase 1 and further refined during Phase 2, only at less frequent intervals.

7.4.1.4 Programmatic Review of Monitoring and Management. This additional component of the Biological Effectiveness Monitoring Program involves a programmatic review of the monitoring techniques, assessment of reserve management practices and an overall assessment of the effectiveness of the operating Conservation Program. These reviews are integral to the process of adaptive management. A programmatic review will occur every five years, for the Permit duration (i.e., 30 years) and every ten years after that in perpetuity. The first review will assess the results of the initial tests of the monitoring protocols, use these results to modify monitoring, as necessary in Phase 2, and further define biologically meaningful performance criteria and significance thresholds. Data from the intensive monitoring during reviews in years 10 and 15 will be used to further refine performance criteria and significance thresholds. The final review in year 30 will assess the effectiveness of the Plan in achieving all of the biological goals and objectives. After this review, review frequency will decrease to every ten years in perpetuity. This frequency will allow for three monitoring cycles during the Long-term Monitoring Phase. All reviews will summarize the results of targeted studies and incorporate results into the monitoring and adaptive management program.

7.4.2 Monitoring Components

Pressures operate at different and often multiple scales concurrently: in addition, the effect of a pressure can differ between scales. For example, large scale disturbances (floods, droughts and fires) might have negative effects at the species or community level but can have positive effects at the landscape level. Therefore, it is important to tailor the monitoring program to multiple ecological scales: landscape, natural community, and species. It is necessary to create a system that is flexible enough to adjust to the needs of each species, but is formal enough to allow for the evaluation of the entire preserve system (i.e., an ecosystem approach). For each phase of the Biological Effectiveness Monitoring Program a hierarchical approach involving landscape, Natural Community, and species-level monitoring has been developed.

7.4.2.1 Landscape-level Monitoring. Landscape-level monitoring focuses on large geographical areas, coarse-scale conservation targets, and monitoring variables representative of large-scale ecological processes. Landscape monitoring can include regional processes such as weather and fire, or other extreme events. This scale of monitoring focuses on processes that affect the condition and dynamics of landscapes that models predict will affect Covered Species and natural communities, but is more effectively monitored at a larger scale. Potential landscape-level monitoring variables include:

- natural disturbance regimes such as weather and fire (e.g., rainfall data),
- habitat disturbance levels,
- surrounding land use practices,
- development of the reserve system, and
- invasive species.

7.4.2.2 Natural Community-level Monitoring. Natural community-level monitoring focuses on monitoring community composition, structure and ecological function as well as monitoring potential effects of local-scale threats to the Natural Community. Natural community-level monitoring variables include community composition variables such as species richness or measures of similarity, vegetation structure and function variables such as percent cover, substrate type or soil type, or variables that measure ecological function such as stream flow hydrographs, duration of inundation, or soil stability. Natural community-level monitoring also addresses quantification of variables that are or may be important to the distribution and abundance of individual Covered Species. In addition, quantitative characterizations of the Natural Community will be obtained that can be used to detect both natural and anthropogenic changes in community structure in time and space. Potential Natural Community level monitoring variables could include:

- Edaphic variables including, soil series, soil pH (alkalinity), soil salinity, slope, and aspect.
- Hydrological and water quality variables, including the duration and area of inundation, pH, dissolved oxygen, and turbidity.
- Plant community and vegetation monitoring variables could potentially include total absolute vegetation cover, relative vegetation cover by native vernal pool species (native species richness), plant species composition, species with at least 20 percent relative cover per pool, estimation of absolute, and relative abundance of native and non-native species and thatch height or residual dry matter (amount of dead and decaying herbaceous vegetation).
- Other potential surrogates for ecological function may include the presence of important pollinator species, amphibian species or other upland species, or species that are potential indicator of habitat quality.

7.4.2.3 Species-level Monitoring. Species-level monitoring will provide data on the extent to which biological goals and objectives for Covered Species are being met. Species monitoring will involve tracking populations of Covered Species. It will also involve collecting information on the ecology of species to better manage them and increase the probability of conservation. This level of monitoring needs to sample in both space and time, to address both distribution and trends in Covered Species. It also tracks species responses to resource fluctuations, management actions and the level at which threats are affecting species (i.e., identifying thresholds).

Effective sampling methods, site specific distributions and species natural history parameters are all needed to develop effective monitoring protocols for Covered Species. During Phase 1 (See Section 7.4.1), monitoring techniques, sampling methods and protocols for each Covered Species or species group will be developed and tested. Baseline surveys will also be used to test *a priori* hypotheses about the factors affecting the distribution of species. Species level monitoring should also be designed to identify mechanisms controlling the distribution of Covered Species, population levels, groups of species, and a means to track the response of Covered Species to management actions. The development of sampling protocols and a sampling design should include the identification of a sample unit or 'point' (i.e., auditory or visual counts, small grids, traps and short transects), the sample unit will vary in size but should be able to integrate with sampling of physical features of the environment (i.e., soil, temperature, pH, etc.). The size of the sample unit will also determine the appropriate metric to use in describing species occurrence and distribution. In general, monitoring to comply with the Covered Species objectives will consist of presence/absence data or the proportion of

area occupied (PAO, MacKenzie et al. 2003). Additional potential species level monitoring variables for Covered Species may include: home range and seasonal movement patterns, number of populations, distribution and range of Covered Species, relative abundance or estimates of population size, apparent recruitment, seed survival or seed bank longevity, and seedling establishment.

Proportion of Area Occupied (PAO). In general, monitoring to comply with the Covered Species objectives will consist of presence/absence data or the proportion of area occupied (PAO, MacKenzie et al. 2003). The PAO was chosen in most cases because it is becoming a widely used and useful cost effective metric for large-area monitoring programs. For example, PAO has been adopted by the Amphibian Research and Monitoring Initiative (ARMI) as the metric by which many amphibian populations nationwide will be measured. The PAO statistical approach, developed by MacKenzie et al. (2003), evaluates the fraction of the landscape that is occupied by a species of interest, but not the actual abundance of the population across the landscape. This is useful for species, such as amphibians, were actual abundance estimates are more difficult and costly to obtain. However, for certain species, such as plants, additional data will be collected on densities. In addition to POA, data will also be collected to assess the overall health and status of these occurrences to see if their population levels and distribution are actually increasing throughout the Plan Area.

PAO is based on population models that incorporate detection probabilities along with the number of habitat area where each species is detected to estimate the area occupied by each species. A quantitative measure of the detection probability of the survey methods is necessary because, even though presence is easily defined, but absence is not. The number of individuals observed or captured at points in a survey area invariably underestimates the number of individuals actually present and if population numbers are low, which they often are for listed species, no detection does not necessarily preclude presence. Thus, it is necessary to also estimate detectability, the probability that the Covered Species will be observed at a point if it is, in fact, present. To estimate species-specific detection probabilities, during Phase 1 of the monitoring program, a sub-sample of sites will be visited greater than 2 times within a short time period (e.g., 2 weeks). Collection of data in this manner is necessary to estimate the proportion of the sampling area occupied by each species (MacKenzie et al. 2006).

7.4.2.4 Targeted Studies. Targeted studies, a special subset of biological effectiveness monitoring and an integral component to adaptive management, increase the effectiveness of monitoring and management by improving knowledge about the ecological system and about management techniques. Targeted studies may be implemented as short-term studies rather than as long-term monitoring and typically include, resolving critical uncertainties and improving knowledge of natural systems under management or applying experimental management treatments (Atkinson et al. 2004). It is not the intent of the Solano HCP to fund research to resolve all uncertainties and data gaps for all species and communities. SCWA and the other Plan Participants will provide funding for targeted studies identifying experimental adaptive management activities that may be undertaken in response to specific issues identified as a result of preserve management and monitoring efforts and/or to provide data to fill in data gaps and address conceptual community model uncertainties (see Appendix B). Such adaptive management activities may involve basic and applied research undertaken by preserve managers, other applicable third parties, and scientists and their students participating in on-the-ground work as part of their own research programs. Decisions to support or fund such programs will be determined by the permit holders in consultation with the Solano HCP Advisory Committee, the Resource Agencies, and other applicable agencies and organizations.

Criteria for supporting such research will be based on the merits/applicability of the specific research proposals submitted to SCWA with respect to HCP goals and objectives and availability of funds.

7.4.3 General Monitoring Design

Monitoring for several of the natural communities and Covered Species on reserves established under the Solano HCP will follow a sampling design similar to that established for the monitoring program of the Arroyo toad on the Marine Corps Base Camp Pendleton (USGS 2003). This monitoring program is used as an example because it is one of the first monitoring programs developed following the monitoring framework promulgated by Atkinson et al. (2004) and is designed to monitor large areas over extended periods of time.

As part of their approval processes, the mitigation banks and/or private-project specific mitigation lands have to conduct baseline surveys of the mitigation area and a general inventory of their resources. SCWA will utilize this existing data to identify the different habitat types and suitable habitat for Covered Species present on the HCP reserve system. Using this information in combination with the anticipated amount of habitat to be preserved under the Plan, different habitat types and suitable habitat areas for each Natural Community or Covered Species will be divided up into six monitoring groups, a permanent monitoring group and five rotating monitoring groups, such that two groups (the permanent and one on a rotating basis) will be monitored in any given monitoring year (Table 7-2). Each monitoring group will consist of a representative sample of each habitat type. For Covered Species monitoring, the permanent monitoring group will consist of only known occupied habitat areas and suitable habitat areas only if the known occupied habitat areas consist of less than $1/6^{th}$ of the total suitable habitat.

Reserve/preserve areas will be divided up into the monitoring groups during Phase 1 of the monitoring program and monitoring of the permanent group will be conducted at least once to refine the monitoring protocols. During the Intense Monitoring Period (Phase 2) the permanent monitoring group will be monitored annually. The remaining groups will be monitored on a rotating basis such that all areas will be monitored twice during Phase 2. During the Long-term Monitoring (Phase 3) the permanent group will be monitored every three years and all of the remaining groups will be monitored at least once in a 15 year cycle in perpetuity. Based on this 15 year rotation, all habitat areas will have been monitored twice during the long-term monitoring phase prior to the end of the permit duration (Table 7-2).

Table 7-2: General monitoring schedule for Natural Communities and Covered Species

Group	Monitoring Year															
	Phase 1	Phase 2										Phase 3				
	1-5	6	7	8	9	10	11	12	13	14	15	18	21	24	27	30
Permanent	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1		X					X					X				
2			X					X					X			
3				X					X					X		
4					X					X					X	
5						X					X					X

Sampling will be conducted within private mitigation banks selling credits for projects approved under the Solano HCP and private-project specific mitigation lands. As additional lands become established as part of the reserve system, new habitat areas will be assigned to a monitoring group and monitored according to the specified monitoring rotation schedule.

Additional monitoring may be required in the event of a population crash or other unexpected event. If this occurs, then additional monitoring and targeted studies will be initiated to evaluate potential causes of this decline followed by an adjustment of management actions as appropriate to offset the affects of the declines. Following these adjustments in management actions the monitoring frequency will continue at an increased frequency (i.e., annually) until the populations of Covered Species in question arrive back to the specified conditions/performance criteria outlined in the Plan. If failure to meet performance criteria is a result of insufficient conservation efforts instead of landscape factors outside of the control of the Plan Participants then additional conservation actions followed by an additional period of monitoring shall be specified.

7.4.4 Landscape Level Monitoring

Landscape-level monitoring focuses on large geographical areas, monitoring variables representative of large-scale ecological processes and focuses on coarse-scale conservation targets. Landscape monitoring includes regional processes such as weather, essential ecological processes, and groundwater levels. This scale of monitoring focuses on processes that affect the condition and dynamics of landscapes that models predict will affect Covered Species and natural communities. The following variables will be monitored to address key landscape level assumptions and processes. Collection of this data will also continue into the long-term monitoring program.

Climatic Variables. The amount, timing, and duration of rainfall will likely have a more significant influence on population levels of Covered Species on an annual basis than ongoing management activities or other environmental pressures. Tracking of local climatic data over time will assist in interpreting potential variations in species population index monitoring results.

Monitoring Objective LAN 1. Monitor rainfall, temperature and extreme weather events, such as floods, extremely hot or cold periods throughout the Plan Area.

Biological Effectiveness Monitoring. SCWA will collect and record the following climatic information:

- Monthly rainfall,
- Average monthly temperature,
- Average day and night temperatures, and
- Any extreme events such as floods, droughts, extremely hot or cold periods, fires, etc.

Extreme Events. Large fires, floods, chemical spills, and other assorted types of events can have regional effects on Covered Species. For migratory species, such events outside of Solano County can also adversely effect species populations in the Plan Area.

Monitoring Objective LAN 2. Document the occurrence of large fires, floods, droughts, chemical spills, and other assorted types of events throughout the Plan Area and in key areas outside of the County.

Biological Effectiveness Monitoring. SCWA will document and record extreme events in the County and will also document such events in key wintering areas for Covered Species as they become aware of such issues.

Vegetation Community/Habitat Condition Assessment.

Monitoring Objective LAN 3. What is the distribution of vegetation communities throughout the Plan Area? What condition are these vegetation communities in?

Biological Effectiveness Monitoring. The Vegetation Community/Habitat Condition monitoring will be accomplished through a quantitative mapping effort that identifies stands, or polygons, of vegetation using aerial photographs and/or satellite images once every five years. The program will consist of geographic imagery analyses and without the on-the-ground assessment except in areas where access is permitted (such as on existing reserves and preserves). On existing reserves and preserve, more detailed habitat mapping will be conducted on the ground using GPS units. This 'on the ground' data will also be used to assess the accuracy of the geographic imagery analyses applied to the entire Plan Area. Landsat thematic mapping imagery, other high resolution aerial photography or satellite products, and/or digital orthophoto quad's (DOQ's) will be used to support the mapping. Vegetation and land cover mapping will follow the standards developed by the Interagency Vegetation Mapping Group and the Department of Fish and Game's Vegetation Mapping Program. Mapping will also be consistent with the HCP baseline community mapping with respect to community designations and minimum polygon size.

This consistency will allow the updated vegetation community maps to be compared to HCP baseline maps (the most current version at the time of HCP implementation) to assess and document changes in vegetation community/habitat extent related to both Solano HCP Covered Activities as well as non-regulated activities. Such information will be useful in assessing the effectiveness of the Solano HCP Conservation Strategy, evaluating conformance with take and habitat threat assumptions (Section 8.0), assurances (Section 10.0), and the potential need to alter or shift locations or emphasis of conservation efforts.

Land Use. One of the key assumptions regarding the regional risk of change or loss of various natural communities (see Section 3.6) is that the broader, County-wide land use patterns will not change significantly over the life of the HCP. Urban development will continue to be focused in defined urban areas and that while agricultural practices may fluctuate over time in response to various market conditions, the overall mix of crop types will remain consistent with current conditions.

Monitoring Objective LAN 4. Are there significant changes in County-wide land use patterns?

Biological Effectiveness Monitoring. The vegetation mapping, above, provides the basic information to assess land use changes, particularly in agricultural crop patterns. The Plan

Participants will further monitor and assess changes in local, County, and State regulations that may effect these basic land use assumptions.

7.4.4.1 Targeted Studies. A specific landscape level conceptual model was not developed similar to the Natural Community and Covered Species Models in Appendix B; however, many of the Natural Community models consider actions that are more representative of large-scale or landscape-level ecological processes. Potential landscape-level targeted studies include:

- The effects of regional climatic patterns on Covered Species.
- The effects of habitat disturbance levels and surrounding land use practices on Covered Species.
- Special status species occurrences and distribution.
- Presence of unique or distinct habitat features.
- A measure of the potential magnitude of impact of identified barriers to movement, dispersal, or hydrology and the effectiveness of habitat corridors.

7.4.5 Valley Floor Grassland and Vernal Pool

Biological effectiveness monitoring evaluates the success of the plan in meeting its stated biological goals and objectives (Noss and Cooperrider 1994). The main biological goals for the Valley Floor Grassland and Vernal Pool Natural Community are to: 1) maintain a reserve system that enhances the essential ecological processes, functions, values and species diversity of the community and 2) maintain and where possible, through restoration, increase population levels and distribution of vernal pool associated Covered Species. The presence and/or relative abundance of particular species, such as vernal pool crustaceans and native plant species, can act as a good surrogate for the ecological processes, functions, and values of the natural community. If management actions are successfully maintaining the integrity of the Natural Community, then the Natural Community should maintain high native species diversity. The primary focus of the Biological Effectiveness Monitoring Program is to establish presence and, in some cases, obtain estimates of relative abundance, species diversity and percent cover for 1) covered vernal pool plants, 2) covered vernal pool crustaceans, 3) Delta green ground beetles, and 4) California tiger salamanders (larvae). In addition to monitoring for these targeted species, incidental observations of Special Management Species, as well as, all other plant and wildlife species, will be noted during field surveys and other management activities shall be recorded and reported with the annual monitoring reports for each reserve.

7.4.5.1 Natural Community Monitoring. The primary goal of the Valley Floor Grassland and Vernal Pool Conservation Strategy is to establish and maintain a reserve system that enhances the essential ecological processes, functions, and values, and maintains species diversity and the potential for adaptation and evolutionary change of the ecosystems. The measurable component of the biological objective (Objective VPG 1.1) consists of preserving between 10,500 to 11,500 acres of vernal pool and valley floor grassland habitat. To determine if the preserved area is meeting the stated goal of establishing a reserve system that enhances the essential ecological processes, functions, and values, and maintains species diversity and the potential for adaptation and evolutionary change of the ecosystems, monitoring of the status and health of that ecosystem needs to be conducted. The relative

abundance and diversity of vernal pool endemics and percent cover of native versus non-native plant species provides a good measure of the overall health of the ecosystem[7]. Therefore, part of the Biological Effectiveness Monitoring Program for this natural community will include general vegetation monitoring.

In addition to preservation, a large component of the Valley Floor Grassland and Vernal Pool Conservation Strategy involves the restoration of between 270 to 400 acres of vernal pool wetlands within High and Medium Value Vernal Pool Conservation Areas (Objective VPG 1.2). The initial restoration activities and subsequent monitoring (at minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan (see Section 7.3.3). Following this initial monitoring period, long-term monitoring of a subset of these restored wetlands will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA. The monitoring of the restored wetlands will be conducted simultaneously and using similar techniques as the vegetation monitoring of existing vernal pool wetlands. This will allow for a comparison of the restored pools with existing pools (i.e., reference pools).

Vegetation Monitoring. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal VPG 1 and objectives VPG 1.1 and 1.2 (See Section 6.0).

Monitoring Objective VPG 1. What is the relative abundance and diversity of vernal pool endemics and percent cover of native versus non-native plant species in existing and restored vernal pools?

Biological Effectiveness Monitoring. Quantitative sampling methodology will be used to monitor vegetation parameters such as relative abundance, species diversity and percent cover in vernal pool, playa pool, seasonal wetland, and other vegetation associations. Pools to be monitored in any given year will be selected depending on the monitoring group they are placed in. Vegetation monitoring will follow the methods developed by and used in Barbour et al. (2007). These methods were developed to characterize vernal pool vegetation in California and provide standardized methods for assessing the success of restored pools. All pools sampled in a given monitoring year will be visually divided into different vegetation subtypes and one 10 m^2 plot will be placed within each vegetation subtype. Within each plot, every species will be identified and recorded, together with its estimated percent cover (use direct estimate - no cover classes). The total number of quadrates will depend on the number of vegetation association/community type present on a preserve. Plot locations will vary each sampling year, but the location of pools sampled will remain the same as set up in the initial sampling groups (see Table 7-2). Any locations of Covered or Special Management Plant Species that are encountered incidentally during these surveys will be mapped using a global positioning system unit.

[7] Hydrology and water quality monitoring to show compliance with specific avoidance and minimization and conservation measures will be done on individual reserves/preserves as part of their Resource Management Plan (See Section 7.3.3)

Performance criteria.

Preserved Vernal Pools

- The diversity and relative abundance of native vernal pool plant species shall remain constant or increase over time.
- The percent cover of native vernal pool plant species shall remain constant or increase over time.

Restored Vernal Pools

- Absolute and relative cover of each vernal pool endemic in constructed pools shall be statistically similar to the average values of each species in reference pools.
- The number of vernal pool endemics in constructed pools shall be statistically similar to the average number of those taxa among reference pools.
- The number and cover of non-native species in any constructed pool shall be statistically similar to or lower than the average among reference pools.
- The identity of community types in created pools and the mixture in which they occur should match that of reference pools (using a Sorensen Similarity Index formula where "matching" means an SSI >50 percent. In other words, constructed pools collectively should contain deep, shallow, and edge community types if reference pools have those community types, meaning that the depth, side slope, shape, and area of created pools should be as diverse as that of reference pools.

Problematic Invasive Species. The establishment and expansion of invasive plants may be the greatest long-term threat to the natural communities in the reserves established under the HCP as these aggressive exotic plants have significant potential to displace native species and impact sensitive species habitat.

While aggressive, exotic species are present in most reserve areas, the majority of the species occur as small and often isolated populations, typically in or adjacent to disturbed areas such as roadways, livestock watering sites, and utility rights of ways. Moody & Mack (1988) modeled the weed invasion process and clearly showed that, to slow the overall area invaded, it was more effective to eradicate small founding populations first, before attempting to eradicate large populations. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal VPG 1 and objectives VPG 1.1 and 1.2 (see Section 6.0).

Monitoring Objective VPG 2. What is the distribution and relative abundance of problematic invasive species on each reserve/preserve?

Biological Effectiveness Monitoring. Areas sampled during the vegetation monitoring will also be visually assessed to identify locations of aggressive, exotic species. Aggressive, exotic species are those classified as immediate management concern [A1 Species] by the California Invasive Plant Council and as Noxious Weeds by the California Department of Food and Agriculture.

Performance Criteria. Aggressive, exotic species (those classified as immediate management concern [A1 Species] by the California Invasive Plant Council and as Noxious

Weeds by the California Department of Food and Agriculture) shall show a downward trend in abundance and distribution in all reserves.

7.4.5.2 Covered Species Monitoring. The second goal of the Valley Floor Grassland and Vernal Pool Conservation Strategy consists of maintaining and where possible, through restoration, increasing population levels and distribution of covered vernal pool associated species (Goal VPG 2). For each Covered Species there is an objective specifying how many occurrences will be either preserved or established within the Solano HCP reserve system. The extant of preserved occurrences will be assessed during the baseline surveys of individual mitigation areas as they become part of the Solano HCP Reserve System. During these baseline surveys, the location and general condition (abundance, density, etc.) will also be assessed. In addition to the occurrence data, suitable habitat areas for Covered Species will also be mapped during the baseline surveys. In general, Covered Species monitoring will be correlated with the Natural Community monitoring to allow for an analysis of correlations between community data and the status of the Covered Species occurrences.

Contra Costa Goldfields. SCWA received an ESA Section 6 grant from the US Fish and Wildlife Service to address the life history and status of Contra Costa goldfields (CCG) in Solano County to assist in the development of the Solano HCP. One of the objectives of the population assessment was to develop a cost-effective sampling program that can provide repeatable and statistically valid density estimates for assessing the effects of management strategies and for monitoring long-term population trends. Monitoring has been conducted in selected areas in 2006, 2007, and 2008 and is scheduled for the spring of 2009. The following monitoring methods are taken from these initial studies. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal VPG 2 and objectives VPG 2.1 and 2.2 (see Section 6.0).

Monitoring Objective VPG 3. What is the distribution and relative abundance of Contra Costa goldfields within preserves?

Biological Effectiveness Monitoring. Population estimates for Contra Costa goldfields shall be completed for all reserves within the range of this species established under the Solano HCP. During the initial inventory phase and for each monitoring period, all potential habitats within the preserve will be surveyed for the presence of Contra Costa goldfields. Each preserve area will be lumped into regions based on hydrological connectivity or similarity in growing conditions. Within each preserve region, all stands of Contra Costa goldfields will be mapped using a GPS unit, with a minimum submeter accuracy, during the peak blooming period at each reserve.

Transects will be established within mapped concentration areas and 5 to 10, 0.25 square meter (m^2) (50cm by 50 cm) plots will be randomly selected along the transect. The total number of transects (and plots) per mapped area will be determined by the size of the goldfield area. If the mapped areas are too small to run transects, individual plots will be counted instead and the location of the plots will be selected by randomly placing the quadrat into the pool. A minimum of 50 quadrates will be sampled per reserve region, as identified by hydrological connectivity and similarity in growing conditions, etc. The total number of quadrates may increase depending on the variation in densities within a region.

Within each 0.25 m^2 quadrat, all CCG plants identified as individuals will be counted. An individual plant that has several stems originating from the same root base shall be counted as one plant. Additional data collected for each quadrate shall included a visual estimate of the percent cover by CCGs, average number of flowers per plant, estimate of percent cover of other goldfield species (*Lasthenia sp.*), and an estimate of percent cover for other dominant plant species observed in the quadrat (at least the three other dominant plant species in the quadrat).

All of the plots from each designated region will be combined to calculate a mean density and the total number of plants. The total number of plants will be estimated by multiplying the mean density of CCGs by the total goldfield area mapped in the field. As an annual species, substantial year to year fluctuations in population numbers is expected based on the timing of rainfall and duration of inundation of the vernal pools. Populations will be surveyed at least once during Phase 1, every year during Phase 2, and every three years after that in perpetuity. The 10 year baseline survey period should provide a reasonable range of seasonal fluctuations to establish threshold levels for adaptive management.

Performance Criteria.

Preserved Stands

- Contra Costa goldfields shall occur in the same or greater percentage of pools sampled during the monitoring year as during the baseline surveys.

Planted/Restored Stands

- The number of Contra Costa goldfields in each planted pool shall show an increasing trend over time, until they are comparable in densities to existing pools.

Covered Vernal Pool Plant Species. The following monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives VPG 2.3 through 2.10.

Monitoring Objective VPG 4. What is the distribution and status of populations/occurrences of covered vernal pool plant species within the reserve system?

Biological Effectiveness Monitoring. Vernal pool plant species covered under this Plan occur in similar habitats, therefore, there will likely be overlap between monitoring efforts for each species. However, how they occur within these habitats differs (i.e., they have different life forms and ecologies); therefore, sampling techniques will differ depending on the species. For all Covered Plant Species, occupied and suitable habitat areas will be divided up into monitoring groups (Table 7-2). The permanent monitoring group will consist of only known occupied habitat areas and suitable habitat areas only if the known occupied habitat areas consist of less than $1/6^{th}$ of the total suitable habitat. Sampling groups for each Covered Plant Species will be correlated with each other and with the vegetation monitoring as possible to maximize efficiency. During Phase 1 of the Biological Effectiveness Monitoring Program, techniques will be developed for each vernal pool plant covered under the Plan to quantitatively assess the overall health and status of each occurrence and of their overall

population levels throughout the reserve system. At minimum, the monitoring technique will collect presence/absence data or estimates of the PAO (MacKenzie et al. 2003).

Performance Criteria. Each Covered Species is observed in the same or greater percentage of pools sampled during the monitoring year as during the baseline survey.

Delta Green Ground Beetle. Biological objectives VPG 2.11 states that the Plan will preserve 2,500 acres of natural vernal pool grassland containing a self-sustaining colony of Delta green ground beetles within the Plan Area. The following monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objective VPG 2.11.

Monitoring Objective VPG 5. What is the distribution and relative abundance of Delta green ground beetles within the preserve system?

Biological Effectiveness Monitoring. All preserved suitable habitat area will be divided up into six monitoring groups as described above (Table 7-2). Observation posts/sites within preserve areas adjacent to known and suitable habitat areas will be established. A few surveys (five) will be performed in known occupied areas on a few warm winter days in January to determine when adult Delta green ground beetles first become active. In late January to early February, each observation site will be surveyed for a minimum of 30 minutes. The number and activity of all Delta green ground beetles will be noted. Data to be recorded includes GPS location, basic vegetation composition (vegetation height, dominant plant types, percentage of bare ground, etc.) and distance to water. If beetles are not found during the first survey, additional surveys will be conducted towards the end of February, March and the beginning of April. The number of return visits will be determined based on the species' detection probability estimated during Phase 1.

Performance Criteria. The proportion of sites occupied by Delta green ground beetle will not decrease significantly on preserves.

Vernal Pool Crustaceans. The following biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives VPG 2.12 through 2.15.

Monitoring Objective VPG 6. What is the distribution and relative abundance of vernal pool crustaceans within the preserve system?

Biological Effectiveness Monitoring. Vernal pool crustaceans will be monitored at sites that will be standardized to ensure that their populations are remaining extant on the preserves and to provide a baseline index for long-term population abundance. Vernal pool crustaceans shall also be monitored at standard sites in restored pools in order to assess effectiveness of habitat restoration and community development. For all covered vernal pool crustaceans, occupied and suitable habitat areas will be divided up into six monitoring groups following the monitoring protocol outlined in Table 7-2. The permanent group will consist of known occupied habitat areas only, unless known occupied habitat areas comprise less than $1/6^{th}$ of the suitable habitat areas. Sampling groups for each species will be correlated as much as possible to maximize survey efficiency.

Covered fairy shrimp (*Branchinecta* sp.) take approximately 3-4 weeks after a pool fills with water to reach maturity. After reaching maturity they are usually only detectible in a pool for another month. Generally, *Branchinecta* sp. are present and detectable in an occupied pool from about the third week after it fills until approximately 8 weeks after it fills. Approximately three to four weeks after pools fill (i.e., contain more than one inch of standing water) they will be sampled for fairy shrimp. Volume-standardized "plankton tow samples," using a standard, hand-held rectangular net frame fitted with 500 micron mesh plankton netting will be used for the sampling. Pool depth at the deepest portion of the pool will also be measured during each survey. If fairy shrimp are not detected during the first survey, pools will be re-sampled approximately 2-3 weeks later (i.e., six weeks after the pool has filled) and again if necessary during the eighth week after the pool has filled.

Vernal pool tadpole shrimp (*Lepiduras packardi*) typically require at least 6 weeks after pools fill with water to reach maturity. However they will remain detectable (present) in a feature until the feature dries up. Sampling will be conducted for vernal pool tadpole shrimp, using the same method described for fairy shrimp, approximately eight weeks after a pool has filled. If vernal pool tadpole shrimp are not detected during the first survey, pools will be re-sampled approximately 2-3 weeks later (or just before the pools dry up). If tadpole shrimp are observed in pools during surveys for other fairy shrimp, then these pools need not be resurveyed.

Additional data to be collected will include maximum pool depth and water temperature. Visual observations of other potential water quality problems such as presence of oil film, trash or other unnatural debris, or algae mats (if not a natural occurrence based on pre-project surveys) will also be recorded.

Performance criteria.
Preserved Vernal Pools

- Each listed vernal pool crustacean species is observed in the same or greater percentage of pools sampled during the monitoring year as during the baseline survey.

Restored Vernal Pools

- Should show establishment of self-reproducing populations of covered vernal pool crustaceans.

California Tiger Salamanders. The following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives VPG 2.16 and 2.17.

Monitoring Objective VPG 7. What is the proportion of area occupied and relative abundance of California tiger salamanders at suitable breeding habitat on each reserve/preserve?

Monitoring Objective VPG 8. Did occupied breeding sites on preserves/reserves hold water long enough to support successful recruitment into the population?

Biological Effectiveness Monitoring. California tiger salamanders will be monitored at sites that will be standardized to ensure that their populations are remaining extant on the

preserves and to provide a baseline index for long-term population abundance. California tiger salamanders shall also be monitored in created pools in order to assess their effectiveness. All currently occupied and suitable breeding habitat areas (any seasonal aquatic habitat that retains ponded water for a minimum of 10 consecutive weeks) will be divided up into six monitoring groups following the monitoring protocol outlined in Table 7-2. Each group will consist of a representative sample of the full range of suitable habitat present within the preserve/reserve system. The permanent monitoring group shall consist of known occupied habitat areas only, unless known occupied habitat areas comprise less than $1/6^{th}$ of the suitable habitat areas. Aquatic larval surveys will be conducted in the permanent and one additional monitoring group in any given monitoring year (i.e., 1/3 of the occupied and suitable habitat areas within preserves/reserves).

Larval surveys will be conducted starting in March. If larval salamanders are not detected during the first survey, pools will be re-sampled in April, and, if necessary again in May, with at least 10 days between surveys. If pools are likely to dry prior to the completion of three surveys, the sampling schedule should be shifted accordingly. For breeding sites smaller than 0.25 acre or larger sites where seines are not practicable, sampling shall be completed using D-shaped or similar (minimum size of 12 inches in width by 6 inches in height), long-handled dipnets with 1/8th inch (3.2mm) or finer mesh. For breeding sites larger than 0.25 acre (10,000 square feet), minnow seines, one-eighth inch (3.2 mm) or finer mesh with weights along the bottom and floats along the top edge shall be used. The following table shall be used to determine the minimum number of dip net samples per breeding site:

Pool Area**	Shallow Samples*	Medium Samples	Deep Samples	Total Samples*
< 100 ft^2	2	0	2	**4**
100 - 500 ft^2	4	0	4	**8**
500 – 1,000 ft^2	4	4	4	**12**
1,000 – 1,500 ft^2	6	6	6	**18**
1,500 – 2,000 ft^2	8	8	8	**24**
2,000 – 5,000 ft^2	10	10	10	**30**
5,000 – 10,000 ft^2	20	20	20	**60**

* Each sample consists of sweeping the dip-net through the same 1-meter section of pond approximately 4 times.

** For sites greater than 10,000 square feet (approximately 0.25 acre), seines shall be used to sample a minimum of 30 percent of the shallow, medium and deep depth portions of the breeding site.

Index values based on the number of larvae captured based on the volume of the pool sampled shall be calculated for each breeding site to estimate abundance. A representative number of larvae shall also be measured for length.

A subset of the shallower occupied breeding areas (i.e., areas with the shortest average hydroperiod) will be sampled during all three larval survey efforts. The first time will be to determine occupancy. The second time shall be to estimate the approximate time required for the larvae to successfully metamorphose and approximately how long the pool will contain water. The final survey shall be timed to determine whether larvae were able to complete metamorphoses prior to the pool drying.

All sampling should adhere to current standard USFWS (2003b) sampling protocols with respect to general sampling protection measures (limiting habitat disturbance, disinfecting equipment, etc.).

Performance Criteria.

Preserved Breeding Habitat

- The proportion of occupied breeding habitat shall not decrease significantly for more than three consecutive monitoring years.
- In an average rainfall year, the majority of the occupied breeding habitat shall have successful recruitment into the population.

Created Breeding Habitat

- Created breeding habitat shall be occupied by California tiger salamanders with the same frequency as pre-existing breeding habitat.
- Created breeding habitat shall show successful recruitment into the population within most rainfall years.

7.4.5.3 Targeted Studies. Potential targeted studies needed for the implementation of the Monitoring and Adaptive Management Program for the Solano HCP are divided into eight categories based on topic. Conforming to the scientific principles established in Section 7.1.3, these potential study objectives are stated as specific hypotheses or questions. Not all studies listed below are anticipated to be funded. This list is intended to be a guide for potential research questions for proposals, submitted to SCWA as part of their research program, to address.

General.

- How reliable are monitoring protocols for Covered Species in determining presence? What are the detection probabilities of various monitoring protocols?
- For most vernal pool plant species, little information is available on population trends and dynamics, species interactions, genetics and connections to regional habitats to carefully quantify the probability of long-term persistence. Targeted studies designed to fill these data gaps are needed.

Dispersal and Corridors.

- What are the dispersal patterns and capabilities of vernal pool species? Where is concentrated movement most likely (along swales, significant slope breaks, near breeding sites, etc.)?
- How wide do corridors have to be to provide "livable habitat" to species? What size and condition do corridors have to be in to allow for animal movement, seed dispersal and long-term genetic interchange between populations?

Vernal Pool Genetic Studies.

- What is the genetic diversity and "evolutionary potential" of vernal pool species, particularly vernal pool plants and crustaceans?
- Where are the boundaries between local genetic population complexes?

Response to Management Regimes.

- What are the responses of vernal pool plant communities to various management regimes, including grazing, burning, and mowing? In particular, research is needed relating specifically to Covered Species or that provide relevant information on managing for these species. Research efforts should focus on the temporal and spatial dimensions and intensity of these management regimes. Long-term research is also required to account for changes in vegetation caused by weather variables that can confound the results of changes caused by manipulating the management regime (Ford and Huntsinger 2004).

Invasive Species Control.

- What methods are most effective in controlling or reducing problematic invasive species?

Restoration.

- What are the best methods for restoring vernal pools? More research is needed on the extent to which vernal pool plant communities can be restored. Most efforts to restore vernal pool ecosystems have failed to fully replace natural system functions (De Weese 1998), although it does appear that at least some functions and characteristics can be re-established (Collinge 2003).
- What are the optimum seeding rates for introduction/reintroduction efforts of covered plant species?
- What are the optimum methods for introduction/establishment of vernal pool crustaceans into restored/constructed vernal pools?
- Is their a need for, and to what extent or priority, should artificial seed banking be used?
- Are there adaptive management measures to supplement natural seed production?
- Where should seeds, salvaged from a specific location, be used for restoration efforts without affecting the genetic structure of the population?

Contra Costa Goldfields.

- What levels of genetic diversity are present within and across Contra Costa goldfield populations within the Plan Area?
- How is genetic diversity structured among populations of Contra Costa goldfields?
- How would the loss of populations affect the overall genetic diversity within the species?
- What recommendations can be made regarding future conservation and restoration projects involving Contra Costa goldfields based on genetic data?
- Is their a need for, and to what extent or priority, should artificial seed banking be used?
- Are there adaptive management measures to supplement natural seed production?
- What are the optimum seeding rates for introduction/reintroduction efforts?

California Tiger Salamanders.

- What ratio of upland habitat to breeding habitat is required to support a viable population of California tiger salamanders?
- How do various diseases impact different life stages and how does disease play a role in population dynamics?

7.4.6 California Red-Legged Frog

Effectiveness monitoring evaluates the success of the plan in meeting its stated biological goals and objectives (Noss and Cooperrider 1994). The two main biological goals for the California red-legged frog are to: 1) maintain or increase frog populations through preservation and management of interconnected blocks of upland and aquatic habitats that support natural movement patterns, breeding, and metapopulations dynamics within the California Red-legged Frog Conservation Area. and 2) re-establish or expand populations of California red-legged frogs within California Red-legged Frog Conservation Area and other portions of its historic range within the Inner Coast Range Natural Community. This will be primarily accomplished through the preservation, management and enhancement of 3,300 acres of inner coast range upland, riparian and aquatic habitats within the California Red-legged Frog Conservation Area. Populations will be re-established and expanded through the control of nonnative predators and competitors (e.g., bullfrog, crayfish, and warm water fish) and the direct transplanting of frogs either from reserves or frogs salvaged from habitats impacted by Covered Activities.

The Biological Effectiveness Monitoring Program for California red-legged frogs focuses on two parameters: 1) the percent of suitable breeding habitat occupied by California red-legged frogs and 2) the percent of habitat occupied by introduced predators. The Monitoring and Adaptive Management Program for California red-legged frogs will be implemented on preserves within the California Red-legged Frog Conservation Area (Figure 4-16).

California Red-legged Frog Population Monitoring. Monitoring of California red-legged frog populations will follow the general monitoring design outlined in Section 7.4.3. As part of the approval processes for a reserve to be established under the Solano HCP, an assessment of potential habitat for California red-legged frogs and surveys using standard protocols (USFWS 2004b) must be conducted. During these initial surveys, suitable breeding habitat will be identified and the locations will be recorded and mapped using a GPS unit and important microhabitat variables will be collected (estimate of total pond area, hydroperiod, percent cover of emergent and submerged vegetation, dominant plant species present, other species observed, the presence of introduced predators [i.e., bullfrogs, crayfish and introduced fish] and any native predators observed). Landscape level variables, such as distance to nearest occupied breeding habitat and surrounding land use practice, will be estimated using GIS. All suitable breeding habitat will then be surveyed during the appropriate time of year for larvae and recently metamorphosed frogs to document breeding. This initial assessment of each reserve prior to becoming established under the Solano HCP will provide the background data for the Biological Effectiveness Monitoring Program administered by SCWA.

A large component of the California Red-legged Frog Conservation Strategy involves the construction of new breeding habitat (Conservation Measure RLF 2.1). The initial construction activities and subsequent monitoring (at minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan (see Section 7.3.4). Following this initial monitoring period, long-term monitoring of these created breeding habitats will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA. After the initial five year monitoring period, the created breeding habitat will be monitored as part of the regular population monitoring for occupancy.

The following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives RLF 1.1 and 1.2.

Monitoring Objective RLF 1. What is the proportion of breeding habitat occupied by California red-legged frogs in a monitoring year?

Monitoring Objective RLF 2. What proportion of breeding habitat is occupied by California red-legged frog metamorphs in a monitoring year?

Biological Effectiveness Monitoring. California red-legged frogs will be monitored at suitable breeding habitats using standard protocols (USFWS 2004b). During surveys, important microhabitat variables will be collected (estimate of total pond area, hydroperiod, percent cover of emergent and submerged vegetation, dominant plant species present, other species observed, the presence of introduced predators [i.e., bullfrogs, crayfish and introduced fish] and any native predators observed). All suitable breeding habitat will then be surveyed during the appropriate time of year for larvae and recently metamorphosed frogs to document successful breeding.

The Solano HCP will adopt a similar strategy to monitoring California red-legged frog populations as the Amphibian Research and Monitoring Initiative (ARMI). This program has adopted PAO (MacKenzie et al. 2003) as a standardized metric for midlevel monitoring of amphibian populations. The PAO statistical approach, (MacKenzie et al. 2003) evaluates the fraction of the landscape that is occupied by a species of interest, but not the actual abundance of the population across the landscape. It is therefore a monitoring technique that is less costly than methods that attempt to estimate population sizes, and ideal for large-area monitoring programs that seek to identify areas where species may be in decline. Once identified, these areas could then be monitored more closely and appropriate management actions taken to halt the decline.

A windows-based software program has been developed called PRESENCE (http://www.mbr-pwrc.usgs.gov/software) that incorporates the statistical method described in MacKenzie et al. (2003) for estimating site occupancy rates. This new statistical model also permits the direct estimation of rate of change in PAO and estimations of seasonal colonization and local extinction probabilities, thus facilitating the mechanistic modeling of factors influencing population change.

Performance criteria. The proportion of habitat occupied by California red-legged frogs shall either remain the same or show an increasing trend from the proportion of habitat occupied during baseline surveys.

Establish New or Augment Existing Breeding Populations. Goal RLF 2 is to Re-establish populations of California red-legged frog within the California Red-legged Frog Conservation Area. Objective CRLF 2.3 is to establish new or augment existing breeding populations in established preserves within the Inner Coast Range Natural Community through establishment of new aquatic breeding habitat and transplanting of California red-legged frog from reserves or frogs salvaged from habitats impacted by Covered Activities. The following monitoring objectives and biological

effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives RLF 1.3 and 2.3.

Monitoring Objective RLF 3. Are California red-legged frogs successfully establishing and reproducing in ponds where translocation has occurred?

Monitoring Objective RLF 4. In occupied ponds where additional California red-legged frogs were translocated to areas where the population was limited, are populations increasing after the translocation?

Biological Effectiveness Monitoring. The California red-legged frog population will be monitored at sites where translocation has occurred using standard protocols (USFWS 2004b). During surveys, important microhabitat variables will be collected (estimate of total pond area, hydroperiod, percent cover of emergent and submerged vegetation, dominant plant species present, other species observed, the presence of introduced predators [i.e., bullfrogs, crayfish and introduced fish] and any native predators observed). All suitable breeding habitat will then be surveyed during the appropriate time of year for larvae and recently metamorphosed frogs to document successful breeding. These populations will be monitored annually for five years to determine the effects of the translocation on the population. After the five consecutive years, these populations will be monitored consistent with the regular population monitoring for the species.

Performance criteria. Population levels of California red-legged frogs in ponds where they have been relocated shall show an increasing trend over time.

Hydrology Monitoring. Goal RLF 2 is to Re-establish or expand populations of California red-legged frog within California Red-legged Frog Conservation Area and other portions of its historic range within the Inner Coast Range Natural Community. Objective RLF 2.1 states to limit the expansion of nonnative predators and competitors of California red-legged frogs and other native amphibians (e.g., bullfrog, crayfish, and warm water fish) within the Inner Coast Range Natural Community. This is designed to be achieved passively through Conservation Measure RLF 6 which prevents the establishment new perennial ponds, small lakes, or other perennial water bodies that could provide habitat for nonnative species such as bullfrogs, crayfish, and warm water fish species. The following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives CRLF 2.3.

Monitoring Objective RLF 5. Is there a net change in hydrology in adjacent streams following a development project?

Biological Effectiveness Monitoring. Plan Participants shall establish monitoring sites in second order streams supporting riparian vegetation, third, fourth, and higher order streams that are currently intermittent, either occupied by or could potential support California red-legged frogs within the Inner Coast Range, and that are either adjacent to or downstream of development projects to be authorized under the HCP. Hydrographs of these drainages will be monitored to ensure that historically intermittent creeks do not become perennial from excess storm water runoff. This monitoring will be conducted in addition to the water quality

monitoring conducted for the Riparian, Stream, and Freshwater Marsh Natural Community. Potentially affected streams will be identified and monitoring sites will be established within the first five years following adoption of the Plan. Baseline monitoring will be conducted annually during Phase 2 and then every three years thereafter in perpetuity during Phase 3. Hydrology monitoring of detention basins or other aquatic habitat features established on reserves/preserves or as part of development projects will be conducted by each individual project as part of their long-term operation and maintenance programs (See Section 7.3.4).

Performance criteria. No net change in the hydrology of streams adjacent to or downstream of approved development projects.

7.4.6.1 Targeted Studies. For the California red-legged frog, few data exist on the dispersal patterns and utilized habitats of the frogs, especially the young, and this information may be critical for evaluating the adequacy of terrestrial habitat that surrounds and connects multiple breeding ponds required by the species.

More information is also needed concerning the most effective methods to eradicate introduced predators, particularly bullfrogs. Some initial questions that should be addressed include:

- Where should initial eradication efforts be concentrated?
- In which areas is it practical and feasible to remove bullfrogs?
- What combination of management techniques can and should be used at each site (i.e., what techniques are the most feasible and effective for each habitat type)?
- How will bullfrogs be prevented from recolonizing areas where they have already been eradicated from?
- How will the plan deal with bullfrog movement from land that is inaccessible for bullfrog control?
- Can an incentives program be developed to get private land owners to implement bullfrog control/eradicate and prevention?

7.4.7 Callippe Silverspot Butterfly

Callippe silverspot butterfly monitoring involves two components. The first component addresses mapping and monitoring the distribution and abundance of the larval host plant (Johnny jump-up). The second addresses surveying and monitoring for adult butterflies. Both of these monitoring components, will follow the general monitoring design detailed in Section 7.4.3 and in Table 7-2.

As part of the reserve approval processes, under the Solano HCP, an assessment of the distribution of the larval host plant, Johnny jump-up, will be conducted. During these initial surveys, patches of Johnny jump-up will be identified and the locations will be recorded and mapped using a GPS unit. The upland areas will be surveyed for adults during the appropriate time of year and under the appropriate weather conditions. This initial assessment of each reserve prior to becoming established under the Solano HCP will provide the background data for the Biological Effectiveness Monitoring.

Another component of the Callippe Silverspot Butterfly Conservation Strategy involves the restoration/enhancement of additional host plant (*Viola pedunculata*) and nectar plant habitat (Conservation Measure CSB 3). The initial restoration activities and subsequent monitoring (at

minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan (see Section 7.3.5 and Section 10.5). Following this initial monitoring period, long-term monitoring of these habitat areas will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA.

Johnny Jump-up Monitoring. The following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives CSB 1.1 and 1.2.

Monitoring Objective CSB 1. What is the distribution and density of stands of the Johnny jump-up (*Viola pedunculata*) on reserves/preserves within the potential range of the Callippe silverspot butterfly within the Plan Area?

Biological Effectiveness Monitoring. Reserve areas within the Callippe Silverspot Butterfly Conservation Area, with suitable habitat for Johnny jump-up, identified during baseline surveys, will be divided up into appropriate monitoring groups (see Table 7-2). These areas will be surveyed for Johnny jump up stands during the peak blooming period. The location and area of all stands, within each monitoring unit, will be measured and mapped using a GPS unit, with minimum submeter accuracy. When a relatively large area supporting the target plant is located a 1-m^2 square quadrat will be used to facilitate the counting of individual plants. Density measures for relatively large areas will be estimated via transects bisecting the center of the subpopulation and all plants within 1 meter of the centerline, 2 meters, 3 meters, etc. will be counted in a predetermined stretch until no more plants are found. For smaller subpopulations, a 1-m^2 square quadrat will be placed in such as a manner as to encompass all the plants in the stand. Stands covering less than 1 m^2 will be counted without the aid of the quadrat, and scattered individuals will not be counted. In this manner a likely estimate of all the plants within a preserve/reserve area will be obtained. The distance between subpopulations will also be estimated using GIS. In addition to populations of the larval host plant, the location and distribution of the adult nectar plants and other dominant plant species will also be noted during these surveys. Populations will be monitored at least once during Phase 1, every year during Phase 2, and every 3 years for the life of the HCP.

Performance Criteria. The relative area and density of Johnny jump-up stands shall show an increasing trend overtime.

Callippe Silverspot Butterfly Population Monitoring. The following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological objectives CSB 1.1 and 1.3.

Monitoring Objective CSB 2. What proportion of habitat is occupied by Callippe Silverspot butterflies within the HCP Reserve System?

Biological Effectiveness Monitoring. Surveys will be conducted for the presence of Callippe sliverspot butterflies within potential habitat on preserve/reserve. Areas containing all three habitat requirements for the Callippe silverspot butterfly, larval host plant, adult nectar plants and hilltops and ridgelines, identified during the baseline surveys will be divided up into potential subpopulations. The habitat area, identified as one potential subpopulation will be

considered one site. Surveys will be conducted by qualified biologists during the appropriate time of year, and will entail walking a route that encompasses the designated subpopulation area on a preserve/reserve that supports the larval host plant, seasonal watercourses, areas supporting nectar plants and hilltops and ridgelines. The location of each butterfly observation will be recorded using GPS, and should include notes on the surrounding habitat (i.e., distance to nearest larval host plant populations, adult nectar plant or hilltop or ridgeline), behavior observed, time of day and weather variables. All sites will be surveyed for the presence/absence of butterflies in a rotating panel design. Populations will be monitored at least once during Phase 1, every year during Phase 2, and every 3 years for the life of the HCP.

To estimate detection probabilities, each site will be visited a maximum of 2 times during the survey year. A second visit will only be performed if butterflies are not observed during the first visit. A subset of sites will be treated as intensive sites and visited 4 times during the survey period, even if butterflies are detected during the first visit, in order to more accurately estimate detectability of butterflies by the protocol and improve accuracy of the calculations.

Performance Criteria. The proportion of sites occupied by Callippe silverspot butterfly will either remain the same or show an increasing trend over time.

7.4.7.1 Targeted Studies. Specific research needs and targeted studies that would improve efforts to successfully manage and monitor this species were broken up into five categories corresponding to the data gaps and uncertainties section. These include:

Population Genetics. In general, more research is needed on the phylogeography of this species complex. For example, how are the 16 different subspecies within the *Speyeria callippe* species complex related? Do the morphological characters that distinguish subspecies correspond to distinct genetic lineages? Is the *Speyeria callippe callippe* that occurs in Solano County the same as other populations of *S. c. callippe* in the Bay Area? In other words, are the silverspot butterflies, resembling the Callippe subspecies within Solano County, more closely related to *callippe callippe* than to *callippe comstocki* or *callippe liliana.*

Rodent Control. Rodents have a large effect on the turn over of grassland soils. This has implications for mineral cycling in grassland ecosystems. Rodents also create local areas of disturbance that could be colonized by a variety of plant species. What is the relationship between rodents and the larval and adult food plants of the Callippe silverspot butterfly?

Fire. The affects of fire on Callippe silverspot butterfly populations is not well known. Experiments need to be conducted to determine whether controlled burning of limited areas of habitat at particular times of year would benefit butterfly populations.

Johnny Jump-up Reproduction and Establishment.

- What are the pollination and seed dispersal mechanisms of Johnny jump-up (*Viola pedunculata*)?
- Specifically, what role do ants play in the seed dispersal of Johnny jump-up?

- What are the factors that affect the germination success of Johnny jump-up? What is the ability of seedlings to compete with other grassland species? This and other factors affecting the expansion of populations of Johnny jump-up should be examined.
- What are the microhabitats requirements of Johnny jump-up? How do factors such as spring moisture, depth of soil, and associated plant species affect the distribution and density of Johnny jump-up stands?
- What is the role of grazing in maintaining violet populations?

Buffers. What are the dispersal capabilities of the Callippe silverspot butterfly? How tolerant is this species to disturbance and how wide should buffers be in order to facilitate movement between subpopulations and minimize disturbance to populations?

7.4.8 Riparian, Stream, and Freshwater Marsh

Biological effectiveness monitoring for the natural community and associated Covered Species are described below. Monitoring for this Natural Community primarily includes water quality monitoring, an assessment of riparian habitat quality and invasive exotic species.

7.4.8.1 Natural Community Monitoring. The primary goal of the Riparian, Stream, and Freshwater Marsh Natural Community is to maintain and enhance the natural hydro-geomorphic processes, essential ecological processes, functions, and values, species diversity and habitat heterogeneity of riparian, stream, and freshwater marsh habitat within the Plan Area. The three main areas of focus for the biological effectiveness monitoring include water quality, riparian habitat quality and problematic invasive species. A large component of the Conservation Strategy involves the restoring riparian habitat. The initial restoration activities and subsequent monitoring (at minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan (see Section 7.3.6). Following this initial monitoring period, long-term monitoring of a subset of these restored areas will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA.

Hydrology and Water Quality. Several of the conservation measures in Section 6.0 are designed to maintain the hydrology and water quality within priority drainages. This monitoring, in combination with project specific monitoring, will be conducted to ensure that these conservation measures are effectively achieving goal RSM 1and objectives RSM 1.5 and 1.6.

Monitoring Objective RSM 1. Are natural hydrological patterns or processes in key watersheds being maintained?

Biological Effectiveness Monitoring. Urban development that would likely increase impervious surfaces above levels that could be expected to alter hydrological patterns is planned within the watersheds of key natural drainages in the Laurel, Ledgewood, Laguna, Gibson Canyon, and Sweeney creeks where at least portions of the creek channels remain in relatively natural conditions (e.g., the creek channels have not been fully reconstructed into trapezoidal channels). Plan Participants shall establish 3 to 5 monitoring sites per affected reach of the key drainages, within the first five years following adoption of the Plan, in order to assess the effectiveness of conservation measures designed to minimize changes in channel

forming and peak flows. Baseline monitoring will be conducted annually during Phase 2 and then every three years thereafter in perpetuity. The following parameters shall be monitored:

- **Suspended Sediment Volumes**. Suspended sediments will be measured in streams using a single stage sampler, or an equivalent apparatus, in coordination with stream flow measurements at suitable locations in the streams. At least one set of samples will be collected during two to three large storm events each season.
- **Bedload Sediment Deposition/Scour.** Bedload sediment deposition and or scour shall be measured at fixed sites by measuring the depth of accumulated sediments or scour in representative stream habitats (pools, riffle, runs) at or near the monitoring stations.
- **Stream Cross Sections**. Cross section profiles shall be measured at permanent stations at each monitoring site. Cross sections will be placed at representative transition points (typically 3 to 5 cross sections) where erosion or sediment deposition is most likely to occur. The cross sections will serve as a control for the map-based geomorphic interpretations, and will also provide data to evaluate future stability or instability.

Performance Criteria. Stream segments should remain stable or should evolve over the monitoring period in the direction of stability:

- There should be no evidence of new significant downcutting, bank erosion, rill formations or formation of new headcuts above baseline levels.
- Bedload sediment volumes should remain relatively stable; there should not be significant increases or decrease over time.
- Cross sections shall remain fairly stable and not show significant changes in channel depth, width, or profile (thalweg elevation).

Significant changes in the above criteria will require more in depth evaluation of the factors influencing channel morphology and potential alterations to the management of upstream hydrological controls associated with residential development.

Riparian Habitat Quality. The ecological and physical functions of streams and associated riparian habitats in Solano County have been severely impaired and continue to be threatened by a number of activities. The Science Advisors recommended that measures be developed to better assess riparian habitat quality and to establish parameters for future preservation, restoration and management. The Riparian Bird Conservation Plan prepared by The California Partners in Flight and The Riparian Habitat Joint Venture (RHJV 2000) identifies a number of important parameters for assessing and monitoring the health and value of riparian systems in the Central Valley. These parameters include factors such as adjacent land use, riparian zone width, distance to higher quality habitats, and structural diversity. During the HCP planning process a riparian habitat assessment was conducted that identified key areas of restoration (LSA 2008a). The riparian habitat quality monitoring program will continue using the approach used in this assessment to track the long-term success of restoration and enhancement activities, as well as, ongoing invasive species control activities. The initial monitoring of restored habitat areas and the success of avoidance and minimization measures will be conducted by individual projects as part of their Resource Management Plans and Restoration and Enhancement Plans (see Section 7.3.6). Following this initial monitoring period, these locations will be incorporated into the long-term monitoring conducted under the Biological Effectiveness

Monitoring Program administered by SCWA. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal RSM 1 and objectives RSM 1.1, 1.2, 1.4 and 1.5 (see Section 6.0).

Monitoring Objective RSM 2. What is the quality of riparian habitat on preserves throughout the Plan Area?

Biological Effectiveness Monitoring. Riparian, stream, and freshwater marsh habitat on preserves within the Plan Area will be evaluated by collecting data at discreet sample locations, with an emphasis on areas where restoration, enhancement, and invasive species control measures have been conducted. All riparian, stream, and freshwater marsh habitat within reserves shall be divided up into five monitoring groups (Table 7-3). Each monitoring group will consist of a representative sample of each habitat type, representing significant drainages and physiographic regions encompassed within the reserve system. Discrete sample locations, encompassing a representative sample of each habitat type, within each monitoring group will be assessed using standard stream assessment methods (Delaware River Basin Commission, et al. 1996; Koning, 1999; Rosgen, 1996; U.S.D.I., Bureau of Land Management, 1994, 1993, 1992a, 1992b). Information on a number of key attributes will be collected at each sample location and a GPS point will be taken. At each location, the following characteristics will be assessed:

- adjacent land uses,
- upland buffers widths,
- stream width,
- channel morphology,
- canopy width,
- canopy cover and species composition,
- shrub cover and species composition,
- herbacious cover and species composition,
- habitat for Covered Species (e.g., elderberry shrubs),
- wildlife habitat features (e.g., snags, down logs, pools etc.),
- invasive species,
- bank erosion, and
- disturbance.

This assessment will occur at least once during phase 1 of the monitoring program (Table 7-3). Unlike, the monitoring schedule for assessing populations, it is unlikely that riparian habitat features will change drastically from year to year. Monitoring of restored and enhanced areas will be conducted annually for at least five years on individual reserves: this monitoring is designed to compliment the reserves specific monitoring. The long-term monitoring cycle, of three year intervals will begin in year 6 (Table 7-3). The permanent monitoring group will be monitored every monitoring year and each additional group will be monitored on a rotating basis, such that all areas will be monitored at least once in 15 year cycles (Table 7-3).

Table 7-3: Monitoring Schedule for Riparian, Stream, and Freshwater Habitats

Monitoring Group	Monitoring Year									
	Phase 1	Long-term Monitoring								
	1 to 5	6	9	12	15	18	21	24	27	30
Permanent	X	X	X	X	X	X	X	X	X	X
1		X				X				X
2			X				X			
3				X				X		
4					X				X	

Performance Criteria. Specific performance criteria have yet to be developed. However, the initial performance criteria will be to see a net overall increase in the health of riparian habitat throughout the Plan Area over time. Long-term performance criteria developed as part of the Restoration and Enhancement Plans for individual sites will be incorporated into the overall performance criteria.

Problematic Invasive Species. The establishment and expansion of invasive plants may be the greatest long-term threat to the natural communities in the reserves established under the HCP as these aggressive exotic plants have significant potential to displace Covered Species and impact natural habitats. That is why Objective RSM 1.3 is to control problematic invasive exotic plant and animal species along a minimum of 30 miles of stream habitat within the County, particularly targeting Conservation Area RSM 2 stream reaches. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal RSM 1 and objectives RSM 1.3 (see Section 6.0).

Monitoring Objective RSM 3. What is the distribution and relative abundance of aggressive, exotic species in riparian areas within the Plan Area?

Monitoring Objective RSM 4. Are control measures successfully decreasing the distribution and abundance of these species?

Biological Effectiveness Monitoring. Monitoring for the distribution and abundance of aggressive, exotic species will be conducted in tandem with the overall monitoring of riparian habitat quality. Within the first 5 years of adoption of the HCP, Plan Participants are required to implement invasive species control measures as a regular part of the ongoing operations and maintenance activities associated with public facilities (flood control channels, parks, bike paths and linear parks, etc.). Within the first five years of the HCP, an assessment of the aggressive, exotic species will be assessed within the areas to be targeted in these programs. This information will then be used to guide the development of these programs and prioritization of areas and species to be targeted.

The areas to be treated within this program will be divided up into monitoring groups similar to those established for the Riparian Habitat Quality monitoring. Each monitoring group will

consist of a representative sample of each habitat type, with an emphasis on areas within Conservation Areas RSM 2 within Priority Drainages as well as other Priority Drainages (see Figure 4-11). Discrete sample locations, within each monitoring group, will be assessed for the abundance and distribution of aggressive exotic species. Invasive species monitoring will be conducted on the same schedule as the Riparian Habitat Quality monitoring (see Table 7-3).

Performance Criteria. Aggressive, exotic species (including those classified as immediate management concern [A1 Species] by the California Exotic Pest Plant Council and as Noxious Weeds by the California Department of Food and Agriculture) shall show a downward trend in abundance and distribution in all riparian areas within the Plan Area.

7.4.8.2 Covered Species Monitoring. Six Covered Species are associated with the riparian, stream and freshwater marsh Natural Community. Specific biological effectiveness monitoring and target studies for two of these species, California red-legged frog, and giant garter snakes, are addressed in Sections, 7.4.6, and 7.4.9, respectively. The second goal of the Riparian, Stream, and Freshwater Marsh Conservation Strategy (Goal RSM 2) is to contribute to the recovery of Covered Species associated with the natural community within the Plan Area through the preservation and expansion of existing populations, and allowing for future population expansion and re-colonization into restored areas. The following section describes the biological effectiveness monitoring for Covered Species associated with the natural community. All habitat restoration activities and subsequent monitoring (at minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan (See Section 7.3.6). Following this initial monitoring period, long-term monitoring of a subset of these restored areas will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA.

Salmonids. SCWA has implemented studies to better assess steelhead distribution within the County. The current effort along with other existing data has essentially focused on confirming presence of steelhead in a number of streams in the County. Such point in time data is valuable, but may not adequately identify important steelhead streams. As identified in the Science Advisors report, local steelhead subpopulations may be occasionally extirpated as a result of natural environmental cycles or other environmental problems, but may become reestablished by colonies from other subpopulations. Thus, the identification of suitable breeding/ rearing through assessment of habitat parameters may be more crucial than presence or absence data.

A salmonid habitat assessment for the Plan Area was conducted in 2008 to provide background information on the location of potentially suitable salmonid habitat as well as an initial assessment of fish passage barriers along key salmonid streams (LSA 2008b). This assessment concluded that American Canyon Creek, Jameson Canyon Creek, Green Valley Creek, Suisun Valley Creek, and Laurel Creek, have extensive lengths of potentially suitable habitat based on gradient and temperature thresholds assessed using a suitability model. Eleven potential fish passage barriers were identified in these streams. Objective RSM 2.1 states that the Plan Participants will remove all existing in-stream barriers, to the maximum extent practicable, within their rights-of-way along important steelhead streams within 10 years of the adoption of the HCP, and prevent the creation of new in-stream

barriers on private lands as new development occurs along Jameson Canyon, American Canyon, Ledgewood, Suisun, and Green Valley creeks and their tributaries that contain suitable breeding and rearing habitat for steelhead.

The Regional Water Quality Control Boards (Regional Boards) established beneficial uses (i.e., "uses that benefit the people of the state") for major streams within their jurisdiction. Three beneficial uses relate to the ability of a stream to support salmonid habitat. These beneficial uses are cold freshwater habitat (COLD), fish migration (MIGR), and fish spawning (SPWN). These are the three aspects that will be monitored under the Solano HCP biological effectiveness monitoring.

Monitoring Objective RSM 5. Is the pass-ability of potential salmonid streams increasing over time?

Biological Effectiveness Monitoring. One of the recommendations from the Salmonid Habitat Assessment (LSA 2008b) was to analyze potential barriers to fish passage in American Canyon Creek, Jameson Canyon Creek, Green Valley Creek, and Suisun Valley Creek using established/approved methods, such as the USDA-Forest Service Inventory and Assessment Procedure for Fish Passage Barriers (USDA 2005), to determine the degree to which passage is actually restricted and the feasibility of restoring passage. More extensive field surveys or polling of property owners should be conducted to identify other potential passage barriers that may have been overlooked by the first assessment. This analysis will be conducted within the first five years of Plan Implementation (i.e., during Phase 1 of the monitoring Program). A follow up assessment will be conducted in year 11 to ensure that Objective RSM 2.1 has been achieved.

Performance Criteria. All in stream barriers that were determined feasible to remove were removed by year 11.

This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal RSM 2 and objectives RSM 2.1 (see Section 6.0).

Monitoring Objective RSM 6. Are the designated salmonid streams maintaining suitable temperature ranges for the species?

Biological Effectiveness Monitoring. The following additional water quality data will be collected in salmonid streams, American Canyon Creek, Jameson Canyon Creek, Green Valley Creek, Suisun Valley Creek, and Laurel Creek, concurrent with the water quality monitoring:

- Water and air temperature data loggers will be installed to obtain annual and seasonal temperature data, capture diurnal variation in temperature, and obtain temperature data on a reach scale. These data will help to determine if shade cast by riparian vegetation keeps water temperatures sufficiently low for salmonids.
- Obtain streamflow and water level data, including an assessment of water withdrawal locations and amounts of water withdrawn seasonally. Flow measurements and stream gauging (installing permanent staff plates and water level monitors at a stable location in the channel) is useful to assess if a stream is providing suitable habitat for salmonids.

Performance Criteria. Key Salmonid drainages maintain suitable water temperature and flow levels to support salmonids.

This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal RSM 2 (see Section 6.0).

Monitoring Objective RSM 7. What is the location and extent of potentially important salmonid breeding and rearing habitat within the Plan Area and to what extent is it occupied?

Biological Effectiveness Monitoring. During Phase 1 a full habitat assessment will be conducted in suitable streams, identified in Salmonid Assessment (LSA 2008b), including a mapping of substrate/pool-riffles. During Phase 2 of the monitoring program, creeks and their tributaries that contain suitable breeding and rearing habitat for steelhead will be surveyed annually during the first ten years of the monitoring program for the presence of salmonids. Since the status of salmonids in these streams is currently not well documented, if salmonids are not observed occupying streams after five years, survey frequency will decrease to every three years consistent with the long-term monitoring schedule (Phase 3). The purpose of periodically surveying these streams over several decades is to determine the temporal patterns of population variability of steelhead and rainbow trout as well as chinook salmon and other native fishes. In addition to survey data, the most recent capture data for streams in Solano County will be obtained from the USFWS and CDFG to identify the streams in the County where spawning has been observed in the previous 5 year period.

Performance Criteria. There are two performance criteria for this monitoring. These are:

- The proportion of streams occupied by salmonids shall either remain the same or show an increasing trend from the proportion occupied during baseline surveys. This performance criterion is highly susceptible to natural environmental cycles or other environmental problems outside of the scope of the Solano HCP. Therefore, this performance criterion will be accompanied by measurements of habitat quality.
- The quality and quantity of potential breeding/rearing habitat for salmonids will remain the same and potentially show a net increase throughout the Plan Area over time.

This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal RSM 2 (see Section 6.0).

Valley Elderberry Longhorn Beetle. Objective RSM 2.2 states that the Solano HCP Conservation Strategy will provide for an increase in the available habitat for the valley elderberry longhorn beetle within the riparian areas of Alamo, Ulatis, Putah, and other creeks in the County by replacing impacted elderberry plants at a minimum ratio of 5:1.

Monitoring Objective RSM 8. What is the status and distribution of elderberry shrubs within riparian areas within the Plan Area and on established reserves?

Biological Effectiveness Monitoring. Monitoring for the distribution and abundance of elderberry shrubs will be conducted in tandem with the overall monitoring of riparian habitat quality. During the riparian habitat quality assessment, the distribution and density of

elderberry shrubs will be assessed at each sample location. Each sample location will be mapped using a Trimble GPS. During surveys a sub sample of elderberry shrubs shall be inspected for exit holes of the valley elderberry longhorn beetle.

Performance Criteria. The distribution and abundance of elderberry shrubs along drainages within the Plan Area shall show and increasing trend over time.

This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal RSM 2 and objectives RSM 2.2 (see Section 6.0).

Tricolored black birds. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal RSM 2 and objectives RSM 2.3 (see Section 6.0). Objective RSM 2.3is to establish a minimum of 28 acres of new, suitable nesting habitat for tricolored blackbird within agricultural reserves established for Swainson's Hawk foraging and nesting habitat mitigation. The establishment and subsequent monitoring of suitable nesting habitat will be conducted by SCWA and not as part of the Restoration and Enhancement Plan of individual reserves because not all Swainson's hawk reserves will have areas suitable to establish such nesting habitat.

Conservation Measure RSM 14 Tricolored Blackbird Habitat Establishment. Tricolored blackbirds usually nest in large flocks in dense vegetation near open water or in emergent wetland vegetation, especially cattails and tules, but sometimes in thickets of willow, blackberry, wild rose, tall herbs, willow thickets, and in certain silage or other grain fields such as sorghum. Plan Participants shall establish a minimum of 28 acres of new, suitable nesting cover within agricultural reserves established for Swainson's hawk foraging and nesting habitat mitigation.

Monitoring Objective RSM 9. Is suitable nesting habitat for tricolored blackbirds being successfully established on Swainson's hawk reserves?

Biological Effectiveness Monitoring. Biological effectiveness monitoring for new suitable nesting habitat will follow the same guidelines outlined in the Restoration and Enhancement Plans for mitigation banks and/or private project specific reserve lands. Restoration plans shall include specific, measurable criteria (i.e., performance criteria) to assess success of the restoration/enhancement in meeting the goals and objectives of the Solano HCP Conservation Strategy. Monitoring to assess performance shall occur for a minimum of 5 years or until fifth year/final performance criteria have been met for a minimum of 2 years without significant human intervention (e.g., irrigation, replanting). The monitoring program shall include provision for remedial action as needed to correct deficiencies.

Performance Criteria. Twenty-eight acres of new, suitable nesting cover for tricolored blackbirds will be established within agricultural reserves established for Swainson's hawks within 25 years of plan implementation.

Monitoring Objective RSM 10. What is the status of the tri-colored blackbird within the Plan Area?

Biological Effectiveness Monitoring. Baseline inventory information will be collected concurrently with the Swainson's hawk inventory (see Section 7.4.11). Sampling blocks correspond with the 1-square-mile (640-acre) sections of the state township and range grid.

For the Solano HCP, the primary monitoring area is defined as all sections north of the Township 06N/05N line within the Irrigated Agriculture PCA where 50 sections will be randomly selected from the above sampling area in which to focus nest-searching efforts. Trained observers visit each section at least three times March 20 through July 30 during the tri-colored blackbird breeding season. Each section should be surveyed as systematically as possible for tri-colored blackbird activity and nesting colonies. GPS data shall be collected at each nest colony for entry in the central HCP's GIS database. Data to be collected includes land use information, dominant vegetation at the breeding colony, and population estimate.

In addition to the 50 sections in the primary agricultural monitoring area, an additional 25 sections south of the Township 06N/05N line within the Valley Grassland PCA to ascertain the status of this species in the non-agricultural portion of the County. Selected sections in this zone will include known nest sites from previous years and areas where suitable nesting habitat has been restored and preserved. This population assessment will be conducted at least once within the first five years of the HCP, every year during Phase 2 and every three years after that in perpetuity as part of the long-term monitoring program.

Performance Criteria. The number and size of breeding colonies will remain the same and potentially show a net increase throughout the Plan Area over time.

7.4.8.3 Targeted Studies. Potential targeted studies needed for the implementation of the Monitoring and Adaptive Management Program for this Natural Community include:

- Targeted studies and research focusing on methods to re-establish riparian vegetation along drainages in the County where riparian vegetation formerly occurred. This will require the cooperation of private landowners and public agencies to secure suitable sites and to alter their current land use activities to cooperate in the restoration of riparian woodland habitat. Cost-effective methods to eradicate and control invasive plants, plus propagation and cultivation techniques for plant taxa used for restoration, also need to be developed and tested.
- Studies on the biology and life history of the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).
- Research needs regarding hydrology and sediment/ water quality concerns as recommended by the Science Advisors include:
    - An assessment of historic fauna and flora of Suisun, Green Valley, Alamo, and Ulatis creeks should be done to determine the true baseline. This information should then be used to help determine how, if at all each of these creeks could be restored or maintained. This should rightfully include consultation with the public to determine what the community wants out of their watersheds.
- Assessments should be done to determine appropriate dry season environmental flows for species of concern (particularly steelhead trout) especially in Suisun and Green Valley creeks. This

assessment should ideally utilize an assessment of historical flow regime and land use change to determine what is potentially feasible.

- If flora and fauna studies, flow regime studies, channel habitat assessments, and fish population assessments demonstrate that beneficial uses are impaired by water quality and/ or quantity, or sediment quality, the following scientific assessments should be done:
  - A scientific study should to determine the relative magnitude sources of non-point contaminants so that appropriate management techniques can be selected.

- Studies should be undertaken to determine the relative sediment supply from various sediment sources (hillslopes, bank and bed erosion, faming, and urban runoff) so that appropriate management techniques can be applied.

7.4.9 Giant Garter Snake

The distribution of the giant garter snake in Solano County is poorly understood. There are only three known locations: one along lower Putah Creek and two near Liberty Island. These records are also somewhat dated. Potential habitat for the snake is also widespread within channels, sloughs, and some canals within agricultural areas (see Figure 4-19). After two years of intensive trapping studies no giant garter snakes have been captured in Solano County (Wylie and Martin 2004 and 2005). Based on the paucity of giant garter snakes records from Solano County and lack of recent observations (i.e., USGS surveys) it appears that the giant garter snake is very rare in or may have been extirpated from Solano County; however, a sizeable population of giant garter snakes was recently discovered in the western edge of the Yolo Bypass near Putah Creek (Hansen, pers. comm.), suggesting that populations could reestablish or expand into suitable habitat areas within the County in the future. That is why the primary goal for the species is to contribute to the recovery of the giant garter snake through protection, management, restoration, and enhancement of suitable habitat within the Yolo Basin-Liberty Farms population area. Objective GGS 1.1 is to improve habitat quality within the Giant Garter Snake Conservation Area and Yolo Basin-Liberty Farms population area through improvements in water quality discharged from urban and agricultural sources and control of invasive exotic plants and animals. Objective GGS 1.2 is to acquire, enhance, and manage 175 acres of aquatic and 121 acres associated upland habitat for the giant garter snake. Since a large part of the Conservation Strategy involves restoration of aquatic habitat, the initial restoration activities and subsequent monitoring (at minimum the first five years) will be conducted by individual mitigation banks and/or private-project specific mitigation lands as part of their Restoration and Enhancement Plan (see Section 7.3.7 and Section 10.5.4). Following this initial monitoring period, long-term monitoring of these habitat areas will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA.

Habitat Monitoring. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal GGS 1 and objectives GGS 1.1 and 1.2 (see Section 6.0).

> **Monitoring Objective GGS 1.** What is the quality of habitat for giant garter snakes within the Solano HCP reserve system?

Biological Effectiveness Monitoring. Habitat within reserves established for giant garter snakes and suitable habitat areas within Plan Participant facilities that are subject to short term impacts shall be monitored to assess habitat quality for the species. This habitat assessment and monitoring will be conducted in conjunction with and on the same schedule as the riparian habitat quality monitoring (Table 7-3) and shall include an assessment of the following additional habitat parameters:

1. Presence of abundant emergent, herbaceous wetland vegetation (e.g., cattails and bulrushes) for escape cover and foraging habitat during the active season.
2. Presence of adjacent upland habitat for basking, shelter, and retreat sites.
3. Presence of adjacent upland habitat (levees or banks) high enough to provide refuge from winter floodwaters.
4. Presence of a suitable prey base (fish and/or frogs).
5. Presence of adequate water during the giant garter snake active period (i.e., April through October).

Because restored habitat for this species may not yet be established within the first five years of the plan, initial surveys during Phase 1 of the monitoring program will be focused on: 1) establishing baseline conditions of suitable habitat areas within Plan Participant facilities prior to the short term impacts; and 2) assess and identify potential restoration opportunities to assist in giant garter snake conservation. Following the restoration of the 85 acres of aquatic habitat specified under Conservation Measure GGS 3, habitat monitoring will be conducted as part of the Restoration and Enhancement Plan of the reserve for the first five years after restoration or until habitat performance criteria have been met. Following the post-restoration and enhancement monitoring, monitoring will be conducted as part of the Biological Effectiveness Monitoring Program every three years, consistent with the Riparian, Stream, and Freshwater Marsh Habitat Quality Monitoring in perpetuity (Table 7-3).

Performance Criteria. The quality and quantity of suitable giant garter snake habitat shall increase over time.

Population Monitoring. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal GGS 1 and objectives GGS 1.1 and 1.2 (see Section 6.0).

Monitoring Objective GGS 2. What is the status of giant garter snakes within the Solano HCP reserve system?

Biological Effectiveness Monitoring. No giant garter snakes have been observed within the County during intensive trapping studies in 2004 and 2005. Long-term monitoring for this species will continue with surveys to document the status of the giant garter snake on reserves established under the HCP. The USGS 2004 and 2005 surveys serve as the baseline for the long-term monitoring plan. Following successful restoration of the initial 85 acres of aquatic habitat on reserves, trapping surveys will be conducted in year 10, 15 and 20 and every ten years after that in perpetuity. If, during any given survey year, weather conditions during the spring are unfavorable to giant garter snake activity the survey period will be shifted to the

late summer and early fall. In the event that a population of giant garter snakes is discovered on reserves, monitoring will be conducted every year for the first five years following rediscovery to establish an estimate of the population, then again in year 7 and 10 following rediscovery prior to resuming long-term monitoring frequencies.

Performance Criteria. Because no giant garter snakes have been observed within the County, no performance criteria have been set for this species except for to maintain and expand suitable habitat for this species within the Plan Area. If a population is discovered on a reserve, the population shall show a steady increase towards self sustaining numbers prior to resuming long-term monitoring frequencies.

7.4.9.1 Targeted Studies. While considerable information has been developed in recent years regarding the species occurrence in agricultural areas that are primarily devoted to rice production, limited information is available for the species uses of ditches and other aquatic habitats in agricultural areas such as Solano County where rice is not grown or of limited extent. Targeted studies should assess use of seasonal irrigation ditches and drains by giant garter snakes.

7.4.10 Coastal Marsh

The main conclusions from the conceptual models discussed in Appendix B is that Suisun Marsh is a dynamic system that is constantly changing. Several of these changes, particularly in foodweb dynamics, are driven by the introduction of exotic species. The presence and expansion of invasive plant and animal species probably poses the current greatest threat to the continued existence of these species. The presence and expansion of these invasive species results from a number of environmental factors and pressures, including contributions from changes in water quality associated with urban runoff and wastewater discharge. As such, the two main monitoring issues addressed in the Biological Effectiveness Monitoring Program for the Solano HCP are water quality monitoring and controlling aggressive invasive species.

7.4.10.1 Natural Community Monitoring. The primary conservation actions for the coastal marsh natural community include enhancing habitat quality (primarily through invasive species control) and improving water quality. Goal CM 1 is to maintain and enhance the essential ecological processes, functions, and values; species diversity; and habitat heterogeneity of coastal marsh habitat within the Plan Area. Objective CM 1.1 is to provide a net increase in the quality of coastal marsh habitat in the Plan Area, through the implementation of programs to control invasive exotic plants and animals and improve water quality. Objective CM 1.2 states that Plan Participants shall prevent increases in dry season (May 1 through October 15) discharge from storm water sewer systems into tributaries draining into Suisun Marsh, Southampton Marsh, and the marshes bordering the Napa River and San Pablo Bay.

Impacts to coastal marsh habitat will primarily be avoided through setbacks and buffer areas. Monitoring for the success of these avoidance and minimization measures will be conducted by individual projects as part of their Resource Management Plans (see Section 7.3.8 and Section 10.5.4). This section deals with the larger conservation commitments designed to mitigate indirect

impacts to the coastal marsh natural community through increases in urban runoff, which are primarily water quality and controlling aggressive invasive species.

Water Quality. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal CM 1 and objectives CM 1.2 (see Section 6.0).

Monitoring Objective CM 1. Are water quality levels in compliance with NPDES permit requirements established by the applicable Regional Water Quality Control Boards and Water Quality Conservation Measures RSM15-17?

Biological Effectiveness Monitoring. The Solano HCP will compile water quality monitoring data collected by the Environmental Monitoring Program (EMP), the Suisun Marsh Program (SMP), the Regional Monitoring Program (RMP), and the Fairfield-Suisun Sewer District (FSSD), annually, to assess compliance with NPDES permit requirements established by the applicable Regional Water Quality Control Boards and Water Quality Conservation Measures RSM15-17.

Performance Criteria. Specific performance criteria for water quality are those outlined in the municipal Plan Participants' NPDES permit established by the Regional Water Quality Control Boards.

Invasive Species Control and Water Quality Improvement Programs. Objective CM 1.1 states to provide a net increase in the quality of Coastal Marsh habitat in the Plan Area, through the implementation of programs to control invasive exotic plants and animals and improve water quality. Funding for the invasive species control program shall be sufficient to control invasive species on between 100 to 170 acres of coastal marsh habitat each year (or between 5,000 to 8,500 acres over the life of the HCP). This objective shall be achieved through the implementation of a grant program administered by SCWA. The following outlines the biological effectiveness monitoring requirements for these programs. All biological effectiveness monitoring of activities preformed shall be the responsibility of the grant recipients. These monitoring objectives and biological effectiveness monitoring are designed to demonstrate that the plan is meeting biological goal CM 1 and objective CM 1.1 (see Section 6.0).

Monitoring Objective CM 2. Are invasive species control programs successfully decreasing the distribution and abundance of problematic invasive species?

Monitoring Objective CM 3. Are water quality improvement measures for agricultural runoff successfully improving water quality into the marsh?

Biological Effectiveness Monitoring. All grant applications submitted to SCWA to receive funds through this program to control invasive species and/or implement water quality improvement measures shall also submit a proposal detailing their biological effectiveness monitoring associated with funded activities for a minimum duration of five years.

Performance Criteria. At the end of the five year monitoring period, the biological effectiveness monitoring shall clearly demonstrate that the goals of the implemented control program and/or water quality improvement measures have been meat.

7.4.10.2 Covered Species Monitoring. The second goal of the Coastal Marsh Conservation Strategy (Goal CM 2) is to maintain and where possible, through restoration, increase population levels and distribution of coastal marsh associated species in order to contribute to their recovery. The following section describes the biological effectiveness monitoring for Covered Species associated with the natural community. All habitat monitoring associated with restoration activities and/or monitoring to show the effectiveness of implemented Avoidance and Minimization Measures (i.e., effectiveness of buffers: Section 5.0) will be conducted by individual projects as part of their Resource Management Plans or Restoration and Enhancement Plan (see Section 7.3.8).

Delta Smelt and Long-fin Smelt Habitat Monitoring. This monitoring objective and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal CM 2 and objective GGS 2.2 (see Section 6.0).

Monitoring Objective CM 4. What is the quality of habitat for Delta smelt and long-fin smelt habitat within the reserve system?

Biological Effectiveness Monitoring. Habitat within reserves established for delta smelt and long-fin smelt shall be monitored to assess habitat quality for the species. This habitat assessment and monitoring will be conducted in conjunction with the riparian habitat quality monitoring and giant garter snake habitat monitoring. The monitoring shall include an assessment of the suitability of restored areas to provide spawning habitat.

Because restored habitat for these species may not yet be established within the first five years of the plan, initial surveys during Phase 1 of the monitoring program will be focused on assessing and identifying potential restoration opportunities to assist in delta smelt and long-fin smelt conservation. Following the restoration of the 85 acres of habitat, habitat monitoring will be conducted, as part of the Restoration and Enhancement Plan of the reserve, for the first five years after restoration or until habitat performance criteria have been met. Following the post-restoration and enhancement monitoring, monitoring will be conducted as part of the Biological Effectiveness Monitoring Program every three years, consistent with the Riparian, Stream, and Freshwater Marsh Habitat Quality Monitoring in perpetuity (Table 7-3).

Performance Criteria. The quality and quantity of suitable shallow water aquatic breeding and rearing habitat for Delta smelt and long-fin smelt shall increase over time.

7.4.10.3 Targeted Studies. The tidal marshes of Solano County are poorly understood in terms of modern and historic plant species composition, vegetation community dynamics, and the interactions between vegetation and geomorphic and hydrologic processes (Noss et al. 2002). There are substantial gaps in the scientific data and understanding of the ecosystems and individual species. Research needs for this Natural Community as recommended by the Science Advisors (Noss et al. 2002) that would support conservation planning for this ecosystem include:

- Suisun thistle: basic biological research on the life history characteristics, population dynamics, species interactions, and response to management (hydrology, water quality) regimes;
- Endangered plant – invasive plant interactions and control methods. *Lepidium latifolium* invasions threaten several endangered wetland plant and animal species, and will compromise

wetland restoration efforts in Solano County. Applied research on the species and community consequences of potential control measures are needed.

- Research directed toward the restoration of biogeochemical function is paramount to the restoration of tidal marsh communities, as most tidal wetland restoration efforts have failed in this regard; and
- A complete classification and description of wetland types considering landscape position, hydrogeomorphology, biogeochemistry, and vegetation (see Ferren et al. 1996) is needed to understand and conserve Solano County wetland diversity.

Additional research needs as identified by workshop speakers during the Suisun Marsh Science Workshop and summarized in Brown (2004) include:

Biogeochemical and Morphological Processes. There are significant data gaps concerning our knowledge of the biogeochemical and morphological processes within the marsh. Some potential studies include:

- comparative land use studies of soils characteristics, biogeochemical cycling, and ecosystem functions;
- accurate, fine-scale elevation data describing Suisun Marsh intertidal elevations and soil surface directional tendencies;
- organic matter/carbon production and storage rates;
- Suisun-specific subsidence rates;
- regional rates of ground surface movement;
- local/regional groundwater characterization; and
- sediment movement and deposition rates into and within Suisun Marsh.

Foodwebs. Some questions emerging form Mueller-Solger and Schroeter model include:

- Are more interior sloughs a "productivity refuge?"
- Based on food resources in the channels, what are appropriate restoration targets?
- What is the relative importance of new zooplankton and benthos in the channels?
- All questions about the effects of introduced species on the system.

Rails. Several information needs for rails in the Suisun Marsh were identified. These include:

- annual abundance surveys and baseline demographic information,
- science-based restoration designs,
- effects of native and introduced predators and effective methods of predator control,
- extent and suitability of existing habitat,
- enhancement opportunities for existing habitat, and
- identification and protection of source populations.

7.4.11 Swainson's Hawk

The main biological goals for Swainson's Hawk are to: 1) maintain a population level of Swainson's hawks similar to current numbers (estimated to be between 120 and 130 pairs) within the Plan Area and 2) provide sufficient nesting habitat in proximity to suitable foraging habitat to support the current Swainson's hawk population levels within the Plan Area. The primary focus of the Biological Effectiveness Monitoring Program for Swainson's hawks is estimating the number of breeding pairs

in the County. The number of breeding pairs was selected as the primary monitoring variable because of its direct association with population size as well as its relative cost-effectiveness compared to other, more labor-intensive parameters (e.g., nesting success, number of young produced/nest). Furthermore, Swainson's hawk population estimates conducted statewide by the CDFG are also expressed as number of pairs. Most members of the Swainson's hawk Technical Advisory Committee (SHTAC) agree that "tracking the number of nest sites over time is the best indicator of HCP success" (M. Bradbury, pers. comm.). By monitoring Swainson's hawk breeding population size over the term of the HCP, the Plan Participants (or other monitoring entity) will be able to determine whether conservation measures aimed at the species (e.g., preservation of foraging habitat, planting of nest trees) are effective at maintaining the current population. In addition, to monitoring population numbers, monitoring of nest trees will also be conducted to determine that the reserve system contains sufficient occupied nest trees, per biological objective SH 2.3. The following section outlines the Biological Effectiveness Monitoring Program for Swainson's hawks.

The biological effectiveness monitoring for Swainson's hawks will follow the implementation schedule outlined in Table 7-4. A baseline assessment of the Swainson's hawk population in the County will be conducted at least once during Phase 1. Then the population will be monitored every year for ten years during the Intense Monitoring Phase (Phase 2). Finally, monitoring will be conducted every three years in perpetuity as part of the long-term monitoring program (Phase 3). The following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal SH 1 and SH2 (see Section 6.0).

Swainson's Hawk Population Monitoring. One of the main goals of the Swainson's Hawk Conservation Strategy is to maintain a population level of Swainson's hawks similar to current numbers (estimated to be between 120 and 130 pairs) within the Plan Area. Several of the objectives under the Swainson's Hawk Conservation Strategy deal with the establishment and management of the reserve system. Monitoring to track compliance with these specific objectives is outlined in the monitoring section for individual reserves and under compliance monitoring in Section 10.6. This biological effectiveness monitoring is designed to demonstrate that all of the conservation actions outlined in the objectives and conservation measures are affectively achieving goal SH 1.

Monitoring Objective SH 1. What is the number of Swainson's hawk pairs breeding within the Irrigated Agriculture and Valley Floor Grassland Conservation Areas?

Monitoring Objective SH 2. What is the long-term population trend of Swainson's hawks within the County?

Biological Effectiveness Monitoring. To estimate the number of breeding pairs within the Plan Area, the Solano HCP is adopting the sampling design and approach developed for the 2005–2006 California Swainson's hawk Inventory conducted by the CDFG (Anderson et al. 2007). In the statewide census, the current known Swainson's hawk range was divided into three strata by known breeding densities: dense, moderately dense, or sparse (Dense = average density is ≥ one breeding pair per 10 sq mi, Moderately Dense = average density is ≥ one breeding pair per 11 to 75 sq mi, and Sparse = average density is ≥ one breeding pair per 76+ sq mi). Within each strata, random sampling blocks were selected. Sampling blocks corresponded to a 1-square-mile (640-acre) section of the state Township and Range grid.

The Solano HCP Plan Area can also be divided up into dense, moderately dense, and sparse areas. The dense area is defined as all sections north of the Township 06N/05N line within the Irrigated Agriculture Conservation Area. This area contains the highest known nesting densities of Swainson's hawk within the County (Resseguie, unpubl. data). The moderately dense area consists of all sections south of the Township 06N/05N line within the Valley Floor Grassland Conservation Area.

Similar to the Statewide Census methods, sampling blocks will only be established within the dense and moderately dense areas. For the dense area, 50 sections will be initially randomly selected in which to focus nest-searching efforts. As Swainson's hawk reserves become established for the HCP future sampling blocks will include these reserve area. Within the moderately dense area 25 sections will be surveyed to ascertain the status of Swainson's hawk nesting in the non-agricultural portion of the County. Because of the current low density of Swainson's hawk nests in this area, selected sections will include known nest sites from previous years as well as random samples.

Trained observers with experience identifying and observing nesting Swainson's hawk will visit each section at least three times (twice from March 20–April 20, once from June 10–July 30) during the Swainson's hawk breeding season. As per the Swainson's Hawk Technical Advisory Committee survey guidelines (SHTAC 2000), surveys should not be conducted between April 21 and June 10 since nests are extremely difficult to locate this time of year. Each section should be surveyed as systematically as possible for Swainson's hawk nests. Although confirmed nest sites (e.g., females sitting on nest, male delivering food to nest, parents delivering food to young) are preferable, observations of pairs in the vicinity of suitable nesting habitat will also be counted as evidence of a nesting pair. If possible, GPS data should be collected at each nest site for entry in the central HCP's GIS database. Data on other raptor nesting activity shall also be documented. Sections that cannot be completely surveyed shall be mapped to show the portion surveyed and only that area will be included when calculating the total amount of area surveyed.

Data gathered from the nesting surveys will be entered into a centralized database, maintained by the SCWA. Population estimates will be expressed in terms of *number of pairs detected per square mile (section) surveyed*. Trend analysis protocols will be adapted from the CDFG statewide survey protocol, which has not yet identified specific data analysis methods. Protocols will be subject to revision and refinement if new information indicates that surveys could be conducted more efficiently (e.g., addition of more observers to adequately survey sections) or the sampling design needs to be modified to more accurately track the number of breeding pairs.

Performance Criteria.

- The estimated number of breeding pairs shall not decrease significantly for two consecutive monitoring years or over a three year period, which ever is greater.
- Average number of nests that fledge young in the field surveyed blocks shall not decrease significantly for two consecutive monitoring years or over a three year period, which ever is greater.

Swainson's Hawk Nest Tree Monitoring. The second goal of the Swainson's Hawk Conservation Strategy is to provide sufficient nesting habitat in proximity to suitable foraging habitat to support the current Swainson's hawk population levels within the Plan Area. There are two programs within the Conservation Strategy that are designed to achieve this goal. The first consists of providing suitable nesting habitat on reserves (Objectives SH 2.1 and 2.2 and Conservation Measure SH 6). The second consists of maintaining a minimum of 17 known nest trees in the reserve system at any one time (Objective SH 2.3 and Conservation Measure SH 7). Monitoring of the actual trees themselves and their suitability to provide nesting habitat for Swainson's hawks will be conducted on individual mitigation banks and/or project specific mitigation lands as part of their Resource Management Plans (i.e., to demonstrate that biological objectives SH 2.1 and 2.2 are being met: see Section 7.3.9). However, monitoring to determine whether these trees are being used by Swainson's hawks and whether other preserved known nest trees, in reserves established under Conservation Measure SH 7, are still occupied will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA. Therefore, the following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting goal SH 2 and biological objective SH 2.3.

Monitoring Objective SH 3. What is the use of known and potential nest trees established on reserves for Swainson's hawks within the Plan Area?

Biological Effectiveness Monitoring. Concurrent with the population surveys, known and potential nest trees established on Swainson's hawk reserves shall be monitored for the presence of nesting hawks. Potential nest trees on reserves shall be visited at least three times (twice from March 20–April 20, once from June 10–July 30) during the Swainson's hawk breeding season. These surveys will be conducted concurrently with the population monitoring described above. Trees on the reserves shall also be assessed for their suitability as nest trees. Nest trees established on Swainson's hawk reserves established under Conservation Measure SH 6 shall follow the same monitoring schedule outlined for the population monitoring. Nest trees established under Conservation Measure SH 7 shall be monitored annually until a sufficient number of known nest trees have become established on reserves provided under Conservation Measure SH 6.

Performance Criteria.

- **Nesting Habitat Preserved Under Conservation Measure SH 6 Nesting Habitat Mitigation:** The number of occupied Swainson's hawk nesting in trees on reserves shall show an increasing trend over time.
- **Nesting Habitat Preserved under Conservation Measure SH 7 Known Nest Trees:** Nesting habitat within reserves shall remain in tacked and occupied. If a preserved nest tree dies of natural causes or is unoccupied for three consecutive years the conservation easement shall be transferred to another known nest tree.

7.4.11.1 Targeted Studies. Potential targeted studies needed for the implementation of the Monitoring and Adaptive Management Program for Swainson's hawk include:

- What is the population status of Swainson's hawk inhabiting the Vernal Pool and Valley Floor Grassland Natural Community and Suisun Marsh? To what extent are grasslands used for

foraging, is prey selection different from agricultural communities, and what is the foraging behavior within this portion of the County?
- What are the effects of herbicides on Swainson's hawks; test and develop a set of best management practices to minimize pesticide effects?
- Are Swainson's hawks susceptible to significant potential mortality as a result of new diseases such as recent new strains of avian influenza (H5N1) and West Nile virus? Are their effective treatments/inoculations for these diseases and how can treatments be applied to the wild population?

7.4.12 Burrowing Owl

The biological goals for burrowing owls are to: 1) maintain a sufficient suitable foraging and nesting habitat to support a self-sustaining burrowing owl population throughout the Plan Area and 2) preserve existing nesting areas and promote expansion of nesting habitat/burrows within the Plan Area. As with the Swainson's hawk monitoring program, the *number of breeding pairs* is the primary monitoring variable for the biological effectiveness monitoring for burrowing owls. The number of breeding pairs is the most cost-effective yet accurate parameter for tracking the Solano burrowing owl population. It is also the most commonly used parameter for reporting population size among most studies conducted in California (DeSante and Ruhlen 1995, Rosenberg and Haley 2004). By monitoring breeding population size, the Plan will be able to determine whether conservation measures aimed at habitat protection for the species (e.g., preservation of foraging habitat, promoting expansion of nesting habitat) are effective at maintaining and expanding the current population. In addition, to monitoring population numbers, monitoring of nest burrows will also be conducted to determine that the reserve system contains sufficient number of active burrowing owl nest sites, per biological objective BO 2.1.

The biological effectiveness monitoring for burrowing owls will follow the implementation schedule outlined in Table 7-4 and be conducted concurrently with Swainson's hawk monitoring. A baseline assessment of the burrowing owl population in the County will be conducted at least once during Phase 1. Then the population will be monitored every year for ten years during the Intense Monitoring Phase (Phase 2). Finally, monitoring will be conducted every three years in perpetuity as part of the long-term monitoring program (Phase 3). The following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting biological goal BO 1 and BO 2 (See Section 6.0).

Burrowing Owl Population Monitoring. One of the main goals of the Burrowing Owl Conservation Strategy is to maintain a sufficient suitable foraging and nesting habitat to support a self-sustaining burrowing owl population throughout the Plan Area. Several of the objectives under the Burrowing Owl Conservation Strategy deal with the establishment and management of the reserve system. Monitoring to track compliance with these specific objectives is outlined in the monitoring section for individual reserves and under compliance monitoring in Section 10.6. This biological effectiveness monitoring is designed to demonstrate that all of the conservation actions outlined in the objectives and conservation measures are affectively achieving goal BO 1.

Monitoring Objective MBO1: What is the number of burrowing owl pairs breeding within the Irrigated Agriculture and Valley Floor Grassland Priority Conservation Areas?

Monitoring Objective MBO2: What is the long-term population trend of burrowing owls within the County?

Biological Effectiveness Monitoring. The burrowing owl population assessment will be conducted at the same time and in the same areas as the Swainson's hawk population assessment. To estimate the number of burrowing owl pairs within the County, randomly selected, 1-square-mile Township sections (the same ones selected for the Swainson's hawk monitoring program) will be surveyed for burrowing owl breeding activity. This method is similar to the statewide burrowing owl census conducted by the Institute for Bird Populations from 1991–1993 (DeSante et al. 1995). Similar to Swainson's hawk distribution, burrowing owls are more dense in the agricultural areas of the Plan Area than the valley floor. Therefore, 50 sections will be initially, randomly selected from the within the irrigated agricultural community and 25 sections will be initially sampled within the Vernal Pool and Valley Floor Grassland Natural Community (Figure 4-2). The dense area is defined as all sections north of the Township 06N/05N line within the Irrigated Agriculture Conservation Area. The moderately dense area consists of all sections south of the Township 06N/05N line within the Valley Floor Grassland Conservation Area. Additional sections may be added after the initial monitoring trials are complete or if populations expand substantially on the valley floor.

Trained observers with experience identifying and observing nesting burrowing owls and Swainson's hawks will visit each section at least three times (twice from March 20–April 20, once from June 10–July 30). Each section should be surveyed as systematically as possible for burrowing owl activity. Although confirmed nest sites (e.g., owls at burrows, male delivering food to nest, parents delivering food to young) are preferable, observations of individual owls or pairs of owls will also be counted as evidence of a nesting pair. If possible, GPS data should be collected at each nest site for entry in the central HCP's GIS database.

Data gathered from the nesting surveys will be entered into a centralized database, maintained by the SCWA. Population estimates will be expressed in terms of *number of pairs detected per square mile (section) surveyed*. Sections that cannot be completely surveyed shall be mapped to show the portion surveyed and only that area will be included when calculating the total amount of area surveyed. Trend analysis protocols will be adapted from the CDFG statewide survey protocol, which has not yet identified specific data analysis methods. Protocols will be subject to revision and refinement if new information indicates that surveys could be conducted more efficiently (e.g., addition of more observers to adequately survey sections) or the sampling design needs to be modified to more accurately track the number of breeding pairs.

A baseline inventory of the number of burrowing owl pairs within the County will be conducted within the first five years of adoptions of the HCP during Phase 1 of the Biological Effectiveness Monitoring Program. Then the population will be monitored every year for ten years during the Intense Monitoring Phase (Phase 2). Finally, monitoring will be conducted every three years in perpetuity as part of the long-term monitoring program (Phase 3). Using appropriate statistical analyses, resulting population estimates (with associated confidence intervals) can then be compared across years to determine if the number of pairs in the County is increasing, decreasing, or remaining stable.

Performance Criteria. The goal of the conservation program is to contribute to maintaining or where possible increasing the burrowing owl population in the County. The following performance criteria will be evaluated:

- The estimated number of breeding pairs shall not decrease significantly for two consecutive monitoring years or over a three year period, which ever is greater.
- Average number of nests that fledge young in the field surveyed blocks shall not decrease significantly for two consecutive monitoring years or over a three year period, which ever is greater.

Burrowing Owl Nest Monitoring. The second goal in the Burrowing Owl Conservation Strategy is to preserve existing nesting areas and promote expansion of nesting habitat/burrows within the Plan Area. There are two programs within the Conservation Strategy that are designed to achieve this goal. The first consists of providing suitable nest burrows on reserves, both natural and artificial (Objectives BO 2.2, 2.3 and 2.4 and Conservation Measures BO 3). The second consists of protecting at least one known active burrowing owl nest site within the reserve system for each active nest site eliminated as a result of Covered Activities (Objectives BO 2.1 and Conservation Measure BO 4). Monitoring of the actual burrows and densities of burrows on reserves will be conducted on individual mitigation banks and/or project specific mitigation lands as part of their Resource Management Plans (i.e., to demonstrate that biological objectives BO 2.2, 2.3 and 2.4 are being met: see Section 7.3.10). Monitoring to determine if artificial burrows established on preserves are actually being occupied and that known active nest sites, established in reserves under Conservation Measure BO 4, continue to be occupied will be conducted as part of the Biological Effectiveness Monitoring Program administered by SCWA. Therefore, the following monitoring objectives and biological effectiveness monitoring is designed to demonstrate that the plan is meeting goal BO 2 and biological objectives BO 2.1, 2.2, 2.3 and 2.4.

Monitoring Objective BO 3. What is the use of artificial burrows by burrowing owls on reserves established within the Plan Area?

Monitoring Objective BO 4. What is the status of known occupied burrowing owl nest sites on reserves and preserves within the Plan Area?

Biological Effectiveness Monitoring. Concurrent with the population surveys, artificial burrows established on agricultural preserves shall and a representative sample of either artificial or natural burrows established on valley floor grassland reserves will be monitored for the presence of nesting owls. In addition, known occupied nest burrows preserved under Conservation Measure BO 4 shall also be monitored to determine their continued status of being occupied. All monitored burrows shall be visited at least three times (twice from March 20–April 20, once from June 10–July 30) during the breeding season. These surveys will be conducted concurrently with the population monitoring described above. Artificial burrows shall also be assessed for their suitability for nesting. Artificial burrows established on agricultural reserves under Conservation Measure BO 3 shall follow the same monitoring schedule outlined for the population monitoring. Monitoring of known occupied nest burrows preserved under Conservation Measure BO 4 shall be monitored annually until a sufficient number of known nest burrows have become established on reserves provided under Conservation Measure BO 3.

Performance Criteria.

- **Artificial Burrows Established Under Conservation Measure BO 3:** The number of artificial burrows or natural burrows established on reserves for burrowing owls shall show an increased trend in occupancy over time.
- **Known Occupied Nest Burrows Preserved under Conservation Measure BO 4:** Preserved know occupied nest sites shall remain in tacked and occupied. If a preserved nest burrow is destroyed by natural causes or is unoccupied for three consecutive years the conservation easement shall be transferred to another known occupied nest site.

7.4.12.1 Targeted Studies. Specific questions that may warrant additional monitoring or focused studies include the following:

- How effective are artificial burrows in attracting owls to preserves? Are there any differences in population levels between sites that contain artificial burrows and those that contain only natural burrows?
- What is the best way to reestablish ground squirrel populations on grassland preserves?
- Are owls evicted from urban development sites able to find nearby burrows? How far will they travel to do so? Are they successful at raising young once they've moved?
- What is the feasibility of actively relocating owls from urban parcels to large grassland preserves? What is the optimum period for habituating owls to a new area?
- Do owls in agricultural habitats display greater tolerance for disturbance (e.g., levee maintenance activities) than those in grasslands?

7.5 DATABASE DEVELOPMENT AND REPORTING

7.5.1 Database Development

Proper data management, analysis and reporting are critical to the success of the Monitoring and Adaptive Management Program. Therefore, Plan Participants will develop and maintain a comprehensive GIS-linked database to track the success of the Monitoring and Adaptive Management Program. This database will also be linked to all other aspects of plan implementation.

Just as the collection of sufficiently robust monitoring data is necessary to evaluate the efficacy of the conservation and adaptive management programs, it is essential that data be analyzed, evaluated and stored in a manner that allows easy retrieval and understanding by all stakeholders. CDFG's Biogeographic Information and Observation System (BIOS) has established database standards, protocol, recommendations, table formats and relationships, and business rules for managing, visualizing and analyzing biogeographic data. These standards were developed to allow data from disparate sources to be assembled and analyzed while recognizing that complete uniformity of all biological databases is unattainable and may not be desirable. The Plan Participants will utilize these standards to the extent that they assist the Plan Participants achieve their goals in implementing the HCP and in meeting their reporting requirements. Metadata will be maintained for all geographic datasets maintained through the GIS-linked database.

To assist in reporting and compliance tracking, the Solano HCP will be using the HabiTrak system: a GIS based data management system (Section 10.6), developed cooperatively by CDFG, USFWS,

local jurisdictions, special districts, and SANDAG in response to the habitat tracking and reporting requirements of the large southern California regional conservation plans. The Plan Participants will either expand the existing data base system or integrate additional information into the HabiTrak program to provide a comprehensive GIS-linked database to assist in implementing the monitoring and adaptive management program. The expanded database will incorporate data on compliance monitoring (see Section 10.6), biological effectiveness monitoring, results of targeted studies, the status of ongoing research and adaptive management, and all relevant reports and baseline studies/assessments reports conducted within the Plan Area.

SCWA will manage the overall database and will be responsible for assuring applicable information is made available to all reserve managers, Plan Participants, resource agencies, and other stakeholders. SCWA will also be responsible for quality assurance and quality control of the data and management of metadata.

In order to facilitate access and retrieval by all stakeholders, the GIS-linked database will be integrated into an ArcIMS format. ArcIMS® is a software and hardware solution for delivering dynamic maps and GIS data and services via the Web. It allows for the centralization of data, while offering access to this data by all stakeholders. The web-based system will also allow data to be made available to the general public. Because some information maintained by the database may be subject to access limitations, due to copyrights, proprietary data or confidential sources, access restrictions will be incorporated through a password system for web-based information.

Similar to management of the reserve system, database manage must also be developed in an adaptive context. Due to the longevity of the permit duration, the database system will need to be periodically updated as new technologies become available. A review of efficiency and updates to the database will be made once every five years during the life of the HCP.

7.5.2 Reporting

Annual reports will be submitted to the California Department of Fish and Game, U.S. Fish and Wildlife Service, NOAA Fisheries, Plan Participants, and Advisory Board within 3 months of the end of the reporting period (reports of the previous years activities would be due by March 31). SCWA will be responsible for production of the report. The annual reports will summarize the previous year's monitoring and research results. The agencies, Plan Participants, and Advisory Board will use results presented in the monitoring reports and other available information to assess success of the HCP in meeting the biological goals and objectives and to formulate recommendations to the Plan Participants for HCP implementation in subsequent years.

The monitoring and research reports should include:

1. a description of all Covered Activities implemented during the reporting period;
2. a description of all HCP Natural Community protection/enhancement/ creation/restoration conservation measures implemented during the reporting period;
3. a year-to-date summary of the extent of protected/enhanced/created/restored natural communities;
4. a summary of impacts on covered Natural Community types and species associated with implementation of Covered Activities and conservation measures;

5. a description of avoidance, minimization, and mitigation conservation measures implemented to address impacts of Covered Activities and conservation measures;
6. a description of performance monitoring undertaken during the reporting period, an analysis of monitoring results, and a description of remedial actions, if undertaken during the reporting period;
7. a description of all HCP research undertaken during the reporting period, an analysis of research results, and a description of integration with monitoring, assessment, and compliance elements;
8. 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;
9. an assessment of the efficacy of habitat enhancement/creation/restoration methods in achieving performance objectives and recommended changes to improve the efficacy of the methods; and
10. an assessment of the appropriateness of performance indicators and objectives based on results of biological effectiveness monitoring and recommended changes to performance indicators and objectives.

7.5.3 Conservation Strategy Modification

The Solano HCP Conservation Strategies, Section 6.0, identify the conservation goals and objectives for Covered Species and Natural Communities. Typically, these objectives envision conservation of the Covered Species being achieved through one or more actions consisting of avoidance measures (habitat and individual animals), protection and stewardship management of habitats, restoration of former habitats, and/or specific management actions designed to enhance or improve habitat quality and therefore carrying capacity of the area to support the species (e.g., control/eradication of invasive exotic species and competitors).

Monitoring is required to evaluate long-term success of the conservation measures by measuring appropriate biological conditions (e.g., population levels, reproductive success, habitat parameter conditions and trends, etc.). If the results of the biological effectiveness monitoring determine that specified biological conditions are outside of specified performance criteria and that the objectives of the conservation strategy are not being achieved, adjustments in the conservation and mitigation strategies and/or management actions may be made. Similarly, if new, outside research identifies alternative and more effective conservation measures, adjustments in the conservation measures may be implemented as agreed to by the Resource Agencies and permit holders pursuant to the restrictions and procedures identified in Section 10.9.

The types of adjustments that may be made include, but are not limited to:

- Shift of funding from habitat acquisition to increased management of existing preserves/reserves;
- Shift of funding from management actions (such as invasive species abatement) to increased habitat acquisition;
- Shifts in priority areas for acquisition and management;
- Modifications to seasonal constraints and other take avoidance and minimization measures;
- Implementation of reintroduction programs for Covered Species;
- Modifications to monitoring survey protocols and procedures; and
- Elimination or modification of reserve management and habitat restoration techniques in favor of alternative measures and procedures.

It is also anticipated that the Resource Agencies will prepare new Recovery Plans during the life of the HCP and that these Recovery Plans may identify alternative and important conservation measures such as:

- New information, procedures, or techniques that would increase the effectiveness of the HCP's conservation program;
- Measures that can be achieved within the Solano HCP Plan Area; and
- New measures which are consistent with the overall intent, framework, and financing Plan of the HCP

The Monitoring and Adaptive Management Program for the Solano HCP provide the ability to incorporate new recovery strategies and goals, subject to new procedures being consistent with the HCP's original goals and objectives, take parameters, and other conditions specified in Section 10.7, the "No Surprises" assurances. Essentially, modified or additional measures may be implemented if the overall costs are roughly equivalent to the current strategies, the Plan Participants approve increases in agreed to funding levels for recovery efforts, or additional outside funding sources are found.

Figure 7-1: Adaptive Management Conceptual Model (Modified from CVMSHCP 2004)

Figure 7-2: Overview of the Structure of the Monitoring and Adaptive Management for the Solano HCP Reserve System

Figure 7-3: Individual Reserve Management and Monitoring schedule

Figure 7-4: Planning and implementation task schedule. (modified from Atkinson et al. 2004)

Table 7-1: Monitoring requirements individual mitigation banks and/or private-project specific mitigation lands and the associated Avoidance and Minimization Measure or Conservation Measure