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4.0 CONSERVATION ANALYSIS

4.1 PURPOSE

This chapter presents the results of the Conservation Analysis conducted for the Solano Habitat Conservation Plan (HCP). The purpose of this analysis is to assess the status of biological resources within the Plan Area and identify biologically based measures necessary to conserve Covered Species and Special Management Species. These broader conservation requirements assess actions necessary under ideal circumstances to promote not only the continued existence of Covered Species (as well as minimize and mitigate impacts from Planned Activities), but the measures necessary to "recover" Covered Species and Natural Communities within the Plan Area. This Conservation Analysis also provides a basis for evaluating the Solano HCP Conservation Strategy (Chapter 5.0) against the standards for issuance of incidental take permits under the Federal Endangered Species Act (FESA) and the California Endangered Species Act (CESA).

The Conservation Analysis presented in this chapter outlines the recovery standards for Covered Species and Natural Communities in the Plan Area and estimates the acreage of each community type needed to achieve recovery. The results of the Conservation Analysis are used to develop the Solano HCP Conservation Program, which collectively consists of the biological goals and objectives in the Conservation Strategy (Chapter 5.0), the Avoidance, Minimization and Mitigation Measures in Chapter 6.0, and the Monitoring and Adaptive Management Program (Chapter 7.0). Figure 4-1 provides a graphical representation of the relationships between the Conservation Analysis described in this section, the other elements of the Solano HCP (e.g., Appendices and previous chapters and sections), and the Solano HCP Conservation Program.

The Conservation Analysis evaluates four broadly defined natural communities that encompass a wide range of habitat types. These natural communities are: Valley Floor Grassland and Vernal Pools; Inner Coast Range; Riparian, Stream, and Freshwater Marsh; and Coastal Marsh (Figure 3-5; see Section 3.3.2 and Appendix B for natural community descriptions). Northeastern Solano County consists primarily of irrigated agriculture that provides important habitat for several Covered Species (e.g., Swainson's hawk and burrowing owl) and Special Management Species (e.g., loggerhead shrike and northern harrier). The Conservation Analysis does not define agriculture as a Natural Community, but the conservation and management of agricultural lands have been considered in the analysis for Swainson's hawk and burrowing owl.

The Conservation Analysis synthesizes biological information at three levels (species, Natural Community, and landscape encompassing multiple Natural Communities) and combines it with information on current and projected land use practices, Solano County General Plan and Zoning restrictions, and environmental constraints (see Section 3.6, Risk Analysis) to identify priority areas for future protection (see Section 4.6). Sections 3.1 through 3.3 provide a review of Solano County's biodiversity and an analysis of the key geographic, geologic, and hydrologic factors that influence the habitats, physical processes, and biota of the region. Appendix B includes detailed biological information for each Natural Community and associated Covered Species. Appendix C includes similar information for each Special Management Species.

The Natural Community accounts in Appendix B contain a background and distribution section and a narrative conceptual model. The preliminary narrative conceptual model outlines the essential ecological processes, habitat variables, and significant pressures affecting the Natural Community. These models make assumptions about the effects of land use practices on the Natural Community based on the current understanding of the ecological processes and habitat variables within that system. The data gaps, uncertainties, and assumptions inherent in these narrative conceptual models are also discussed in the natural community account.

The Conservation Analysis for each Natural Community (Section 4.3) is organized into three sections: (1) Covered Species and Special Management Species; (2) Key Conservation Elements; and (3) Conservation Areas. Table 4.1 summarizes the Covered Species and Special Management Species associated with each Natural Community. The Natural Community accounts (see Appendix B) form the basis for identifying the key conservation elements (Figure 4-1). A key conservation element is a habitat feature or environmental characteristic that can be physically mapped that corresponds to, or is a surrogate measure of, the relative conservation value and/or overall habitat quality of the Natural Community. Conservation areas are identified based on key conservation elements and the reserve design principles outlined in Section 4.2. The conservation areas are used to develop a conservation approach for each Natural Community, outline compensation/mitigation levels (see Chapter 6.0) for Covered Activities, and determine the level of development compatible with regional conservation goals and objectives.

Section 4.4 describes the Conservation Analysis for the entire Plan Area. It combines all of the key conservation elements identified in Section 4.3 to identify priority areas for acquisition and define an overall vision for developing reserves in the Plan Area. This Plan-wide Conservation Analysis represents the synthesis of biological information at the species, Natural Community, and landscape levels.

In Section 4.5, various methods, including the species-area relationship model, recovery plans, and expert opinion, are employed to develop conservation targets for each Natural Community. These conservation targets address the question of “how much is enough?” Specifically, what proportion of an ecosystem must be conserved to ensure that ecological processes continue to function and the composition and structure of native species remain intact?

When combined, the results of the Conservation Analysis (Sections 4.3 and 4.4), the Risk Analysis (Section 3.6), Conservation Targets (Section 4.5) and the Reserve Design Principles (Section 4.2) form the basis for developing an overall vision for the design of reserves in the Plan Area and specific reserve design criteria for each Natural Community.

4.2 RESERVE DESIGN PRINCIPLES

Designing a reserve system draws upon all aspects of conservation biology and must take into consideration all ecological scales from species to landscape. Reserve design encompasses the size, shape, connectivity, orientation, and juxtaposition of conservation areas. All of these factors influence the ability of a reserve to sustain viable populations of Covered Species, minimize edge effects, maintain natural disturbance regimes and movement patterns, and support evolutionary processes (Cowling and Pressey 2001).

Table 4.1: Covered Species, Special Management Species, and Natural Community Associations

Natural Community	Covered Species[1]		Special Management Species	
	Primary Species	Secondary Species	Primary Species	Secondary Species
Valley Floor and Vernal Pool Grasslands	**Plants:** alkali milk-vetch, Bogg's lake hedge-hyssop, Colusa grass, Contra Costa goldfields, Ferris's milk-vetch, legenere, San Joaquin Valley Orcutt grass[2], Solano grass, vernal pool small scale **Invertebrates:** conservancy fairy shrimp, delta green ground beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp **Amphibians:** California tiger salamander **Birds:** burrowing owl	**Birds:** Swainson's hawk, tricolored blackbird	**Plants:** Baker's navarretia, bearded popcorn flower, brittlescale, Carquinez goldenbush, dwarf downingia, Ferris's goldfields, fragrant fritillary, heartscale, Heckard's peppergrass, hispid bird's-beak, hogwallow starfish, papoose tarplant[3], recurved larkspur, saline clover, San Joaquin spearscale **Invertebrates:** Ricksecker's water scavenger beetle **Birds:** grasshopper sparrow, mountain plover	**Birds:** northern harrier, short-eared owl, loggerhead shrike, yellow headed blackbird
Inner Coast Range	**Invertebrates:** Callippe silverspot butterfly **Amphibians:** California red-legged frog	**Invertebrates:** valley elderberry longhorn beetle **Birds:** Swainson's hawk, burrowing owl		**Amphibians:** foothill yellow-legged frog **Reptiles:** western pond turtle **Birds:** yellow-breasted chat, loggerhead shrike, yellow headed blackbird
Riparian, Stream and Freshwater Marsh	**Invertebrates:** Valley elderberry longhorn beetle **Reptiles:** giant garter snake **Birds:** tri-colored blackbird **Fish:** Chinook salmon (fall run), steelhead (Central Coast ESU), steelhead (Central Valley ESU)	**Birds:** Swainson's hawk **Fish:** delta smelt, Sacramento splittail, green sturgeon	**Amphibians:** foothill yellow-legged frog **Reptiles:** western pond turtle **Birds:** yellow-breasted chat, Modesto song sparrow	**Birds:** loggerhead shrike, yellow headed blackbird
Coastal Marsh	**Plants:** Mason's lilaeopsis, soft bird's-beak, Suisun thistle **Birds:** California clapper rail, California black rail **Mammals:** salt marsh harvest mouse **Fish:** Chinook salmon (winter run), Chinook salmon (spring run), delta smelt, longfin smelt, Sacramento splittail, and green sturgeon	**Fish:** steelhead, Chinook salmon (fall run) **Birds:** burrowing owl	**Plants:** Delta mudwort, delta tule pea, hispid bird's-beak, rose mallow, Suisun marsh aster **Birds:** northern harrier, salt marsh common yellowthroat, short-eared owl, Samuel's song sparrow, Suisun song sparrow **Mammals:** Suisun shrew	**Reptiles:** western pond turtle **Birds:** loggerhead shrike, yellow headed blackbird
Irrigated Agriculture	**Birds:** Swainson's hawk	**Birds:** burrowing owl, tricolored blackbird		**Birds:** loggerhead shrike, yellow headed blackbird

[1] These covered species will primarily benefit from the conservation measures for that natural community. Thus, the natural community is considered it's primary natural community association.

[2] Federally endangered species recently identified in Solano County; not known to occur in Solano County at time of water contract renewal.

[3] Replaced Cogdon's tarplant.

ESU = Evolutionarily Significant Unit

Reserve design is critical to the conservation and recovery of Covered Species. Each individual reserve should support a viable population of species for which it was designed, and the reserve network, as a whole, should preserve natural movement patterns and metapopulation dynamics. The size, spatial distribution, and connectivity of reserves can significantly alter the structure of metapopulations, which is a collection of sub-populations that exchange genetic information through individual dispersal events. The classic metapopulation model assumes that sub-populations inhabiting individual patches come into and out of existence with colonization rates that depend on the spatial arrangement of these patches. Certain design assumptions need to be considered when using a metapopulation model. First, empty patches can be just as valuable for species conservation as occupied patches. Second, protection of dispersal routes is critical because dispersal between patches dictates colonization rates. Finally, reservoir populations and sink areas must be identified, protected, and/or enhanced (e.g., removal of invasive species) to increase their productivity. In short, all potential habitat, occupied or unoccupied, has value. Connectivity between reserves and preserves must be maintained in order to preserve genetic diversity and buffer local extinction events. Restoration of lower quality (i.e., sink) areas could increase overall population numbers, even populations within high quality areas.

Well-designed reserve networks should preserve functional landscapes, minimize risk from invasive species, conserve Natural Community conditions, and provide for or increase resilience to natural and anthropogenic (human-caused) disturbances. Functional landscapes support a number of ecological processes, natural communities, and species at various scales (coarse, intermediate, and local); are ecologically intact; and retain (or can have restored) most or all of their key components, patterns, and processes (The Nature Conservancy 2000). Reserve design should facilitate the preservation and/or restoration of functional landscapes.

The reserve system is the backbone of any HCP. The extent to which the reserve system can protect and support viable populations of Covered Species and maintain biological diversity and ecosystem function will determine the overall success of the HCP. The Conservation Analysis (Sections 4.3 and 4.4) and Conservation Strategy (Chapter 5.0) refer to the reserve design principles to guide the development of the Solano HCP reserve system. The reserve design principles are:

1. **Preserve Large Blocks of Habitat.** Preservation of large blocks of habitat supporting large populations of Covered Species is superior to preservation of smaller blocks of habitat (Groves 2003). Large blocks of habitat are necessary for maintaining ecosystem processes and buffering against anthropogenic pressures. Large blocks typically provide a variety of habitat conditions and have greater ecosystem resilience. However, smaller reserves may be necessary to preserve isolated populations of extremely rare or range-limited species (particularly rare plant species).
2. **Conserve Covered Species Throughout the Plan Area.** Species distributed across their native ranges are less susceptible to extinction than those species confined to small portions of their native ranges. Therefore, the design of the reserve system shall attempt to conserve target species throughout the entire Plan Area rather than in limited habitat segments.
3. **Prioritize Habitat with High Conservation Value and at High Risk of Development.** Habitat with the highest conservation value at the highest risk of development shall be given the highest priority for acquisition. Parameters that define conservation value vary by community type. Areas of high conservation value typically support an abundance of native species and contain few roads, trails, or other human disturbances. However, degraded habitats

may also have high conservation value if they link preserve areas together, contain unique habitat features, support key populations of Covered Species, or have high potential for restoration and enhancement.

4. **Incorporate a Range of Environmental Gradients.** Reserves/preserves shall encompass a representative range of environmental gradients including moisture, soil, slope, elevation, aspect, climate, and habitat diversity in order to accommodate shifts in species distribution due to changing weather patterns and other circumstances.
5. **Protect Regional Water Quality.** Regional water quality affects all Covered Species. The best way to protect regional water quality is to preserve and manage entire watersheds or subwatersheds (particularly within headwater reaches), maintain sufficient riparian buffer zones, and sustain the ecological processes needed to efficiently catch, filter, and cycle water through the environment.
6. **Maintain Connectivity.** Interconnected blocks of habitat sustain effective movement and interchange of organisms and serve conservation purposes better than isolated blocks. Corridors or linkages between reserves function best when they resemble preserve habitats.
7. **Preserve Blocks of Habitat Close Together.** The juxtaposition of conservation areas is an important factor in reserve design. Preserving blocks of habitat close together is better than preserving blocks farther apart.
8. **Incorporate Buffer Zones.** Where possible, reserves shall incorporate land specifically designed to buffer the natural ecosystems from direct and indirect impacts associated with urbanization. The size and characteristics of the buffer zone will depend on site-specific conditions such as topography, local land practices, intensity of adjacent urban development, and needs of the Natural Community and Covered Species. Buffer zones may result from direct land acquisition or conservation easements with adjacent landowners.
9. **Minimize Edge Habitat.** The design of preserves and reserves shall maximize area-to-perimeter ratio, thereby decreasing the amount of edge habitat, particularly within urban development and along buffer zones, to minimize indirect effects of adjacent land use on the Natural Community. Maximizing the area-to-edge ratio of future development projects will also minimize edge habitat.
10. **Provide Diverse Environmental Conditions.** Species that are distributed across a range of environmental conditions exhibit greater genetic diversity; thus, promoting the continuation of evolutionary processes. Usually, species are not distributed at random across suitable habitat because they are responding to microenvironmental characteristics. Some of these environmental characteristics remain constant between years (e.g., soil salinity), but several conditions are dependent on climate conditions (e.g., hydrology). Preserves and reserves shall include a diverse range of physical and environmental conditions, including the preservation of unique or uncommon habitat features (such as large playa pools or lakes, alkali flats, and unique soil types) that reflect the ecological diversity of the Plan Area. Preserving a diverse range of physical and environmental conditions will better preserve genetic diversity and buffer species distributions in the face of fluctuating environmental conditions (i.e., buffer the effects of climate change).
11. **Consider Ecotone and Transition Areas.** Ecotone or transition areas, especially those between wetlands and uplands, are important habitat components and shall be given special consideration in the development of priority conservation areas.

12. **Target "'Hot Spots" of Diversity.** Areas with unique habitat features, concentrations of Covered Species, and/or high biological diversity shall be targeted for preservation.
13. **Minimize Human Disturbance.** Blocks of habitats with limited accessibility to humans conserve target species better than accessible blocks. However, parks with hiking, biking, and horseback riding trails may buffer adjacent preserve lands from the indirect effects of urban development.
14. **Consider Management Needs.** Once reserves/preserves are established, long-term management and/or stewardship is required to maintain the biological values for which the lands are preserved. Introduced species have significantly altered and overtaken California's natural communities, such that in many communities, nonnative species are more prevalent than native species. Long-term management is critical for addressing the altered ecology of these lands, protecting new and existing reserve lands from surrounding land uses (and vice versa), controlling invasions of exotic pests (animal and plants) prevalent in the region, and maintaining infrastructure. Reserves, preserves and other sites established to fulfill the Solano HCP conservation objectives will need to address these issues.
15. **Incorporate Restoration Activities.** While significant resources exist throughout the Plan Area, current and historic land use practices have altered many of these resources. For these areas, restoration and active management are needed to reestablish historic productivity and value. Therefore, restoration will be an important component of the Solano HCP reserve system. In addition, restoration activities should be conducted on lands adjacent to existing high quality preserves in order to increase the potential for successful restoration.

4.3 CONSERVATION ANALYSIS BY NATURAL COMMUNITY

The Conservation Analysis for each Natural Community is organized into three sections: (1) Associated Covered Species and Special Management Species; (2) Key Conservation Elements; and (3) Conservation Areas. Table 4.1 summarizes the Covered Species and Special Management Species associated with each Natural Community. Key conservation elements for each Natural Community have been determined based on the Natural Community accounts presented in Appendix B (Figure 4-1). A key conservation element is a habitat feature or environmental characteristic that can be physically mapped within the Plan Area that reflects the conservation value and/or habitat quality of the Natural Community. Conservation areas are identified based on key conservation elements and the reserve design principles outlined in Section 4.2. The conservation areas are used to develop a conservation approach for each Natural Community, determine compensation or mitigation levels (see Chapter 6.0) for Covered Activities, and determine the level of development compatible with the regional conservation goals and objectives.

4.3.1 Landscape Level Key Conservation Elements

Certain conservation issues cannot be adequately addressed under a single Covered Species or Natural Community. Landscape-level issues simultaneously affect multiple Natural Community assemblages and are best addressed from a broad perspective that ties all of the Natural Community assemblages together. For the Solano HCP, landscape-level issues primarily concern dispersal corridors, habitat connectivity across Natural Community boundaries, and species diversity. Another concern discussed at the landscape level, as well as at the Natural Community and Covered Species level, is global climate change.

4.3.1.1 Corridors

An analysis of major and minor barriers and patterns of habitat fragmentation revealed seven major potential corridor areas within the Plan Area. These corridors are the area north of Vacaville, the Vacaville-Fairfield Green Belt, the Suisun Valley agricultural area, Vallejo Lakes, Rockville Hills, and Jepson Prairie-Suisun Marsh Corridor (Figure 4-2). Most of these corridors contain some type of habitat for Covered and Special Management Species; however, the habitat is often highly disturbed. In addition, several of the corridors contain development features that may be considered a barrier to some species but not others. As a result, only certain species may benefit from the protection of certain corridors.

1. **North Vacaville:** The North Vacaville Corridor represents the portion of the English Hills north of the rural residential areas in northern Vacaville. This area provides an important transition between the Vaca Mountains, Pleasants Valley, and the Vacaville Vernal Pool High Value Conservation Area (Figure 4-2). This corridor contains high value vernal pool habitat within the hardpan pool area (Corning series soils: see Section 4.3.2.2) and oak savanna and oak woodland habitat within the English Hills. This corridor could provide dispersal habitat for Swainson's hawks, as their populations expand westward into Napa County, and burrowing owls. All of the vernal pool Covered Species would benefit from preservation of this corridor.
2. **Vacaville-Fairfield Green Belt:** Despite the presence of Interstate 80 (I-80) and several other major roadways, the Vacaville-Fairfield Green Belt provides connectivity between the lowlands of the Valley Floor/Jepson Prairie and the Vaca Mountains (Figure 4-2). Habitat within this corridor includes vernal pool and valley floor grasslands, Inner Coast Range grasslands, oak savanna, and oak woodland. This corridor is most valuable for avian species such as Swainson's hawks, burrowing owls, and several of the avian Special Management Species; however, several creek crossings provide passage for fish, amphibian, and mammal species. Many additional species with smaller home ranges would also benefit from preservation of habitat within this corridor.
3. **Suisun Valley:** The Suisun Valley agricultural area, which is dominated by vineyards and orchards, provides a "greenbelt" connecting the West Hills to Suisun Marsh (Figure 4-2). Habitat within this corridor consists of riparian vegetation that is immediately adjacent to Suisun Valley Creek, but the majority of the corridor consists of irrigated agriculture. There is one Swainson's hawk nest that occurs within this corridor in Cordelia that would benefit from preservation of the irrigated agriculture within the Valley. Suisun Valley Creek is considered a Salmonid stream and contains records for valley elderberry longhorn beetle. Maintaining the integrity of Suisun Valley as a corridor area would benefit these Covered Species as well as several Special Management Species.
4. **West Hills–Vaca Mountains Corridor:** Intensive agricultural land use in Suisun Valley separates the West Hills from the Vaca Mountains, but a small area of natural vegetation north of Suisun Valley provides a corridor between these two areas (Figure 4-2).
5. **Vallejo Lakes and Rockville Hills:** Rural residential development has expanded northwest from Cordelia into the West Hills, separating them from the Tri-City/County Planning Area. However, two corridors maintain connectivity between these two areas: Vallejo Lakes west of the rural residential development, and Rockville Hills between the rural residential development and Cordelia (Figure 4-2). Habitats within these corridors consist of oak woodland and grassland in the Vallejo Lakes corridor and oak woodland, grassland, and irrigated agriculture within the Rockville Hills corridor area. These corridors are important

because they connect the existing populations of California red-legged frog and callippe silverspot butterfly with additional potential habitat areas to the north.

6. **Jepson Prairie-Suisun Marsh Corridor:** The region surrounding the Potrero Hills represents important transition habitat between Suisun Marsh and Jepson Prairie (Figure 4-2). The primary habitat within this corridor consists of vernal pool grasslands, coastal marsh habitat, and a rare transition habitat that occurs only in areas where these two community types intersect. This transition habitat has become increasingly rare, as development has expanded along the edge of the marsh along Suisun and Fairfield. Grasslands adjacent to marsh habitat are vitally important to salt marsh harvest mice. The largest known population of Contra Costa goldfields also occurs within this transition habitat in this corridor. This corridor provides important habitat for several coastal marsh and vernal pool Covered and Special Management Species. Preservation of this corridor area would also help buffer marsh species from sea level rise due to climate change.

4.3.1.2 Rarity-Weighted Richness Index

Areas containing, potentially supporting, or with high richness of Covered Species and Special Management Species were identified throughout the Plan Area. Areas of high richness were identified by calculating a rarity-weighted richness index (RWRI) using methods developed by Chaplin et al. (2000) and the California Department of Fish and Game (CDFG 2003a) for the CDFG *Atlas of the Biodiversity of California*. An RWRI measures the irreplaceability of certain areas based on species occurrence records. The methods and biases inherent in this approach are described in Hunting (2003). One significant bias in the analysis conducted for the HCP is the lack of survey data available for the majority of the County. With more data collection, the resulting diversity patterns may change. The analysis and its results are described in further detail below.

For the RWRI, a grid of equal-area hexagonal cells with sides 0.25-mile (mi) long and approximately 2,286 feet (ft) (0.433 mi) between centers was overlaid onto the Plan Area (see Figure 4-3). Species occurrence information was then used to determine rarity values for each cell. The RWRI assigns a weight to each species based on the inverse of the number of hexagons in which it occurs. For example, a species found in only one hexagon receives the maximum possible score of 1/1, or 1.0. The score for a species occurring in 20 hexagons would be 1/20, or 0.05. The rarity-weighted index for the cell is the sum of the individual scores for all species in the hexagon (Chaplin et al. 2000).

Two sources of rare species occurrence data were used for this analysis: (1) California Natural Diversity Database (CNDDB) polygon records, and (2) additional species occurrences collected by LSA Associates, Inc. that do not appear in the CNDDB. Following the methods outlined in the CDFG *Atlas of the Biodiversity of California*, data was "filtered" to exclude extirpated or low precision occurrence records. CNDDB records identified as "extirpated" or "likely extirpated" or with an accuracy class of 10 (indicating the record had been created by placing a 5 mi radius around very non-specific locality information) were removed. Non-CNDDB records considered extirpated based upon evaluation of available habitat via field surveys or aerial imagery were also removed.

Figure 4-3 presents the results of the RWRI for Covered Species and Special Management Species within the Plan Area. Dark green and blue hexagons represent irreplaceable conservation areas

based on species occurrence records; however, this map must be used with caution because the results are highly affected by insufficient survey information.

Figure 4-3 depicts Jepson Prairie as a hot spot of diversity within the Plan Area. Jepson Prairie is known for its diversity of vernal pool species and would be recognized as a biological diversity hot spot even with additional survey data. The RWRI also identified Suisun Marsh as an area of high biological diversity within the Plan Area. Suisun Marsh is also known to host a suite of rare and threatened species. However, limited data are available for privately owned areas of Suisun Marsh; more records from these areas may change the results of the RWRI analysis. Other hot spots within the Plan Area include the area northeast of Vallejo where callippe silverspot butterfly records occur.

Figure 4-3 depicts the Inner Coast Range as predominantly low richness with isolated "hot spots" of biological diversity, reflecting the limited availability of data for that region. The isolated high value hexagons represent the small number of Covered Species and Special Management Species associated with this Natural Community and the limited availability of records for some of the Special Management Species, such as the yellow-breasted chat (*Icteria virens*), foothill yellow-legged frog (*Rana boylii*), and western pond turtle (*Actinemys marmorata*). More data would likely alter the pattern observed for this region from low to moderate richness with occasional areas of high richness (i.e., light to dark green with occasional blue hexagons). The depiction of the Inner Coast Range does not accurately reflect its biodiversity because only Covered Species and Special Management Species were included in the RWRI analysis. An analysis of all species in the region would indicate high biodiversity in the Inner Coast Range. Approximately 331 species depend on oak woodlands throughout their lifecycle (Verner 1980; Barrett 1980; Block and Morrison 1998) and riparian or streamside vegetation provides important habitat for over 225 species of fish, amphibians, reptiles, birds, and mammals in California (RHJV 2000).

Another region with surprisingly low values for species diversity and rarity is the Vacaville Vernal Pool High Value Conservation Area due to the lack of biodiversity data. This area likely contains a diverse range of claypan vernal pool species, similar to the Jepson Prairie, and may even contain a slightly different composition of species. Regardless, with more data, this area would likely rank higher for species richness.

The patchwork of light to moderately dark hexagons in the northeastern portion of Solano County corresponds to an area dominated by irrigated agriculture and predominantly represents records of Swainson's hawk and burrowing owl. Both species occur throughout this area, and the pattern observed from this analysis likely results from greater public accessibility to some areas (e.g., more public access increases the likelihood of species being observed and recorded), particularly the southern part of the Maine Prairie (Figure 1-3).

4.3.1.3 Climate Change

Global climate change, which most scientists believe is caused by greenhouse gas (GHG) emissions, is a widely discussed scientific, economic, and political issue. Climate change is defined as a change in the average weather of the earth that can be measured by wind patterns, storms, precipitation, and temperature (AEP 2007). California recognizes that climate change will cause tremendous impacts on ecosystems, agriculture, natural resources, and public health (California Natural Resources Agency 2009). The State Legislator passed the California Climate Solutions Act of 2006 and the Governor issued Executive Order S-3-05. These laws address the impacts of

climate change by sponsoring research to assess the effects of climate change[1], implement efforts to reduce GHG emissions, and develop an adaptive strategy to respond to present and future climate change within its jurisdiction.

Ongoing research on the causes and effects of global climate change continues to expand and refine the scientific basis for policy and management decisions. The United Nations Intergovernmental Panel on Climate Change (IPCC) and others have constructed climate models to predict the potential effects that various GHG emission rates might have on sea levels, precipitation, average temperatures, ecosystems, agriculture, and wildfire frequency and size. The IPCC predicted that a global mean temperature increase from 1990 to 2100, under six scenarios, could range from 34 degrees Fahrenheit (°F) to 43.5°F (IPCC 2007). There is no clear consensus on the results of climate modeling. Models differ and often conflict with each other, and specific predictions continue to cause controversy among climate scientists.

In general, expected changes for California include:

- Hotter and drier conditions overall, with fewer extremely cold nights, more extremely hot days, and hotter, longer extreme heat events;
- A decreasing Sierra Nevada snow pack and increases in winter rains;
- More frequent and more severe droughts and floods; and
- More frequent and larger wildfires (California Natural Resources Agency 2009).

The variables or stressors identified by the Society for Ecological Restoration International (2009) associated with global climate change predictions that have the greatest potential to affect rare, threatened, and endangered species are:

- Increased rates of sea level rise;
- Increases in temperatures;
- Increases in carbon dioxide (CO_2) concentrations;
- Changes in precipitation (which will affect the frequency and severity of droughts, floods, and wildfires);
- Increases in diseases, pests, and nonnative species that compete with native species; and
- Increases in the frequency and severity of storm events.

Based on currently available information, the Covered Species anticipated to be most at risk from global climate change are:

- **Coastal Marsh Species:** *Suisun thistle, soft bird's-beak, Mason's lilaeopsis, California black rail, California clapper rail, Suisun song sparrow, salt marsh harvest mouse, Delta smelt, Sacramento splittail, longfin smelt, and green sturgeon.* Rising sea level will inundate coastal marsh habitat unless there is available space for the marsh to migrate upland. Sea level in San Francisco Bay has risen 7 inches over the past century, and there is general consensus that the rate of rise will accelerate due to global climate change, although projections for this century

[1] The California Energy Commission's Public Interest Energy Research (PIER) program has established the California Climate Change Center to direct and provide a central location for climate change research relevant to the State.

vary widely, from 7 to 23 inches to 32 to 79 inches above recent levels (California Natural Resources Agency 2009).

- **Amphibians:** *California tiger salamander and California red-legged frog.* These animals require appropriate aquatic environments for their reproduction. Breeding is depressed during drought, especially prolonged drought.
- **Vernal Pool Species:** *Ferris's milk-vetch, alkali milk-vetch, vernal pool smallscale, Boggs Lake hedge hyssop, Contra Costa goldfields, legenere, Colusa grass, San Joaquin Valley Orcutt grass, Solano grass, Conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, midvalley fairy shrimp, and Delta green ground beetle.* While this natural community is adapted to seasonal drought, it is vulnerable to species invasions. In addition, drought will result in a shorter wetted phase, thereby reducing the time period during which vernal pool species can reproduce.
- **Fish that Depend on Delta Outflows:** *Green sturgeon, Chinook salmon, steelhead, Delta smelt, Sacramento splittail, longfin smelt.* Diminished Delta outflows cause excessively high salinity levels, excessively warm water temperatures, and/or insufficient water levels. Low outflows will not signal anadromous species to initiate migration for spawning and can exacerbate migration barriers.
- **Swainson's Hawk:** Swainson's hawk foraging behavior is well adapted to agricultural land used for alfalfa, irrigated pasture, and row and truck crops. Changes in agricultural crops and patterns based on decreased water availability could diminish foraging habitat quality.
- **Callippe Silverspot Butterfly:** Callippe silverspot butterflies in their larval or pupal stages remain on the ground, where they are vulnerable to wildfire. Changes in rainfall patterns, especially drought or increased spring rainfall, may decrease the distribution of the larval host plant, Johnny jump-up. Increase spring rainfall increases production of annual grasses in California grasslands and decrease the abundance of forbs (Suttle, Thomsen, and Power 2007).

The Solano HCP contains provisions that will facilitate the assessment of climate change impacts within the Plan Area as well as crafting and implementing responses to those impacts. Primary among these is the monitoring and adaptive management approach it employs (Chapter 7.0), which provides a means to continually assess effectiveness and incorporate new information on the ecology of Covered Species into the management of reserves. Data collected during monitoring will be analyzed and used to determine whether reserves are functioning as intended and are actually able to support Covered Species. If necessary, conservation and management strategies will be adjusted. In addition, funding to implement the HCP includes substantial funds earmarked for monitoring and adaptive management as well as contingency funds to address unexpected situations and cover the cost of remedial actions (Chapter 11.0).

4.3.2 Valley Floor Grassland and Vernal Pools

Valley Floor Grassland and Vernal Pools are dominated by two typically intermixed associations: vernal pool system grasslands and grasslands associated with low hills, such as the Montezuma Hills, Potrero Hills, and upper terraces along the Valley Floor/Inner Coast Range Foothills. Vernal pool ecosystems in Solano County consist of seasonally inundated pool basins and swales embedded in a matrix of undulating grasslands.

The Valley Floor Grassland and Vernal Pool Conservation Analysis applies to all areas on historical alluvial terraces on the valley floor that currently support or likely historically supported vernal pool habitats. Areas that likely historically supported vernal pools are encompassed within the Conservation Analysis because they are reasonably capable of being restored. This Natural Community encompasses both the wetland component, including vernal pool and other seasonal to semi-permanent wetlands, and associated uplands within their immediate watersheds that provide habitat for vernal pool associated species.

This section presents the conservation analysis for the Valley Floor Grassland and Vernal Pool Natural Community including identification of key conservation elements and conservation areas. The conservation analysis is based on information for this Natural Community provided in Appendix B.

4.3.2.1 Associated Covered Species and Special Management Species

Vernal pools and their associated plant communities provide the primary habitat for 15 Covered Species and 19 Special Management Species (Table 4.1). Two additional Covered Species and four additional Special Management Species will receive secondary benefits from vernal pool conservation in the Plan Area. Covered Species and Special Management Species have been divided into four groups based on specific habitat associations (Table 4.2).

1. **Group 1 – Vernal Pool/Grassland Complex Species:** This group includes species capable of tolerating a broad range of water quality/alkalinity, depth, and duration. These species are expected to occur in almost any vernal pool community complex within their respective range or distribution in the Plan Area. However, several of these species are quite uncommon and have a very limited range or occurrence.
2. **Group 2 – Alkali Playa, Flats, and Meadow Species:** This group includes a number of plant species typically associated with highly alkaline plant communities such as alkali playas, flats, and meadows. These species may also occur in higher salinity zones around the drying edges of vernal pool communities.
3. **Group 3 – Long Duration Hydro-Period/Playa Pool/Vernal Lake Species:** This group includes a number of species that are extremely rare or range-limited within the Plan Area and are closely tied to the larger playa pools/vernal lakes. These pools are characterized by turbid water and an extended hydro-period and are typically associated with Pescadero Series soils.
4. **Group 4 – Upland Species:** This group is composed of species (or life stages) primarily associated with upland grasslands (or vernal pools and swales during the dry season) as opposed to the aquatic-oriented species described above.

4.3.2.2 Key Conservation Elements

As described above, key conservation elements reflect the conservation value and/or habitat quality of the Natural Community. The following key conservation elements were assessed to determine the relative conservation value of areas within the Valley Floor Grassland and Vernal Pools Natural Community:

Table 4.2: Valley Floor Grassland and Vernal Pool Associated Covered and Special Management Species

Group 1: Short- to Long-Duration Hydro-Period Vernal Pool and Swale Species	Group 2: Highly Alkaline Flat and Meadow Species	Group 3: Long-Duration Hydro-Period/Playa Pool/Vernal Lake Species	Group 4: Upland Species
Covered Species			
Alkali milk-vetch	Ferris's milk-vetch	Bogg's Lake hedge hyssop	Burrowing owl
Contra Costa goldfields[1]	Vernal pool smallscale	Colusa grass	Swainson's hawk
Legenere		Solano grass	California tiger salamander (upland)
San Joaquin Valley Orcutt grass[1]		California tiger salamander (breeding)	
Vernal pool fairy shrimp		Conservancy fairy shrimp	
Vernal pool tadpole shrimp		Delta green ground beetle	
Tri-colored blackbird			
Special Management Species			
Baker's navarretia	Brittlescale	Ferris's goldfields[1]	Carquinez goldenbush
Bearded popcorn flower[1]	Heartscale	Ricksecker's water scavenger beetle	Fragrant fritillary
Dwarf downingia	Hispid bird's-beak		Recurved larkspur
Heckard's peppergrass	San Joaquin spearscale		Grasshopper sparrow
Hogwallow starfish			Modesto song sparrow
Pappose tarplant			Mountain plover
Saline clover			Loggerhead shrike
			Yellow-headed black bird

Group 1 Species: Species that appear to be capable of tolerating a broad range of water quality/alkalinity, depth, and duration.

Group 2 Species: This group includes a number of plant species that are typically associated with higher alkalinity plant communities such as alkali playas, flats, and meadows. These species may also occur in higher salinity zones around the drying edges of vernal pool communities.

Group 3 Species: This group includes a number of species that are extremely rare or range-limited within the County. These species tend to be closely tied to the larger playa pools/vernal lakes. These pools are characterized by having turbid water, depths greater than 1.5 feet, and an extended hydro-period. In Solano County, such pools are typically associated with Pescadero Series soils.

Group 4 Species: This group is composed of species (or life stages) that are primarily associated with the grassland community in the uplands (or vernal pools and swales during the dry season) rather than the more aquatic-oriented species in the previous groups.

[1] Species marked with an "*" are quite uncommon and have a very limited range or occurrence within Solano County.

- Disturbance Levels
- Distribution of Covered Species and Special Management Species
- Unique or Uncommon Habitat Features
- Proximity to Existing and Proposed Preserves/Reserves
- Barriers
- Core Recovery Areas and Designated Critical Habitat
- Corridors and Linkage Areas

Disturbance Levels. All potential vernal pool habitat (Figure 4-4) was ranked into five disturbance categories based on aerial photographs from varying dates and sources and limited ground-truthing/verification. These disturbance levels establish a metric for assessing the degree to which anthropogenic pressures have degraded or altered the ecological processes, functions, and overall habitat value of the Natural Community. The five disturbance categories are as follows:

- **Converted:** This category includes areas on historic vernal pool soils (Figure 3-7) that have been converted to agriculture, urban development, or other uses, essentially eliminating the natural communities.
- **Very High Disturbance Levels:** This category includes areas supporting grassland cover, but in which historic vernal pool features have been largely erased (i.e., current land use was incompatible with vernal pools or there was clear evidence of plowing and/or leveling). Severe disturbance within these areas occurs when the underlying claypan/hardpan no longer exists or has been covered by development. These areas have very little, if any, potential for restoration due to the significant alteration of essential habitat and ecological processes.
- **High Disturbance Levels:** This category includes areas containing evidence of current or historic farming (i.e., plow lines) as well as some evidence of topographic variation, pools, swales, or native vegetation despite being extensively graded. Restoration within these areas, while possible, would likely require hydrologic changes and extensive revegetation.
- **Moderate Disturbance Levels:** This category includes areas containing evidence of historic disturbance, vehicle tracks, or bare ground from an unknown source, but no visible plow lines or apparent leveling. These areas also exhibited topographic variation, clearly defined pools or swales, or natural vegetation. Restoration/revegetation and changes in land management would be needed to establish or maintain vernal pool habitat in these areas.
- **Low Disturbance Levels:** This category includes areas where the landform and vegetation appeared to be in relatively "pristine" condition. In these areas, natural topographic variation (including mima mound topography), ponds and/or swales, and natural vegetation was evident, with little or no evidence of historic farming (furrows or leveling) or other serious disturbance. These areas would require little or no restoration to establish or maintain vernal pool habitat for the purpose of conservation.

  A large, essentially contiguous block of native topography/low disturbance vernal pool habitat occupies much of the greater Jepson Prairie in Solano County (Figure 4-4). This large block extends approximately 18 square miles (sq mi), from Travis Air Force Base (AFB) on the west, State Route 113 (SR-113) on the east, Hay Road on the north, and Creed Road on the south. Additional scattered blocks occur east of Highway 113 in the Gridley Ranch Mitigation Bank along Alamo Creek, and in an area north of Robinson Road south of Calhoun Cut (Figure 4-4). Disturbance in this block relates primarily to historical and ongoing agricultural operations.

Additional, smaller blocks of moderately disturbed habitats occur in northeastern Fairfield and north of Vacaville (Figure 4-4).

Distribution of Covered Species and Special Management Species. Three types of data were used to evaluate the distribution of Covered Species and Special Management Species in the Valley Floor Grassland and Vernal Pool Natural Community: (1) the distribution of all Covered Species and Special Management Species according to the RWRI; (2) the distribution of Contra Costa goldfield occurrences and the known and potential range of the species (Figure 4-5); and (3) the known core breeding area and potential range of California tiger salamanders (Figure 4-6).

Rarity-Weighted Richness Index. Areas containing or potentially supporting and areas with high richness of Covered Species and Special Management Species were identified throughout the Plan Area by calculating the RWRI (see Section 4.3.1.2). This analysis identified Jepson Prairie, which is known for its diversity of vernal pool species, as a hot spot of biological diversity within the Valley Floor Grassland and Vernal Pool Natural Community (Figure 4-3).

Contra Costa Goldfields. Contra Costa goldfields have been designated into seven Core Population Areas to address potential genetic variations among various locations in Solano County (see Appendix B). These seven Core Population Areas are shown on Figure 4-5. Most of these Core Population Areas are located around the periphery of, or within, existing and proposed development within the Cities of Fairfield and Suisun. Core Population Areas containing large contiguous blocks of habitat, unfortunately, lack large populations of Contra Costa goldfields. However, these areas may be valuable for re-establishment efforts. Areas adjacent to Core Population Areas may also be important for the conservation of Contra Costa goldfields because there is a small chance they may be occupied; but if not, they also provide important corridor habitat for dispersal and help maintain the integrity of the watersheds that support core populations.

California Tiger Salamander. The distribution and range of California tiger salamanders within the Plan Area is divided into two components: a known core breeding area and a potential range (Figure 4-6). The known core breeding area is defined as all habitat within 1.3 mi of a breeding record, with the exception of northeast Fairfield. This is the same methodology used by CDFG (2010a) to estimate occupied habitat. CDFG (2010a) used 1.3 mi as a "normal" maximum distance a California tiger salamander would move from the nearest breeding pond (Orloff 2007). For northeast Fairfield, significant movement barriers such as Putah South Canal, Peabody Road, and existing development defined the edge of the known core breeding area.

The known core breeding area is divided up into four partially isolated population nodes (Figure 4-6). The largest population node, which forms the core population in Solano County, is on the Jepson Prairie. The other sub-population nodes are northeastern Fairfield, the Potrero Hills, and the Montezuma Hills. The corridor between the Jepson Prairie and the northeastern Fairfield population has been diminished to a very narrow and fragmented corridor from incompatible land uses (irrigated agriculture and Travis AFB runway). The barrier created by the existing high traffic volumes on State Route 12 (SR-12) has largely eliminated California

tiger salamander movement between the core population on the Jepson Prairie and the sub-populations in the Potrero Hills and Montezuma Hills.

The potential range of California tiger salamanders within the Plan Area is an extension of the known core breeding area southeast into the Montezuma Hills, west into the remainder of the Potrero Hills, north into the eastern portion of Suisun City, northwest into the Vacaville-Fairfield Green Belt, and northeast into remnant vernal pool habitat areas. McCoy Basin and surrounding habitat were excluded from both the core breeding area and potential range of the species because salamanders have not been found in this area and there are significant barriers impeding the movement (such as development along Peabody Road and the Putah South Canal) of individuals from adjacent occupied areas (i.e., Noonan Ranch Conservation Bank) (Figure 4-6).

Unique or Uncommon Habitat Features. In order to meet the reserve design criteria for preserving a diverse range of physical and environmental conditions, unique or uncommon habitat features (such as large playa pools) and potential outlier or edge populations were identified for vernal pool species within the Plan Area. These two features include the distribution of playa pools and hardpan soils. Within the Plan Area, playa pools occur from the northern edge of the Potrero Hills northeast to the Jepson Prairie (Figure 4-7). North of Vacaville, a small remnant vernal pool region is characterized by hardpan soils. Whether this region supports a different fauna than the claypan pools of the Jepson Prairie is unknown; until that is determined, this region is highlighted as a unique environmental feature.

Proximity to Existing and Proposed Preserves/Reserves. Areas adjacent to existing preserves and reserves have high conservation value because land acquired adjacent to existing conservation areas will effectively increase preserve size and establish additional connectivity between preserve lands. Figure 3-11 shows the distribution of existing preserves/reserves and proposed mitigation banks within the Valley Floor Grassland and Vernal Pool Natural Community. The majority of these existing and potential reserves/preserves encompass the higher quality/low disturbance vernal pools of the greater Jepson Prairie.

Barriers. Barriers, such as roads and development, that significantly hinder wildlife movement and hydrology were identified within the Plan Area and were classified as either major or minor barriers. Major barriers include high-volume roads such as I-80, Interstate 680 (I-680), and Interstate 505 (I-505), SR-12, and SR-113, and local roads such as Vanden Road and Peabody Road where traffic volumes are high and the ability for small animals to cross the road successfully is unlikely. These roads also form significant barriers to the natural flow of water. Minor barriers include lower traffic volume roads that would not represent a significant barrier to terrestrial animal movement, but would affect hydrology and drainage patterns and serve as corridors for invasive species expansion. The delineation of potential barriers reveals patterns of habitat fragmentation and helps to identify where linkages should be established. The largest area of uninterrupted habitat within the Valley Floor Grassland and Vernal Pool Natural Community is an essentially roadless area within the Jepson Prairie (Figure 4-4). No public roads occur within this large block of habitat, and access is limited to a few minor ranch roads/trails.

Corridors. Three corridors have been identified within the Valley Floor Grassland and Vernal Pool Natural Community: the North Vacaville Corridor, the Vacaville-Fairfield Green Belt, and the Jepson Prairie-Suisun Marsh Corridor (Figure 4-2). Section 4.3.1.1 provides a description of all three corridors. The North Vacaville Corridor primarily contains Inner Coast Range habitat, but also supports a small remnant of hardpan vernal pool habitat. If the North Vacaville Corridor is preserved, it will encompass some of the northern hardpan pools within the Plan Area. California tiger salamanders occur within the Vacaville-Fairfield Green Belt. If the Vacaville-Fairfield Green Belt is preserved, it will help link the California tiger salamander populations in Northeast Fairfield with the populations at Jepson Prairie. The Jepson Prairie-Suisun Marsh Corridor provides unique transition habitat and currently contains the largest population of Contra Costa goldfields and several other Covered and Special Management Species.

Core Recovery Areas and Designated Critical Habitat. The Vernal Pool Ecosystem Recovery Plan (USFWS 2005) designated five Core Recovery Areas in Solano County: Jepson Prairie, Suisun Marsh, Collinsville, Montezuma Hills, and Vacaville. In addition to these Core Recovery Areas, designated critical habitat for the Delta green ground beetle and California tiger salamander, and vernal pool critical habitat is present within the Plan. The locations of these areas are shown on Figure 4-7.

4.3.2.3 Conservation Areas

The Valley Floor Grassland and Vernal Pool Natural Community, as depicted in Figure 3-5, has been divided into three conservation areas (low, medium, and high) based on the key conservation elements described in Section 4.3.2.2. These conservation areas are shown on Figure 4-8 and are further detailed below.

High Value Conservation Areas. Based on the key conservation elements described in Section 4.3.2.2, high value conservation areas were delineated using the following criteria:

- Large blocks (greater than 500 acres [ac], regardless of ownership) of vernal pool complexes and associated habitats with low to moderate levels of disturbance and containing or potentially supporting populations of target species;
- Unique or uncommon habitat features (such as large playa pools or lakes, alkali flats, and unique soil types) and areas with high concentrations of target species and biological diversity;
- Moderately to highly disturbed habitats within and adjacent to moderate to high quality vernal pool complexes that have a high potential for restoration and enhancement of vernal pools and associated habitats;
- Complexes that support isolated populations of extremely rare or range-limited species and/or core populations of Contra Costa goldfields regardless of size (less than 500 ac, regardless of ownership), level of disturbance or existence of barriers;
- Areas that may serve as corridors or linkages between other high value lands;
- Vernal pool complex ecotone or transition areas, especially areas between estuarine, lacustrine, palustrine, and riverine systems; and
- Areas representing separate Evolutionarily Significant Units (ESUs).

Based on the above criteria, the high value conservation areas (39,555 ac in total) are further subdivided into 12 subareas to facilitate conservation activities (Figure 4-8). These subareas are:

1. **Subarea 1A – Jepson Prairie:** High Value Conservation Criteria 1, 2, 3, 4, 5, 6, and 7 (26,860 ac)
2. **Subarea 1B – McCoy Creek Basin Contra Costa Goldfields Core Population:** High Value Conservation Criteria 3, 4, and 7 (610 ac)
3. **Subarea 1C – Upper Union Creek Contra Costa Goldfields Core Population:** High Value Conservation Criteria 1, 3, 4, 5 and 7 (1,380 ac)
4. **Subarea 1D – Vanden Contra Costa Goldfields Core Population:** High Value Conservation Criteria 3, 4, and 7 (100 ac)
5. **Subarea 1E – Walters/Air Base Parkway Contra Costa Goldfields Core Population:** High Value Conservation Criteria 3, 4, and 7 (170 ac)
6. **Subarea 1F – Potrero Hills/Lower Union Creek/Denverton Creek Contra Costa Goldfields Core Population:** High Value Conservation Criteria 1, 2, 3, 4, 5, 6, and 7 (4,990 ac)
7. **Subarea 1G – Ledgewood Creek Contra Costa Goldfields Core Population:** High Value Conservation Criteria 2, 3, 4, 6, and 7 (280 ac)
8. **Subarea 1H – Cordelia Contra Costa Goldfields Core Population:** High Value Conservation Criteria 4, 6 and 7 (15 ac)
9. **Subarea 1I – Montezuma Hills Core Recovery Area:** High Value Conservation Criteria 4 and 7 (140 ac)
10. **Subarea 1J – Collinsville Core Recovery Area:** High Value Conservation Criteria 4, 5, 6, and 7 (880 ac)
11. **Subarea 1K – Hardpan Pools (Corning Series Soils – Northwest Area):** High Value Conservation Criteria 1, 2, 3, 5, 6 and 7 (3,530 ac)
12. **Subarea 1L – Davis Communications Annex:** High Value Conservation Criteria 4 and 7 (600 ac)

Medium Value Conservation Areas. Medium value conservation areas include highly to very highly disturbed lands located on historic vernal pool soils and adjacent Valley Floor Grassland habitat located on non-vernal pool soils. These disturbed lands on historic vernal pool soils have been previously leveled and/or cultivated such that the natural soil profile has been altered, but the underlying impermeable layers remain intact. Other lands in this category include moderate to highly altered lands that are isolated or surrounded by existing urban development, or other land uses that have substantially altered the hydrological integrity of the site. Typically, medium value conservation areas lie on the periphery of or adjacent to high value conservation areas but are hydrologically and ecologically separated from these areas by roads, canals, ditches, and/or other development. Although medium value conservation areas may contain suitable habitat, they

typically do not support target species (as documented through surveys of an appropriate timing and intensity), or are inhabited by more common and widespread target species[1].

Medium value conservation areas were delineated based on the following criteria:

- Watershed and buffer lands to high value conservation areas;
- Areas that support (or may support) populations of more common and widespread species;
- Areas that serve as corridors, linkages, or transition zones to other terrestrial habitats;
- Areas that contain fringe or edge populations that represent separate ESUs; and
- Sites of limited size that are isolated and/or subject to significant anthropogenic pressures, and the potential for restoration is limited.

The medium value conservation areas (90,780 ac in total) are further subdivided into 14 subareas based on geographical location and species-specific conservation requirements:

1. **Subarea 2A – Maine Prairie/Valley Floor Region:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (5,880 ac)
2. **Subarea 2B – McCoy Creek Contra Costa Goldfield Buffer/Watershed Lands:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (comprising mostly pre-approved projects; minor remnant areas remain) (70 ac)
3. **Subarea 2C – Upper Union Creek Contra Costa Goldfield Buffer/Watershed Lands:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (2,020 ac)
4. **Subarea 2D – East Vacaville:** Medium Value Conservation Criteria 2, 4, and 5 (870 ac)
5. **Subarea 2E – Walters/Air Base Parkway Contra Costa Goldfield Buffer/Watershed Lands and Corridor Area:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (380 ac)
6. **Subarea 2F – Potrero Hills:** Medium Value Conservation Criteria 1, 2, 3, and 4 (5,990 ac)
7. **Subarea 2G – Ledgewood Creek Contra Costa Goldfield Buffer/Watershed Lands:** Medium Value Conservation Criteria 1, 2, and 5 (100 ac)
8. **Subarea 2H – Cordelia Contra Costa Goldfields Watershed and Corridor Area:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (2,040 ac)
9. **Subarea 2I – Montezuma Hills:** Medium Value Conservation Criteria 1, 2, 3, and 4 (69,750 ac)
10. **Subarea 2J – Cordelia/Western Fairfield:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (530 ac)
11. **Subarea 2K – Vacaville Area Corning Series Soils:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (1,970 ac)
12. **Subarea 2L – Yolo County:** Medium Value Conservation Criteria 2, 4, and 5 (560 ac)

[1] Medium and low value conservation areas may include highly altered lands supporting small, isolated populations of Contra Costa goldfields that occur within existing urbanized areas.

13. **Subarea 2M – Vallejo:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (300 ac)
14. **Subarea 2N – Lagoon Valley:** Medium Value Conservation Criteria 1, 2, 3, 4, and 5 (320 ac)

Low Value Conservation Areas. Low value conservation areas (approximately 6,450 ac in total) primarily include small, infill parcels that are surrounded by existing development, have limited or no connectivity to other natural habitats, and do not support isolated populations of extremely rare or range-limited species[1] (Figure 4-8).

Revisions. The conservation areas outlined above guide the Natural Community Conservation Strategy in Chapter 5.0, and project Avoidance, Minimization, and Mitigation Measures in Chapter 6.0. However, future biological surveys may identify small, isolated populations of Contra Costa goldfields or other rare or range-limited species in medium and low value conservation areas. As a result, the categorization of vernal habitat and the associated conservation measures may need to be revised. As data gaps are filled and more detailed information becomes available, the conservation area boundaries outlined above will be adjusted appropriately.

4.3.3 Inner Coast Range

The Inner Coast Range lies in the western margin of Solano County, and includes the Sky Valley/Sulphur Springs Mountain area (Tri-City/County Planning Area), the area west of Green Valley (e.g., West Hills), the Rockville Hills, and the Vaca Mountains/Blue Ridge area (Figure 3-5). Its geographic location, elevation, and soils distinguish this Natural Community from the low-lying Valley Floor Grassland and Vernal Pool Natural Community. Consisting of ridges and valleys that trend northwest, the Inner Coast Range is better characterized as a geographical region because it encompasses a number of vegetation communities, including grassland, oak woodland, oak savanna, and mixed chaparral/scrub that form a mosaic over the entire Inner Coast Range (see Figures 3-5 and 3-6). This mosaic of vegetation communities at various successional stages provides a diverse array of habitat types for plants and wildlife. Conserving, maintaining, and managing for the continued existence of this mosaic is critical for preserving the highest levels of biodiversity within the region.

This section presents the conservation analysis for the Inner Coast Range Natural Community including identification of key conservation elements and conservation areas. The conservation analysis is based on information for this Natural Community provided in Appendix B.

4.3.3.1 Associated Covered and Special Management Species

Two Covered Species are primarily associated with the Inner Coast Range Natural Community: California red-legged frog and callippe silverspot butterfly (Table 4.1). Three additional Covered Species and three Special Management Species are secondarily associated with the Inner Coast

[1] For the purposes of the Solano HCP, the following covered species are considered to be extremely rare or range-limited species: Colusa grass, Solano grass, San Joaquin Valley Orcutt grass, Ferris's milk-vetch, Conservancy fairy shrimp, and Delta green ground beetle.

Range Natural Community, these are Valley elderberry longhorn beetle, burrowing owl, Swainson's hawk, foothill yellow-legged frog, western pond turtle, and yellow-breasted chat.

4.3.3.2 Key Conservation Elements

To assess the overall conservation value of habitats within the Inner Coast Range, key conservation elements were identified that could be assessed spatially using GIS. For the Inner Coast Range Natural Community, the following key conservation elements were assessed to determine areas of high conservation value:

- Habitat Diversity
- Priority Watershed Areas
- Proximity to Existing and Proposed Preserves/Reserves
- Barriers and Patterns of Habitat Fragmentation
- Corridors and Linkage Areas
- Edge Effects
- Distribution of Covered Species and Special Management Species
- Core Recovery Areas and Designated Critical Habitat

Habitat Diversity. The Inner Coast Range Natural Community comprises several plant communities and habitats. The mix of woodland, chaparral, and grassland creates a landscape mosaic that provides important habitat for wildlife. Multi-source vegetation data, compiled by the California Department of Forestry and Fire Protection (CAL FIRE) as part of their Fire and Resource Assessment Program (FRAP; Figure 4-9), were used to assess areas with high diversity of native vegetation. From this data, two major areas within the Inner Coast Range contain unique vegetation mosaics: the West Hills above Green Valley, and the northwest corner of Solano County encompassing the Vaca Mountains, Pleasants Valley, and the English Hills (Figure 1-3).

The English Hills consist primarily of grassland mixed with agriculture, bordered by oak savanna on the west and denser oak woodland on the north (Figure 3-6). According to the FRAP data, this area contains the highest density of Valley oaks within the County (Figure 4-9). Low-density populations of Valley oaks, which prefer deep alluvial soils, occur in small pockets above Suisun Valley, east of the West Hills (at the southern tip of the Vaca Mountains); west of I-505 (Figure 4-9); and in the southern tip of the Tri-City/County Planning Area, at the northern tip of Sulphur Springs Reservoir. Maintaining a high diversity of oak species within the Plan Area may help stabilize acorn productivity between years (acorn productivity varies by species) and provide an important resource for several wildlife species (Koenig et al. 1999).

Maintaining a diversity of tree species, as well as a mixture of age classes and large snags, may enhance wildlife diversity. For example, as described in Appendix B, cavities are an important resource for wildlife, particularly cavity nesting birds (Wilson et al. 1991). Recent research on cavity nesters has focused on the concept of "nest webs" that require the interaction of multiple species such as keystone excavators and keystone tree species in order to be sustained (Martin et al. 2004). Based on these studies, maintaining high tree diversity within the Plan Area is recommended to support the highest diversity of wildlife. The FRAP data highlight areas within the Plan Area with high species diversity (Figure 4-9).

Priority Watershed Areas. Priority watershed areas have been identified in the Riparian, Stream, and Freshwater Marsh conceptual models included in Appendix B. Maintaining the integrity of watershed lands is critical for preserving the ecological integrity of streams. Removal of vegetation from watershed lands, particularly on steep hillsides, creates soil erosion and compaction leading to increased sedimentation in downstream watercourses. Therefore, protecting watershed areas associated with priority drainages (see Figure 4-10) should be a high conservation priority.

Uplands within a watershed strongly influence riparian and aquatic ecosystems. The flux of water and sediment from the upper portions of the watershed determine the form of channels and floodplains and many associated attributes of riparian ecosystems (Naiman et al. 2005, Scott et al. 2004). Urbanization and intensive agriculture are the primary land uses within the Plan Area that negatively affect watershed integrity; therefore, the percentage of each watershed under development or intensive agriculture was calculated (Figures 4-11 and 4-12). Several of the upper watershed areas within the Inner Coast Range are relatively "pristine," with little agriculture or urban development. These watersheds include Miller Canyon, Cold Canyon, Putah #1, and to a lesser degree, the Jameson Canyon, Lynch Canyon, and Lagoon Valley watersheds (Figures 4-11 and 4-12).

Proximity to Existing and Proposed Preserves/Reserves. Several existing preserves are located within the Inner Coast Range, comprising 13,374 ac or 13.6 percent of the total land area for this Natural Community (Figure 3-11). After ranking the quality of protected lands within Solano County, the majority of preserves in this Natural Community fall within Group 3, "moderate" quality preserves (see Section 3.5; Figure 3-11). Because the existing preserves within this Natural Community are of moderate quality, resources should be devoted to enhancing existing preserves through restoration and adaptive management.

Barriers and Patterns of Habitat Fragmentation. The locations of potential barriers to dispersal and migration were assessed to determine the extent of habitat fragmentation and to identify key corridors and linkages within the Inner Coast Range (Figure 4-2). Possible barriers were classified as either major or minor barriers based on their potential to hinder movement and dispersal. Major barriers such as large roads and developments significantly hinder the movement of animals. Major barriers within the Plan Area include I-80, I-680, I-505, SR-12, and SR-113, and local roads such as Vanden Road and Peabody Road, where traffic volumes are high and the ability of small animals to successfully cross is low. Minor barriers include agricultural areas and local roads with light traffic. Agricultural areas are not considered major barriers because they often provide transition habitat that shares some of the habitat values of the adjacent natural communities.

Three natural areas within the Inner Coast Range remain relatively intact and unfragmented. These areas are the Vaca Mountains/Pleasants Valley area (and to some extent, the English Hills), the West Hills south to I-80, and the Tri-City/County Planning Area (located between I-80 to the north, I-680 to the east, and the Cities of Vallejo and Benicia to the south and west) (Figures 1-3 and 4-2).

Corridors. Based on the analysis of barriers and patterns of fragmentation within the Inner Coast Range, important corridor areas were identified (Figure 4-2). The main corridors within the Inner Coast Range include: North Vacaville, Vacaville-Fairfield Green Belt, Suisun Valley,

West Hills-Vaca Mountains Corridor, Vallejo Lakes, and Rockville Hills. These corridors are described in Section 4.3.1.1 and illustrated on Figure 4-2.

Edge Effects. Habitat loss and fragmentation are not the only impacts that development and intensive agriculture have on wildlife and their habitat. The negative impacts of human occupancy (i.e., increased road density, introduced species, unauthorized access) extend beyond the parcel boundary and can compromise habitat quality for some distance from development. Over 190 mi of urban/wildland edge and over 90 mi of intensive agriculture/wildland edge occur within the Inner Coast Range as a result of irregular development patterns creating "fingers" of development that encroach into natural communities. This pattern of growth exponentially increases the amount of edge habitat compared to a uniform wave of development. Areas most affected by these edge effects are the West Hills, the region west of Green Valley, the English Hills in the Vacaville area, the southern tip of the Vaca Mountains near Fairfield, and the Tri-City/County Planning Area near Vallejo and Cordelia (Figure 1-3).

Distribution of Covered Species and Special Management Species. Two types of data were used to evaluate the distribution of Covered Species and Special Management Species in the Inner Coast Range Natural Community: (1) the distribution of all Covered Species and Special Management Species according to the RWRI; and (2) the distribution of Covered Species and Special Management Species associated with the Inner Coast Range and/or dependent on watershed lands within the Inner Coast Range.

Rarity-Weighted Richness Index. As described in Section 4.3.1.2, the results of the RWRI (Figure 4-3) indicate that the Inner Coast Range has low richness with isolated "hot spots" of biological diversity, reflecting the limited data available for this region and the small number of Covered Species associated with the Inner Coast Range (as compared to the Valley Floor Grassland and Vernal Pool Natural Community). Isolated high value areas represent occurrence records for yellow-breasted chat, foothill yellow-legged frog, western pond turtle, and Valley elderberry longhorn beetle. Hot spots in the Tri-City/County Planning Area represent records for callippe silverspot butterfly and California red-legged frog. More data for this region would likely alter the pattern observed for this region, from low to moderate richness with occasional areas of high richness (e.g., generally light to dark green with occasional blue hexagons). The pattern observed does not reflect the biodiversity of the Inner Coast Range as a whole, because only Covered Species and Special Management Species were included in this analysis. If the analysis accounted for all species, the pattern of biodiversity for this region would likely be reversed. The Inner Coast Range supports a wide array of vegetation communities including grassland, oak woodland, and oak savanna that provide important habitat for wildlife. Approximately 331 species depend on oak woodlands throughout their life cycle (Verner 1980; Barrett 1980; Block and Morrison 1998), and riparian or streamside vegetation provides important habitat for an additional 225 species of fish, amphibians, reptiles, birds, and mammals (RHJV 2000).

Callippe Silverspot Butterfly. Available data on observations of callippe silverspot butterfly (or closely related hybrids) and mapped locations of *Viola pedunculata*, the obligate larval host plant, occur from a number of areas in the Tri-City/County Planning Area (Figure 4-13).

Core Recovery Areas and Designated Critical Habitat. Critical habitat designated by the United States Fish and Wildlife Service (USFWS 2008b) for the California red-legged frog is located in the Tri-City/County Planning Area. This area occupies 9,245 ac of the Jameson Canyon-Lower Napa River Core Recovery Area (USFWS 2002a; Figures 4-14 and 4-15), named the Sky Valley (SOL-1) unit (USFWS 2005b).

4.3.3.3 Conservation Areas

Based on specific ecological values, threats, and conservation needs derived from the above analyses, the entire Inner Coast Range is considered to have high conservation value. However, the reasons for this designation vary, making it difficult to divide the Inner Coast Range into areas of high, medium, and low conservation value as was done for the Valley Floor Grassland and Vernal Pool Natural Community. Instead, three areas have been designated based on geography and existing patterns of habitat fragmentation. These areas are the Vaca Mountain/Pleasants Valley/English Hills Area, the West Hills/Green Valley Area, and the Tri-City/County Planning Area (Figure 1-3). Each area has unique ecological value, experiences varying anthropogenic pressures, and possesses different conservation needs, as described below.

- **Vaca Mountain/Pleasants Valley/English Hills Conservation Area**
    - **Ecological Value:** This area contains large blocks (greater than 500 ac) of Inner Coast Range habitat with diverse vegetation types potentially supporting a high diversity of native species. It contains two important corridors, linking the Inner Coast Range to the Valley Floor Grassland and Vernal Pool Natural Community (North Vacaville Corridor and Vacaville-Fairfield Green Belt; Figure 4-2). This area also contains seven key watershed drainages, foothill yellow-legged frog, Valley elderberry longhorn beetle, and is part of the Lake Berryessa Tributaries Core Recovery Area for California red-legged frog.
    - **Potential Risk:** Potential risk was assessed for the Vaca Mountains/Pleasants Valley/English Hills Conservation Area using current County zoning (see Section 3.6 and Figure 3-12). Table 4.3 summarizes the total acres and overall percent of land within the Conservation Area in each zoning category.

      Lands designated as “watershed” are under relatively little threat of development. However, the remainder of this conservation area is under threat of conversion to agriculture or low-density rural residential development, particularly those areas zoned for rural residential or agriculture (20 ac minimum). The English Hills are perhaps most at risk due to the expansion of rural residential development and isolation from the Vaca Mountains by agricultural expansion in Pleasants Valley.
    - **Conservation Needs:** The primary conservation need for this area is the protection of additional land through land acquisition (i.e., conservation easements, fee title) or rezoning (i.e., from agriculture to open space). Conservation efforts should focus on the Vacaville/Fairfield Green Belt. This area is under the most threat from Plan Participant-related impacts and provides an important linkage between the Inner Coast Range and the

Table 4.3: Summary of Protected Lands and County Zoning within the Vaca Mountains/Pleasants Valley/English Hills Conservation Area of the Inner Coast Range[1]

County Zoning	Minimum Parcel Size (acres)	Total Acres within Conservation Area	Percent of Conservation Area
Protected	N/A	4,785	8.5%
Watershed	160	22,892	40.8%
Agriculture 160	160	648	1.2%
Agriculture 40	40	3,263	5.8%
Agriculture 20	20	14,880	26.5%
Rural Residential	5	1,474	2.6%

[1] Consisting of protected lands as of December 2005.
N/A = not applicable

- Valley Floor Grassland and Vernal Pool Natural Community. Preserves in this area will help maintain connectivity between the Jameson Canyon-Lower Napa River and the Lake Berryessa Tributaries Core Recovery Areas for California red-legged frog.

- **West Hills/Green Valley Conservation Area**
  - **Ecological Value:** This area contains large blocks (greater than 500 ac) of Inner Coast Range habitat with diverse vegetation types potentially supporting a high diversity of native species. It contains two key watershed drainages (Figure 4-10) and three important corridors. One corridor connects the Inner Coast Range and Suisun Marsh and two connect the Tri-City/County Planning Area to the West Hills (Suisun Valley, Vallejo Lakes, and Rockville Hills; Figure 4-2). These corridors maintain connectivity between the Jameson Canyon-Lower Napa River and the Lake Berryessa Tributaries Core Recovery Areas for California red-legged frog.
  - **Potential Risk:** Potential risk was assessed for the West Hills/Green Valley Conservation Area of the Inner Coast Range using current County zoning (see Section 3.6 and Figure 3-12). Table 4.4 summarizes the total acres and overall percent of land within the Conservation Area in each zoning category.

    All of the areas zoned as either rural residential or agriculture (20 ac minimum) are under threat of development.

Table 4.4: Summary of Protected Lands and County Zoning within the West Hills/Green Valley Conservation Area of the Inner Coast Range

County Zoning	Minimum Parcel Size (acres)	Total Acres within Conservation Area	Percent of Conservation Area
Protected	N/A	3,224	16.6%
Watershed	160	5,619	28.9%
Agriculture 40	40	2,302	11.8%
Agriculture 20	20	6,263	32.2%
Rural Residential	5	287	1.5%
Estate Residential	1	65	0.3%

N/A = not applicable

- **Conservation Needs:** Within this area, 3,224 ac (16.6 percent) are currently protected in preserves, and 5,619 ac (28.9 percent) are zoned as watershed land. Preserved areas include two important corridors, Rockville Hills Park and Vallejo Lakes, that provide connectivity to the Tri-City/County Planning Area. Conservation activities in this area should focus on the enhancement of existing preserves through restoration and adaptive management, as well as the protection of additional land.

- **Tri-City/County Conservation Area**
  - **Ecological Value:** This area contains primary habitat for the callippe silverspot butterfly and the majority of the Jameson Canyon-Lower Napa River Core Recovery Area for California red-legged frog (Figures 4-13 and 4-14). It also contains three key watersheds and habitat for burrowing owls and other sensitive species.
  - **Potential Risk:** Within the Tri-City/County Planning Area (Figure 1-3), 23.5 percent (6,911 ac) is protected within existing preserves/reserves and 37.5 percent (11,000 ac) is zoned as agriculture (20 ac minimum). The threat of development or agricultural conversion is small in this conservation area due to limited water availability. In addition, in 2003, Benicia voters approved Measure K, an urban growth boundary initiative to prevent development in the hills northeast of Benicia known as Sky Valley (see Section 3.6). Urban development is not allowed beyond the Urban Growth Boundary. The major threat to the Tri-City/County Planning Area comes from the secondary pressures associated with development (habitat degradation, invasive exotic species, etc.) as it is surrounded on three sides by major urban areas (Vallejo, Benicia, and Cordelia).
  - **Conservation Needs:** A large portion of this area (6,911 ac, 23.5 percent) is currently protected in moderate quality preserves. Conservation efforts for this area should focus on enhancing existing preserves through restoration and adaptive management; preserving and managing essential habitat areas for the California red-legged frog and callippe silverspot butterfly (e.g., breeding sites, larval host plant areas, nectar source); avoiding and minimizing impacts to sensitive areas (particularly core habitat for the California red-legged frog and the callippe silverspot butterfly); and maintaining connectivity between preserves through additional land acquisitions and conservation easements. Conservation efforts in this area are primarily driven by the conservation needs of the California red-legged frog and the callippe silverspot butterfly and are further detailed in Sections 4.3.4 and 4.3.5. The primary threat to these species is the invasion of exotic species including bullfrogs and annual grasses. Management and restoration of existing preserves could substantially enhance their overall quality and value thereby increasing populations of sensitive species.

4.3.4 California Red-Legged Frog

This section presents the conservation analysis for California red-legged frog including identification of key conservation elements and conservation areas. The conservation analysis is based on background information for this species, including habitat types, natural community associations, distribution, ecological processes, habitat variables, and threats that are provided in Appendix B.

4.3.4.1 Associated Natural Communities, Covered Species, and Special Management Species

In Solano County, the California red-legged frog is associated with the Inner Coast Range and Riparian, Stream, and Freshwater Marsh Natural Communities (Figure 3-5). Covered Species and Special Management Species that will also benefit from this conservation strategy are the callippe silverspot butterfly, Valley elderberry longhorn beetle, foothill yellow-legged frog, western pond turtle, and other species associated with these two Natural Communities (Table 4.1).

4.3.4.2 Key Conservation Elements

The relative conservation value of habitat areas for red-legged frogs within the Plan Area were determined based on the following key conservation elements:

- Core Recovery Areas and Designated Critical Habitat
- Watershed Area
- Location of Potential Breeding and Essential Hydration Habitat
- Species Occurrence Data
- Known Distribution of Introduced Predators
- Proximity to Existing Preserves and Reserves

Core Recovery Areas and Designated Critical Habitat. The Recovery Plan for California red-legged frog (USFWS 2002a) designated core recovery areas throughout its range. Solano County contains portions of two core recovery areas: the Jameson Canyon-Lower Napa River Core Recovery Area and the Lake Berryessa Tributaries Core Recovery Area. The Jameson Canyon-Lower Napa River Core Recovery Area encompasses 27,270 ac and is located in the hills west of Green Valley and in the Tri-City/County Planning Area. The Lake Berryessa Tributaries Core Recovery Area encompasses 4,253 ac located in the extreme northwestern corner of the County, near the University of California Stebbins Cold Canyon Preserve (USFWS 2002a; Figure 4-14).

In addition to Core Recovery Areas, the Plan Area has long supported critical habitat for this species. The most recent revision to proposed critical habitat occurred on September 16, 2008, and encompasses approximately 1,804,865 ac in 28 California counties (USFWS 2008b). Three revised critical habitat units are located within the Plan Area (SOL-1, SOL-2 and SOL-3; Figure 4-14). The Sky Valley unit (SOL-1) encompasses approximately 11,971 ac and is located in southwestern Solano County, south of I-80 and west of I-680. The Jameson Canyon unit (SOL 2) encompasses approximately 3,360 ac and is located north of SR-12. The American Canyon unit (SOL–3) encompasses approximately 4,597 ac and is located north of I-80 and south of SR-12.

Watersheds (Percent of Watershed Area Developed). The percent of developed land within a watershed likely has a significant adverse effect on amphibian populations (Richter and Azous 1995). Within Solano County, the Lake Berryessa Tributaries Core Recovery Area falls almost entirely within the Cold Canyon watershed, except for the northwest corner of Putah Creek. Less than 0.01 percent of the Cold Canyon watershed within Solano County is developed, and less than 0.5 percent is currently farmed (Figures 4-11 and 4-12). The Jameson Canyon Creek Core Recovery Area falls within multiple watersheds and contains significantly more development. Table 4.5 lists the percentage of watershed lands in the core recovery area under development (Figure 4-11) and agriculture (Figure 4-12).

Table 4.5: Percent Development and Agriculture in Watersheds within the California Red-legged Frog Jameson Canyon Core Recovery Area[1]

Watershed within Jameson Canyon Core Recovery Area	Total Area within Watershed (acres)	Percent of Recovery Area	Percent of Watershed Developed	Percent of Watershed in Agriculture
Jameson	2,464	9%	6%	<1%
Lynch Canyon	4,375	16%	2%	0%
Marsh #1	6,150	23%	12%	8%
Lake Herman	9,532	35%	17%	<1%
Chabot	2,171	8%	69%	<1%
Green Valley	2,218	8%	20%	7%
Vallejo #2	172	1%	92%	0%
Vallejo #10	156	1%	61%	0%
Benicia #4	24	0%	47%	0%

[1] Protected lands as of December 2005.

Location of Potential Breeding and Hydration Habitat (Pond, Open Water, Marsh, Springs, Seeps, and Channel Habitats). The locations of suitable breeding and hydration habitats (i.e., pond, open water, marsh, springs, seeps, and channel habitats) were identified in the Core Recovery Areas (Figure 4-14) using multiple data sources. These sources include the United States Geological Survey (USGS) high-resolution National Hydrography Dataset; the vegetation and cover type data for Solano County (CH2MHill's digitized Vegetation Habitat Delineations of Solano County [CH2MHill 2002], the San Francisco Estuary Institute's [SFEI] Modern Baylands data, and verified wetland delineations for the area); 2004 aerial photographs of Solano County and USGS 7.5-minute quadrangle maps. Based on this data, the southern portion of the Inner Coast Range, which is within the Jameson Canyon-Lower Napa River Core Recovery Area, contains the highest density of potential breeding and hydration habitat for this species (Figure 4-15).

Species Occurrence Data. Species occurrence data for Solano County is limited to a small number of CNDDB records and other observations from the Jameson Canyon-Lower Napa River Core Recovery Area. Although California red-legged frogs have also been reported in the extreme northwestern corner of the County, in the University of California Stebbins Cold Canyon Preserve, no records currently exist to support these reports. Based on species occurrence data, watersheds occupied by California red-legged frogs within the Plan Area include Lake Herman, Chabot, Marsh #1, Lynch Canyon, and Jameson Canyon (Figures 3-4 and 4-15; USFWS 2001). Because California red-legged frogs can be found in a range of habitats within a watershed (e.g., stock ponds, creeks), and may occur in a single location or numerous locations throughout a watershed, an occupied watershed refers to a network of habitat areas, populations, and site-specific localities. Occupied drainages or watersheds include the bodies of water that support frogs (e.g., streams, creeks, tributaries, associated natural and artificial ponds, and adjacent drainages), and the habitats through which frogs can move (e.g., riparian vegetation, uplands) (USFWS 2001).

The first CNDDB record for Solano County was recorded in 1993 when LSA Associates, Inc. found 3 adults and 20 juveniles at the northern end of Sky Valley in the Page Flat area of the Lake Herman watershed. California red-legged frogs were observed in artificial golf course ponds, storm water detention ponds, and one spring-fed pool. California red-legged frogs were likely present in the natural springs and seeps in the upper watershed of Sulphur Springs Creek prior to the

development of the artificial ponds within Sky Valley. The earliest records for California red-legged frogs occur in the upper portions of Sky Valley, so frogs likely moved down from these springs and seeps following the creation of perennial water sources. After 1993, California red-legged frogs were observed throughout Sky Valley in various created wetlands, storm water detention ponds, golf course ponds, and spring boxes (CDFG 2004a). Frogs continued to thrive in this area until nonnative predators were introduced (see the synergisms section of the Narrative Conceptual Model in Appendix B).

Only one CNDDB record currently exists from the Chabot watershed (Figures 3-4 and 4-15). Element Occurrence 289 lists tadpoles, juveniles, and an adult as being observed in Rindler Creek on the north side of Columbus Parkway, east of Vallejo. Three CNDDB records occur within the Marsh #1 watershed: (1) Laabs and Allaback observed three individuals in a pool along Old Paseo Creek (April 1997); (2) Jennings collected a juvenile frog from an old quarry area adjacent to an unnamed tributary (April 1999); and (3) Guinon observed an adult frog in a created pond north of Garibaldi Creek (April 2000). The first record of red-legged frogs from the Lynch Canyon Watershed is from Foreman (LSA Associates, Inc.) in Spring 1997 in Lynch Canyon in Windmill Pond. In July of 2000, Muth and Dearn (LSA Associates, Inc.) observed adult red-legged frogs in three plunge pools along Lynch Canyon Creek. In the Jameson Canyon Watershed, Element Occurrence 660 lists one adult in a drainage containing small plunge pools surrounded by open grassland. All of these populations are presumed to be extant, and these watersheds are considered by the USFWS to be currently occupied by California red-legged frogs (Figure 4-15). This assumption is uncertain, and additional information about the location and status of California red-legged frog populations within the Plan Area, particularly within the Jameson Canyon-Lower Napa River Core Recovery Area, must be determined.

Introduced Predators. As mentioned in the Recovery Plan (USFWS 2002a), the primary threats to California red-legged frogs within the Jameson Canyon-Lower Napa River Core Recovery Area are urban development, predation, and competition from exotic species. Very little data on the distribution of introduced predators within Solano County currently exists. However, several bullfrog records occur within the Jameson Canyon-Lower Napa River Core Recovery Area, particularly within the Lake Herman Watershed. Figure 4-15 illustrates the known distribution of bullfrogs within water bodies of this area. Bullfrog records within the County are highly biased toward the Lake Herman Watershed due to monitoring requirements for the Sky Valley development. Bullfrogs, introduced fish, and crayfish are likely to occur in perennial watercourses throughout the Inner Coast Range, although no data is currently available to confirm this information (i.e., represents a data gap for the HCP).

Proximity to Existing and Proposed Preserves and Reserves. A large portion of the Inner Coast Range is currently protected within existing preserves and reserves (see Section 4.3.3.3). Important areas for California red-legged frog conservation include the Jameson Canyon-Lower Napa River and Lake Berryessa Tributaries Core Recovery Areas. Within these areas, 7,716 ac (28.3 percent) and 1,596 ac (37.53 percent), respectively, are currently protected within existing preserves and reserves. The remainder of the Inner Coast Range provides habitat connectivity between the two core recovery areas; 15,035 ac (14 percent) of this remaining habitat are currently protected within existing preserves and reserves (Figure 3-11).

4.3.4.3 Conservation Areas

Based on the key conservation elements described above, the California Red-Legged Frog Conservation Strategy covers two areas: (1) the California Red-Legged Frog Conservation Area, and (2) the remainder of the Inner Coast Range, including Riparian, Stream, and Freshwater Marsh habitat (Figure 4-15). The California Red-Legged Frog Conservation Area encompasses most of the Jameson Canyon-Lower Napa River Core Recovery Area within Solano County minus the developed portions of Vallejo and Benicia (Figure 4-15).

4.3.5 Callippe Silverspot Butterfly

This section presents the conservation analysis for the callippe silverspot butterfly including identification ok key conservation elements and conservation areas. The conservation analysis is based on background information for this species including habitat types, associated natural communities, ecological processes, habitat variables, and threats that are provided in Appendix B.

4.3.5.1 Associated Natural Communities, Covered Species and Special Management Species

The callippe silverspot butterfly is primarily associated with the Inner Coast Range Natural Community. The primary species that will benefit from the Callippe Silverspot Butterfly Conservation Strategy is the California red-legged frog because they occur in the same general area of the Plan. However, other species associated with the Inner Coast Range Natural Community will also benefit from the Callippe Silverspot Butterfly Conservation Strategy (e.g., Swainson's hawk and burrowing owls) (Table 4.1).

4.3.5.2 Key Conservation Elements

The following key conservation elements were assessed to determine the relative suitability and/or conservation value of habitat areas for the callippe silverspot butterfly in the Plan Area:

- Population occurrence data
- Distribution of Johnny jump-up
- Availability of adult nectar plants
- Topography

Population Occurrence Data. Ten records for the callippe silverspot butterfly in Solano County occur within the Tri-City/County Planning Area, in the hills between Vallejo and Cordelia (i.e., vicinity of Lake Herman, Columbus Parkway, and Sky Valley) and northward into Jameson Canyon (CDFG 2004a; Buggy Data Base as cited in Noss et al. 2002; Figure 4-13).

Distribution of Johnny Jump-up (*Viola pedunculata*). The distribution of the larval host plant, Johnny jump-up, within the Plan Area is largely unknown. Although it grows in various grassland types throughout California, it must occur at relatively high densities in order to support callippe silverspot butterflies. Areas known to support butterflies typically contain multiple stands of Johnny jump-up, ranging in size from a few acres to approximately 40 ac. Johnny jump-up density in these stands range from less than 1 percent to more than 25 percent cover. In Solano County, the

densest stands of Johnny jump-up occur on shallow, rocky or thin soils where annual introduced grasses are less dense. A few dense stands of *Viola pedunculata* have been recorded from field observations conducted by LSA Associates, Inc. and others, primarily in the Hunter Hill, Lake Herman, Kings and Swett Ranches, and Chabot watersheds. Figure 4-13 shows the locations of these field observations.

Availability of Adult Nectar Plants. Adult callippe silverspot butterfly have flexible nectaring requirements and adapt to different flowers, depending on availability. In addition, they use a wide variety of plants for nectaring, including native and exotic species that occur throughout the Plan Area.

Topography. Adult callippe silverspot butterfly employ a behavior called hilltopping in order to find mates (Longcore, Lam, and Wilson 2004); therefore, ridgelines and hilltops are critical for reproduction and perpetuation of this species. In addition, the flowering period for Johnny jump-up appears to be longer on eastern facing slopes, extending the growing period for larvae and increasing rates of survival from larvae to adults. Conservation efforts should target ridgelines and hilltops, linking existing populations of the callippe silverspot butterfly and patches of Johnny jump-up, and include eastern-facing hillsides.

4.3.5.3 Conservation Areas

The callippe Silverspot Butterfly Conservation Area encompasses all known occurrences within Solano County and additional areas within the Inner Coast Range (i.e., Nelson Hill in Cordelia and the Rockville Hills) that contain all three habitat conditions necessary to support the species (populations of Johnny jump-up, adult nectar plants, and ridgelines or hilltops). The callippe Silverspot Butterfly Conservation Area is shown on Figure 4-13.

4.3.6 Riparian, Stream, and Freshwater Marsh Natural Community

This section presents the conservation analysis for the Riparian, Stream, and Freshwater Marsh Natural Community, including identification of key conservation elements and conservation areas. The conservation analysis is based on background information for this Natural Community including habitat types, ecological processes, habitat variables, and threats that are provided in Appendix B.

4.3.6.1 Associated Covered Species and Special Management Species

The Covered Species primarily associated with this Natural Community are Valley elderberry longhorn beetle, giant garter snake, tri-colored blackbird, Chinook salmon (fall run ESU), steelhead (Central California Coast ESU), and steelhead (Central Valley ESU). The Covered Species that are secondarily associated with this Natural Community are Swainson's hawk, delta smelt, longfin smelt, Sacramento splittail, Chinook salmon (late fall, spring, and winter runs ESUs), and green sturgeon. The Special Management Species primarily associated with this Natural Community are foothill yellow-legged frog, western pond turtle, yellow-breasted chat, and Modesto song sparrow. The Special Management Species that are secondarily associated with this Natural Community are loggerhead shrike and yellow-headed blackbird (Table 4.1).

4.3.6.2 Key Conservation Elements

Five key conservation elements were assessed for this Natural Community, including:

- Riparian Vegetation
- Key Corridor Streams
- Watershed Integrity
- Impaired Waters within the Plan Area
- Covered Species Occurrences
    - Valley elderberry longhorn beetle
    - Chinook salmon
    - Steelhead – Central California coast and Central Valley ESUs
    - California red-legged frog
    - Giant garter snake
    - Tricolored blackbird
- Occurrences of Special Management Species
    - Foothill yellow-legged frog
    - Western pond turtle
    - Yellow-breasted chat

Riparian Vegetation. Well-developed riparian plant communities occur primarily in small areas along the banks of major creeks such as Putah Creek, Alamo Creek, Ulatis Creek, Dan Wilson Creek, Green Valley Creek, Ledgewood Creek, and Suisun Valley Creek (Figure 4-16). Reconnaissance surveys conducted by SFEI and LSA Associates, Inc. (2008a) revealed that the riparian zones of Alamo, Ulatis, Suisun and Green Valley Creeks are largely intact upstream of I-80 (L. McKee, October 14, 2002, as reported in Noss et al. 2002). SCWA conducted a riparian habitat assessment in 2008. The results of this assessment verified the statement made by the Science Advisors that the majority of the streams contain riparian canopy widths of only one to two trees. Most of the lower reaches along Ulatis Creek, Lower Ulatis Creek, Barker Slough, and Calhoun Cut have no riparian canopy cover. The more defined riparian canopies (more than two trees) occur in the upper reaches of Ulatis, Alamo, Suisun Valley, and Jameson Canyon Creeks. There is a distinct divide in canopy width along Ulatis Creek, with areas upstream of I-80 containing riparian canopies greater than two trees and downstream of I-80 containing riparian canopies of zero to two trees. The upper area corresponds to old town Vacaville, where the riparian areas still contain mature valley oak trees and other larger trees associated with riparian areas (LSA 2008a).

Surprisingly, the majority of the riparian canopy cover for all of the drainages surveyed during the Riparian Habitat Assessment consisted of native species. The predominant native canopy species include: alder, ash, big leaf maple, black walnut, box elder, California bay, California buckeye, California sycamore, cottonwood, live oak, valley oak, toyon, white aster, and willow. Nonnative species were dominant in the canopy along Ulatis, Alamo, Laurel, Ledgewood, Gordon Valley, and Suisun Valley Creeks. The nonnative species that comprised the riparian canopy were almond, elm, English walnut, eucalyptus, locust, palm tree, pepper tree, and tree of heaven (LSA 2008a). Nonnative species were more prevalent in the shrub and herbaceous layers along the creeks. Ulatis,

Alamo, Gibson Canyon, Ledgewood, Gordon Valley, Suisun Valley, and Green Valley had the largest amount of nonnatives as dominant species within the shrub understory (LSA 2008a).

Key Corridor Streams. Many "riparian" habitats within and near cities, and in agricultural portions of Solano County, are very narrow (i.e., only one or two tree canopies wide) and are often characterized by nonnative trees and shrubs (LSA 2008a). Nevertheless, with restoration and control of invasive species, urban riparian vegetation along parts of Ulatis, Alamo, and Sweeny Creeks provides important habitat linking the Vaca Mountains to the valley floor. In addition, riparian corridors along Jameson Canyon, Lynch Canyon, Green Valley, Suisun Valley, and Ledgewood Creeks provide connectivity between the Inner Coast Range and Suisun Marsh.

Watershed Integrity. Uplands within a watershed strongly influence riparian and aquatic ecosystems. The flux of water and sediment from the upper portions of the watershed determine the form of channels and floodplains, and many associated attributes of riparian ecosystems (Naiman et al. 2005, Scott et al. 2004). Urbanization and intensive agriculture are the primary land uses within the Plan Area that adversely affect watershed integrity; therefore, the percentage of each watershed under development or intensive agriculture was calculated (Figures 4-11 and 4-12). Most of the watersheds have been extensively impacted by either development or agriculture. However, Calhoun watershed, marsh watersheds 2, 3, 4, 5, 6 and 7, and river watersheds 5, 6, 7, 8 and 9 within the Valley Floor Grassland and Vernal Pool Natural Community remain relatively intact (Figures 4-11 and 4-12). Within the Inner Coast Range, Miller Canyon, Cold Canyon, Putah #1 and, to a lesser degree, Jameson Canyon, Lynch Canyon, and Lagoon watersheds remain relatively intact (Figures 4-11 and 4-12).

Impaired Water within the Plan Area. Under Section 303(d) of the 1972 Clean Water Act, states are required to develop lists of impaired waters that do not meet water quality standards and action plans (known as Total Maximum Daily Loads or "TMDLs") to improve the quality of impaired waters. Table 4.6 lists the impaired waterways within the Plan Area. Impaired waterways within the Plan Area are highlighted in Figure 4-11. Impaired waterbodies within the Suisun subbasin include Ledgewood Creek, Laurel Creek, Suisun Bay, the Suisun Marsh wetlands, and Suisun Slough. In the Napa River subbasin, the Napa River and San Pablo Bay are considered impaired. Streams in eastern Solano County drain to the Central Valley subbasin and flow to the Sacramento River Delta, which is also listed as impaired. Because some pollutants can be conveyed long distances through stream networks, 303(d) listings can affect landowners within tributary watersheds of listed water bodies, as well as those who discharge directly into listed waterbodies.

Location of Covered Species and Special Management Species. The locations of Covered and Special Management Species associated with the Riparian, Stream, and Freshwater Marsh Natural Community were assessed based on CNDDB records and information on historic occurrence and suitable habitat. (Locations and conservation areas for California red-legged frogs and giant garter snakes are provided in Sections 4.3.4 and 4.3.7.)

Table 4.6: Impaired Waterways within the Plan Area

Waterway	Pollutant / Stressor	Source
SUISUN SUBBASIN		
Ledgewood Creek	Diazinon	urban runoff / storm sewers
Laurel Creek	Diazinon	urban runoff / storm sewers
Suisun Marsh Wetlands	Metals	Agriculture
		urban runoff / storm sewers
		flow regulation / modification
	Nutrients	Agriculture
		urban runoff / storm sewers
		flow regulation / modification
	Organic Enrichment / Low Dissolved Oxygen	Agriculture
		urban runoff / storm sewers
		flow regulation / modification
	Salinity	agriculture
		urban runoff / storm sewers
		flow regulation / modification
Suisun Bay	Chlordane	non-point sources
	Copper	municipal point sources
		urban runoff / storm sewers
		atmospheric deposition
		other
	DDT	non-point sources
	Diazinon	non-point sources
	Dieldrin	non-point sources
	Dioxin Compounds	atmospheric deposition
	Exotic Species	ballast water
	Furan Compounds	atmospheric deposition
	Mercury	industrial point sources
		resource extraction
		atmospheric deposition
		natural sources
		non-point sources
	Nickel	non-point sources
		urban runoff / storm sewers
		other
	PCBs	unknown non-point sources
	Dioxin-Like PCBs	unknown non-point sources
	Selenium	industrial point sources
		natural sources
		exotic species
Suisun Slough	Diazinon	urban runoff / storm sewers
NAPA RIVER SUBBASIN		
Napa River	Nutrients	agriculture
	Pathogens	agriculture
		urban runoff / storm sewers
	Sedimentation / Siltation	agriculture
		construction / land development
		urban runoff / storm sewers
San Pablo Bay	Chlordane	non-point sources
	Copper	municipal point sources
		urban runoff / storm sewers
		atmospheric deposition
		other

Table 4.6: Impaired Waterways within the Plan Area

Waterway	Pollutant / Stressor	Source
San Pablo Bay (cont'd)	DDT	non-point sources
	Diazinon	non-point sources
	Dieldrin	non-point sources
	Dioxin Compounds	atmospheric deposition
	Exotic Species	ballast water
	Furan Compounds	atmospheric deposition
	Mercury	municipal point sources
		resource extraction
		atmospheric deposition
		natural sources
		non-point sources
	Nickel	municipal point sources
		urban runoff / storm sewers
		other
	PCBs	unknown non-point sources
	Dioxin-Like PCBs	unknown non-point sources
	Selenium	industrial point sources
		agriculture
		natural sources
		exotic species
CENTRAL VALLEY SUBBASIN		
Sacramento Delta	Chlordane	non-point sources
	Copper	municipal point sources
		urban runoff / storm sewers
		other
		atmospheric deposition
	DDT	non-point sources
	Diazinon	non-point sources
	Dieldrin	non-point sources
	Dioxin Compounds	atmospheric deposition
	Exotic Species	ballast water
	Furan Compounds	atmospheric deposition
	Mercury	industrial point sources
		municipal point sources
		resource extraction
		atmospheric deposition
		non-point sources
	Nickel	municipal point sources
		urban runoff / storm sewers
		other
	PCBs	unknown non-point sources
	Dioxin-like PCBs	unknown non-point sources
	Selenium	industrial point sources
		agriculture
		natural sources
		exotic species

Source: California State Water Resources Control Board 303(d) list, 1998.
DDT = dichlorodiphenyltrichloroethane
PCBs = polychlorinated biphenyls

- **Valley Elderberry Longhorn Beetle:** Valley elderberry longhorn beetles are known from a number of locations along Alamo and Ulatis Creeks in Vacaville (Figure 4-17), from areas along Putah Creek, and from one location in the Green Valley area of Fairfield. In addition, suitable habitat occurs along many streams and associated uplands throughout Solano County. Parts of the riparian zone around Putah Creek are considered essential habitat by the USFWS (1984).
- **Salmonid Fish:** Streams that support or have the potential to support salmonids (steelhead and fall-run Chinook salmon in particular) include the main stems and tributaries of Lynch Canyon, Jameson Canyon, Ledgewood, Green Valley, and Suisun Valley Creeks, and the Napa River (Figure 4-17). Steelhead have been documented in most of these streams, and relatively continuous corridors are available to allow these species to access suitable breeding habitats in the upper watersheds. Fall-run Chinook salmon have been periodically reported in Green Valley Creek although the breeding status of this run is not well documented (LSA 2008b).
- **Tricolored Blackbird:** The CNDDB (CDFG 2004a) and Tricolored Blackbird Portal (http://tricolor.ice.ucdavis.edu) provide approximately 20 records for tri-colored blackbird colonies in Solano County (Figure 4-17). During the 2011, at least eight of these colonies were active.
- **Foothill Yellow-Legged Frog:** The CNDDB (CDFG 2004a) lists three records for the foothill yellow-legged frog: (1) Cold Creek Canyon, a tributary to Putah Creek in the northeastern part of the County; (2) a tributary to Ledgewood Creek in the Rancho Solano area in northeastern; Fairfield; and (3) upper Alamo Creek (Figure 4-17). The lack of records probably relates more to the lack of survey effort for this species in the County than an absence of other populations. Most suitable habitat in the County is located on private lands outside of urban areas within the upper reaches of streams, such as Green Valley Creek, Suisun Creek, Ledgewood Creek, Wild Horse Creek, Cook Canyon Creek, Laguna Creek, Alamo Creek and its perennial tributaries, and Ulatis Creek. Foothill yellow-legged frogs historically occurred in Sulphur Springs Creek, but were not found in this drainage during surveys in the mid-1990s as part of the Sky Valley-Benicia environmental analysis.
- **Western Pond Turtle:** The CNDDB (CDFG 2004a) lists five records for the western pond turtle in Solano County: (1) Lagoon Valley Lake, between Vacaville and Fairfield; (2) south-southeast of Winters, along Putah Creek and an unnamed tributary; (3) south of Wild Horse Canyon, in the Vaca Mountains; (4) west of I-680, south-southwest of Fairfield; and (5) in a diked upland area adjacent to Montezuma Slough and Honker Bay (Figure 4-17). Pond turtles are widespread within Solano County and are reported from a number of other locations. These locations include Sulphur Springs Creek/Sky Valley in Vallejo (S. Foreman, pers. obs.[1]), a stock pond in northwest Fairfield in the upper Ledgewood Creek watershed (D. Muth, pers. obs.[2]), along Putah Creek in the Dan Wilson/Green Valley Creeks watershed (Melanson 2004a), and the Ulatis Creek watershed (Melanson 2004b).
- **Yellow-breasted Chat:** The status, distribution, and population levels of the yellow-breasted chat in Solano County are unknown. Potential habitat for this species occurs along the Putah Creek riparian corridor and in riparian woodlands in the upper Delta region of Solano County.

[1] Steve Foreman, Principal, LSA Associates, Inc., personal observations on various dates (1985 to 2012).
[2] David Muth, Herpetologist, LSA Associates, Inc., personal observation (2006).

Occurrence at other locations in the County is likely limited to individuals that forage in dense riparian habitats during migratory stopover periods in the spring and fall.

4.3.6.3 Conservation Areas

All stream habitats have high conservation value because they contribute to regional water quality. However, certain stream areas have been preserved in a more "natural" state and are less impacted by urban development and intensive agriculture, support populations of Covered Species and Special Management Species, and are more suitable for restoration. Priority Drainages and Watersheds were identified within the Plan Area (Figure 4-10) based on the following criteria:

- Streams and watersheds that have been maintained in a more "natural" state (i.e., lower percentage of developed or intensively farmed land) that are typically characterized by dense, often multi-story stands of primarily native riparian vegetation;
- Streams supporting or potentially supporting populations of Covered Species and Special Management Species;
- Disturbed stream habitats that are adjacent to other high quality habitat areas or serve as linkage habitat between high value conservation areas;
- Stream habitat that represents important transition zones between San Francisco Bay and the Sacramento-San Joaquin River Delta; and
- Streams known or suspected to support important populations of steelhead and other native fish species.

Future acquisition, restoration, adaptive management and monitoring efforts within Solano County should target the following Priority Drainages and Watersheds:

- Putah Creek
- Pleasants Creek
- Sulphur Springs Creek
- Jameson Canyon Creek
- Lynch Canyon Creek
- Green Valley Creek
- Suisun Valley Creek
- Ledgewood Creek
- Gordon Valley Creek
- Laurel Creek
- Laguna Creek
- Alamo Creek
- Ulatis Creek
- Gibson Canyon Creek
- Sweeney Creek
- Barker Slough
- Calhoun Cut
- Hass Slough
- Duck Slough

The Priority Drainages and Watersheds are further subdivided into three categories based on site-specific conservation actions, including preservation, restoration, invasive species control, protection of water quality, and maintenance of hydrological process.

Conservation Area RSM 1 – Preservation and Restoration. The upper watersheds of streams that have been maintained in a "natural" state with stands of riparian vegetation are targeted for preservation with an emphasis on avoiding and minimizing impacts to sensitive resources. Several upper watershed areas within the Inner Coast Range remain relatively "pristine" with little agriculture and urban development. The locations of these Priority Drainages and Watersheds are shown on Figure 4-10 and consist of:

- Sulphur Springs Creek
- Jameson Canyon Creek, upstream of I-80
- Lynch Canyon Creek, upstream of Oak Brook Drive
- Green Valley Creek, upstream of I-80
- Suisun Valley Creek
- Ledgewood Creek, upstream of I-80
- Gordon Valley Creek
- Laurel Creek, upstream of I-80
- Laguna Creek
- Alamo Creek, just downstream of the confluence with Encinosa Creek
- Ulatis Creek, upstream of Gibson Canyon Road
- Gibson Canyon Creek, headwaters to 0.3 mi west of I-505
- Sweeney Creek, upstream of Leisure Town Road and the existing flood control channel
- Pleasants Creek
- Miller Canyon Creek

For the majority of these streams, less than 10 percent of the watershed area is developed or intensively farmed (Figure 4-10). Maintaining the integrity of the watershed is the main conservation approach for Conservation Area RSM 1. Implementation of the Conservation Strategy (Section 5) will result in the preservation of natural hydrologic features, maintenance of water quality, and the preservation and restoration of additional Riparian, Stream, and Freshwater Marsh habitats.

Conservation Area RSM 2 – Invasive Species Control, Maintenance of Hydro-geomorphic Processes, and Restoration. Much of the riparian habitat within and near cities is very narrow (i.e., only one or two tree canopies wide) and characterized by nonnative trees and shrubs. Despite the high level of disturbance, urban streams provide important corridors linking high value conservation areas together. For example, urban riparian habitat within Vacaville provides an important linkage between the less-developed upper watersheds of the Inner Coast Range, the high value vernal pool conservation areas, and Swainson's Hawk irrigated agriculture conservation areas. The conservation approach for riparian and stream habitat within and near cities focuses on invasive species control, riparian restoration, and maintenance of water quality and hydro-geomorphic processes. The urban creek areas targeted for riparian restoration and invasive species control include:

- Alamo Creek, below the confluence of Encinosa Creek and Nut Tree Road
- Old Alamo Creek, between Nelson Park and Leisure Town Road
- Ulatis Creek, between Gibson Canyon Road and Ulatis Drive
- Ledgewood Creek, downstream of I-80
- Green Valley Creek, downstream of I-80
- Lynch Canyon, downstream of Oak Brook Drive
- Jameson Canyon, downstream of I-80

With restoration and control of invasive species, urban riparian vegetation, particularly along parts of Ulatis, Alamo, and Sweeny Creeks, will provide important corridor habitat linking the Vaca Mountains to the valley floor. In addition, Plan Participants will develop and implement programs to remove or minimize existing in-stream barriers and prevent creation of new in-stream barriers from development along Jameson Canyon, Lynch Canyon, Ledgewood, Suisun Valley, and Green Valley creeks, and their tributaries that contain suitable breeding and rearing habitat for steelhead.

Conservation Area RSM 3 – Restoration. Conservation Area RSM 3 Priority Drainages include stream reaches that meander through the alluvial fans, terraces and basins, and Delta and Bay marshlands of the County (Noss et al. 2002). Historically, Riparian, Stream, and Freshwater Marsh habitat within the Delta and Bay marshland geographical province represented an important habitat transition between San Francisco Bay and the Sacramento-San Joaquin River Delta. Within the alluvial fans, terraces, and basins geographical province (Noss et al. 2002), dense oak forests reportedly once covered the plains along the major streams (such as Putah Creek) and their fans, with high fans and terraces having more open stands of grasses and oaks. Lower lying basin deposits supported tules, reeds, and other water-tolerant plants (Burcham 1957, Bates et al. 1977).

Most urban development occurs on, or downslope of, the alluvial fans of the Vaca Mountains and upslope of the Delta and Suisun marshlands. As a result, palustrine wetlands, floodplains, and riparian forests that historically bordered the larger rivers and adjacent sloughs and waterways, have largely been drained and converted into farmland over the last century or more. Based on Kuchler's (1977) map (Figure 3-3), 34,720 ac of potential Riparian Forest occurred along Putah Creek. Presently, only 694 ac of riparian vegetation are present in this area, representing a 98 percent loss of this potential natural vegetation type. The primary conservation actions for these areas are restoration of natural floodplain corridors that allow development of natural channel meander patterns, restoration of riparian and freshwater marsh habitat, and removal of barriers. Target areas for conservation and restoration include:

- The Old Alamo Creek Channel, east of Leisure Town Road to the Vacaville Urban Growth Boundary (UGB)
- The Old Ulatis Creek Channel, east of Leisure Town Road to the Vacaville UGB
- Horse Creek and its tributaries
- Gibson Canyon Creek
- Barker Slough, City of Vacaville UGB to SR-113
- Union Creek, between Peabody Road and Vanden Road
- Lynch Canyon Creek, east of I-680
- Jameson Canyon Creek, east of I-680
- Calhoun Cut
- Hass Slough

- Duck Slough
- Putah Creek

Conservation of these stream reaches will require substantial restoration and creation of new habitat features. Where compatible with flood control objectives, restoration of a two-stage floodplain corridor that allows for development of natural channel meander patterns is encouraged under the Solano HCP. Major restoration efforts will focus on the Priority Drainages and Watersheds within Conservation Area RSM 3.

4.3.7 Giant Garter Snake

This section presents the conservation analysis for giant garter snake, including identification of key conservation elements and conservation areas. Due to the lack of records and suitable habitat in the Plan Area, a habitat model was developed using basic information on the habitat and natural history of giant garter snakes (see Appendix B) as well as other applicable information. The conservation analysis is based on the results of the habitat model and information provided in Appendix B.

4.3.7.1 Associated Natural Communities, Covered Species, and Special Management Species

Giant garter snakes are associated with dense emergent aquatic vegetation, such as cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.), in freshwater marshes, oxbows, and backwaters along slow-flowing creeks. Giant garter snakes are also found along canals supporting beds of fringing cattails or bulrushes. Covered Species associated with the giant garter snake include: Sacramento splittail and Delta smelt, which occur in the open water of sloughs and backwaters and may serve as prey items for the giant garter snake; and the tri-colored blackbird, which breeds in beds of cattails and bulrushes. In addition, one Special Management Species may be associated with the giant garter snake: the western pond turtle, which occupies the same type of aquatic habitat as giant garter snake and requires adjacent uplands for egg laying.

4.3.7.2 Giant Garter Snake Habitat Model

Potential giant garter snake habitat was assessed using field analysis, review of aerial photographs, and information obtained from the Solano HCP Participants. A simple habitat model was developed using basic information on the habitat and natural history of giant garter snakes, detailed in Appendix B, as well as other applicable information. Data and observations from various sources were used to rank Plan Participant facilities (see Appendix A) within the Plan Area based on their ability to support giant garter snake.

Methods. Suitable giant garter snake habitat within the Plan Area includes marshes, sloughs, ponds, small lakes, low gradient streams, and agriculture-associated wetlands, such as irrigation, flood control, and drainage canals and the adjacent uplands. Upland habitat is defined here as the inside (waterside) bank, top, and landward slope of levees along various water facilities and adjoining areas of uncultivated land. Dry fallow fields, most of which have been plowed and/or are subject to winter flooding, are not considered part of giant garter snake upland habitat due to their high level of disturbance and lack of essential upland habitat components. A Plan Participant

facility is considered potential giant garter snake habitat if it is located within the historic range of the giant garter snake and contains the following habitat components:

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 active season for giant garter snake (i.e., April through October)

The giant garter snake habitat model is based on a simple evaluation of the presence or absence of the habitat components described above. For the purposes of this model, areas with perennial water or continuous water during the giant garter snake active season were assumed to contain a suitable prey base of native or nonnative fish and/or nonnative frogs (habitat component #4).

Water facilities operated by the Plan Participants were evaluated using the checklist outlined below.

A) Wetland habitats along water facilities were evaluated in the field by noting the presence/absence of suitable vegetation (habitat component #1).

B) Upland habitats along water facilities were evaluated in the field by noting the presence/absence of basking and retreat habitat (habitat component #2) and winter upland habitat (habitat component #3).

C) Plan Participants data were used to evaluate food availability (habitat component #4) and aquatic habitat suitability (habitat component #5). Water features were classified into one of three categories:

   C1) Perennial water present
   C2) Water present continuously during the giant garter snake active season
   C3) Water present intermittently

The presence of habitat components #1, #2, #3, and #5 indicate potential habitat.

Field studies were conducted during September and November 2003 by driving along public roads and accessible canal/irrigation ditch rights-of-way to assess and document site conditions.

Suitable habitat was assessed using geographic information system (GIS) based data developed for the Solano HCP. The extent of potential habitat was calculated from aerial photos using the following formula:

$$\frac{\textit{Total length of segment (in feet) x average width (in feet)}}{\textit{43,560 square feet}}$$

The width of a given water feature was measured every 2,000 to 3,000 ft, depending on the uniformity of the habitat and averaged over the total length of the segment. Upland habitat constitutes the sloped land surrounding the aquatic section of the channel, between the water line and the top of bank.

Results. The estimated extent of potential giant garter snake habitat within the Plan Area, based on the presence of the five essential habitat elements, is approximately 453 ac (Figure 4-18). Table 4.7 presents the amount of wetland and upland components within each of the Plan Participants' water features.

Table 4.7: Estimated Potential Giant Garter Snake Habitat within the HCP Plan Area

HCP Participants	Aquatic Habitat (acres)	Upland Habitat (acres)	Total (acres)
Solano Irrigation District (SID)	0	0	0
Maine Prairie Water District (MPWD)	6	12	18
Dixon Resource Conservation District (Dixon RCD)	6	17	23
Solano County Water Agency (SCWA)	70	112	182
Reclamation District No. 2068 (RD 2068)	88	79	167
City of Rio Vista	30	33	66
Total HCP Area	**200**	**253**	**453**

HCP = Habitat Conservation Plan

4.3.7.3 Conservation Areas

The extent of suitable habitat and occupied range for giant garter snake encompasses the lower portions of Putah, Ulatis, and Alamo Creeks, Hass Slough, the tidally influenced portions of Reclamation District No. 2068 (RD 2068) drains emptying into Hass Slough and Duck Slough, interconnected irrigation canals and ditches, and Delta sloughs in the southeastern portion of the Plan Area (LSA 2004a; Figure 4-18). Figure 4-18 shows the remaining suitable habitat within the historic range of the giant garter snake, including high quality habitat within Plan Participant facilities. These areas, in particular, represent priority areas for habitat restoration and creation that will benefit giant garter snake conservation. This area is referred to as the Giant Garter Snake Conservation Area.

4.3.8 Coastal Marsh

Coastal Marsh habitat addressed in this section includes those areas that lie within the historic influence of tidal action and are either currently influenced by tidal action, or are diked and no longer affected by tides. These marshes exhibit a broad range of characteristics and include the current and historic estuarine-influenced marshes of San Pablo Bay/Lower Napa River, Southampton Marsh in the Carquinez Straits, Suisun Marsh, and tidally influenced freshwater marshes in the upper regions of the sloughs and creeks in the Delta Region of Solano County.

This section presents the conservation analysis for Coastal Marsh, including identification of key conservation elements and conservation areas. The conservation analysis is based on background

information for this habitat type including habitat types, distribution, ecological processes, habitat variables, and threats provided in Appendix B. Conceptual models developed for Suisun Marsh during a 2004 workshop sponsored by the San Francisco Bay-Delta Science Consortium are also summarized in Appendix B. This section also identifies the Covered Species associated with this Natural Community and gives a general overview of the regulatory framework governing marsh habitat within the Plan Area.

4.3.8.1 Associated Covered Species and Special Management Species

Eleven (11) of the 37 Covered Species and 12 of the 36 Special Management Species depend on Coastal Marsh habitat for all, or a portion of, their lifecycle. The relative richness of Covered Species found within marsh habitats is depicted on Figure 4-3, the Rarity-Weighted Richness Map. The Covered Species primarily associated with this natural community are Mason's lilaeopsis, soft bird's-beak, Suisun thistle, California clapper rail, California black rail, salt marsh harvest mouse, Chinook salmon (winter run), Chinook salmon (spring run), delta smelt, longfin smelt, Sacramento splittail, and green sturgeon (Table 4.1). The Covered Species secondarily associated with this natural community are steelhead, Chinook salmon (fall run), and burrowing owl.

4.3.8.2 Conservation Background

Significant ongoing conservation efforts are directed toward estuarine marsh protection, particularly within Suisun Marsh where CDFG owns and manages large portions of marsh habitat. In addition to Suisun Marsh, CDFG has also purchased substantial portions of the Napa Marshes in Napa and Solano Counties, and plans to restore these areas to tidal marsh for the purpose of endangered species restoration and recovery. USFWS also owns and manages the majority of the tidal marshes fronting San Pablo Bay, including the bay marshes on Mare Island, and plans to restore approximately 1,560 ac of the former Cullinan Ranch along State Route 37 (SR-37), just east of Vallejo. The California Department of State Parks owns and manages the Southampton Marsh in Benicia.

Since the early 1970s, the California Legislature, the State Water Resources Control Board (SWRCB), United States Department of the Interior, Bureau of Reclamation (USBR), CDFG, Suisun Resource Conservation District (SRCD), California Department of Water Resources (CDWR), and other agencies have focused on preserving Suisun Marsh as a unique environmental resource (Suisun Marsh Program 2005).

In 1974, the California Legislature passed the Suisun Marsh Protection Act to protect Suisun Marsh from residential, commercial, and industrial development. The Act directs the San Francisco Bay Conservation and Development Commission (BCDC) and CDFG to prepare the Suisun Marsh Protection Plan "to preserve the integrity and assure continued wildlife use" of Suisun Marsh (BCDC 1976). The objectives of the Protection Plan are to preserve and enhance the quality and diversity of Suisun Marsh aquatic and wildlife habitats, and to assure retention of upland areas adjacent to the Marsh in uses compatible with its protection. Between 1974 and 2000, several agencies and working groups collaborated on a set of measures to meet the objectives of the Suisun Marsh Protection Plan. Figure 4-19 depicts the boundaries of the Suisun Marsh Protection Plan and the locations of tidal restoration projects in Suisun Marsh.

The 2000 CALFED Bay-Delta Program Record of Decision and Ecosystem Restoration Plan called for the restoration of 5,000 to 7,000 ac of tidal wetlands in Suisun Marsh through cooperative

programs that result in fee title or conservation easements. Restoration of tidal wetlands will be conducted as part of a marsh management plan, recognizing the importance of managed wetlands for wildlife protection. The focus of this regional management plan is on protecting water quality, endangered species, and heritage values in Suisun Marsh. In order to balance the goals and objectives of the CALFED Bay-Delta Program, the Suisun Marsh Protection Act, and other management and restoration programs within Suisun Marsh, a habitat management, preservation, and restoration plan was developed for the Marsh.

To ensure that the best available science would be used in developing the Suisun Marsh Protection Plan, the Bay-Delta Science Consortium sponsored a two-day workshop in March 2004 for a broad group of scientists, managers, and stakeholders to engage in scientific discussions regarding Suisun Marsh. The workshop consisted of 31 presentations on the physical and biological systems of Suisun Marsh, its management infrastructure, and methods for restoring (re-creating) an additional 5,000 to 7,000 ac of tidal marsh (Brown 2004). A summary of the workshop presentations was compiled for the San Francisco Bay-Delta Science Consortium and is available online at http://www.baydeltaconsortium.org/education/workshops/index.

The draft goals for the Habitat Management, Preservation, and Restoration Plan for Suisun Marsh (Suisun Marsh Plan) are:

- Rehabilitate natural processes where feasible in Suisun Marsh to fully support, with minimal human intervention, natural aquatic and associated terrestrial biotic communities and habitats, in ways that favor native species of those communities, with a particular interest in waterfowl and sensitive species.
- Protect, restore, and enhance habitat types where feasible in the Suisun Marsh for ecological and public values, such as supporting species and biotic communities, ecological processes, recreation, scientific research, and aesthetics.
- Provide long-term protection for multiple Suisun Marsh resources by maintaining and improving the integrity of the Suisun Marsh levee system.
- Prevent the establishment of additional nonnative species and reduce the negative ecological and economic impact of established nonnative species in the Suisun Marsh.
- Improve and/or maintain water and sediment quality conditions to provide good quality water for all beneficial uses and fully support healthy and diverse aquatic ecosystems in the Suisun Marsh, and to eliminate, to the extent possible, toxic impacts to aquatic organisms, wildlife, and people.
- Maintain the heritage of waterfowl hunting and increase the surrounding communities' awareness of the ecological values of the Suisun Marsh.

The Coastal Marsh Conservation Strategy supports the goals of the Habitat Management, Preservation, and Restoration Plan for Suisun Marsh (the Suisun Marsh Plan) as well as conservation of other coastal marsh habitat within Solano County.

4.3.8.3 Key Conservation Elements

The following key conservation elements were identified for the Coastal Marsh Natural Community:

- Location of Tidal Marsh Habitat
- Location of Marsh Habitat
- Location of Covered Species and Special Management Species
- Suisun Marsh Protection Plan Primary and Secondary Management Zones
- Designated Critical Habitat

Location of Tidal Marsh Habitat. Presently, only 9,842 ac of high elevation tidal marsh remain within the Plan Area, which is approximately 16 percent of the historic tidal marsh area. Most of this remaining tidal marsh is located around the periphery of Suisun Marsh, surrounding the Potrero Hills and within the San Pablo Bay National Wildlife Refuge, Napa-Sonoma Marshes, Sandpiper, and White Slough, just west of Vallejo (Figure 3-8).

Location of Marsh Habitat. Approximately 72,000 ac of marsh habitat were mapped within Solano County. The largest contiguous area is Suisun Marsh. Additional large marsh areas include Southampton Marsh and the San Pablo Bay and Napa Marshes (Figure 3-6).

Location of Covered Species and Special Management Species. As described in Section 4.3.1.2, areas of high richness of Covered Species and Special Management Species were identified using the RWRI. Based on the results of this analysis, Coastal Marsh habitat within the Plan Area has substantially higher levels of diversity than the majority of Solano County, with the exception of Jepson Prairie. Coastal Marsh habitat is a very restricted vegetation type and is becoming extremely rare within the San Francisco Bay. In addition, Suisun Marsh hosts a suite of rare and threatened species, such as the Suisun thistle and Suisun shrew.

Suisun Marsh Protection Plan Primary and Secondary Management Zones. The Suisun Marsh Protection Plan divides Suisun Marsh into two zones: a primary management zone and a secondary management zone (Figure 4-19). The primary management zone encompasses 89,000 ac of tidal marsh, managed wetlands, adjacent grasslands, and waterways under BCDC jurisdiction (Figure 4-19). The secondary management zone encompasses approximately 22,500 ac of buffer (Figure 4-19). Solano County administers the local protection program, while BCDC represents the State's interest and serves as the land use permitting agency for major projects in the primary management zone.

Designated Critical Habitat. Critical habitat has been designated in the Plan Area for three coastal marsh Covered Species. Critical habitat for Delta smelt was designated on March 5, 1993, and encompasses Suisun Marsh and the Delta (Figure 4-20). Critical habitat for Suisun thistle and soft bird's-beak was designated on April 4, 2006. There are three Critical Habitat Units for the soft bird's-beak: Southampton Marsh, Hill Slough Marsh, and Rush Ranch/Grizzly Island Wildlife Area (Figure 4-20). There are three Critical Habitat Units for the Suisun thistle: Hill Slough Marsh, Rush Ranch/Grizzly Island Wildlife Area, and Peytonia Slough (Figure 4-20).

4.3.8.4 Conservation Areas

All Coastal Marsh habitats, both tidal and managed, have extremely high conservation value. The Suisun Marsh is home to 221 bird species, 45 mammal species, 16 species of reptiles and amphibians, and more than 50 species of fish, 12 of which are either State or Federally listed as threatened or endangered (Brown 2004). The Coastal Marsh Natural Community was divided into three geographical units reflecting the conservation, management, and restoration programs currently being conducted in these areas. The Coastal Marsh Conservation Areas are: Suisun Marsh, the San Pablo Bay and Napa Marshes, and tidally influenced freshwater marshes in the upper regions of the sloughs and creeks in the Delta Region of Solano County.

- **Suisun Marsh:** As described above, the Suisun Marsh encompasses two zones: the primary management zone and the secondary management zone. The principal consideration in the primary management zone is the protection of environmental values and existing uses. Urban development is precluded, and other uses such as oil and gas exploration and construction and operations of utilities and other facilities are highly regulated by BCDC. Activities that conflict with the protection of the Marsh are not permitted provided other practicable alternatives are available. Activities within the secondary marsh zone are also severely restricted to activities that will not adversely impact Suisun Marsh.
- **San Pablo Bay and Napa Marshes:** This Conservation Area encompasses Coastal Marsh habitat west of Vallejo and Southampton Marsh in the Carquinez Strait (Figure 4-20). CDFG has purchased substantial portions of the Napa Marshes in Napa and Solano Counties and plans to restore these areas to tidal marsh for the purpose of endangered species restoration and recovery. USFWS also owns and manages the majority of the tidal marshes fronting San Pablo Bay, including the bay marshes on Mare Island, and plans to restore approximately 1,560 ac of the former Cullinan Ranch along SR-37 just east of Vallejo.
- **The Delta Region:** This Conservation Area includes the tidally influenced freshwater marshes in the upper regions of the sloughs and creeks in the Delta Region of Solano County (Figure 4-20). Only a small area of marsh habitat remains in this area; the majority of historic marsh habitat has been converted for agricultural uses. Within this area, CDFG owns the Calhoun Cut Ecological Reserve, which contains the upper portions of marsh and riparian habitats and are currently being restored. This Conservation Area overlaps with the Giant Garter Snake High Value Conservation Area; therefore, most of the conservation activities for this area are addressed in the Giant Garter Snake Conservation Analysis (Section 4.3.7) and Conservation Strategy (Chapter 5).

The combination of significant public ownership in Suisun Marsh, Southampton Marsh, and Napa and San Pablo Bay Marshes, and special regulatory restrictions in Suisun Marsh have resulted in the protection of over 95 percent of the Coastal Marsh habitats in Solano County from conversion to other land uses (Figure 3-11).

The primary threat to Coastal Marsh habitat is the potential for indirect effects associated with urban growth in Solano County. Specifically, the Fairfield-Suisun Sewer District will upgrade their wastewater treatment plant, increasing plant capacity from 17.5 million gallons per day (mgd) to 25 mgd over the next 20 years. Most Coastal Marsh habitats do not occur within urban boundaries; Coastal Marsh habitats that do are managed as or incorporated into established open space areas to protect and enhance habitat values (e.g., White Slough, River Park, and Mare Island in Vallejo). Minor direct impacts may result from road projects (i.e., widening of Cordelia Road in Fairfield),

construction of a redundant outfall pipeline for the Fairfield-Suisun Sewer District main effluent outfall, or maintenance of flood control channels.

The main conservation action for Coastal Marsh habitat within the Plan Area is to minimize secondary impacts to marsh habitat, hydrology, and water quality using best management practices. To mitigate for direct and indirect impacts to marshes associated with population growth, the Solano HCP will establish invasive species control programs and assist in restoration of tidal marsh habitat throughout the Plan Area.

4.3.9 Swainson's Hawk

This section presents the conservation analysis for Swainson's hawk, including identification of key conservation elements and conservation areas. The conservation analysis is based on background information on this species, including habitat types, natural community associations, ecological processes, habitat variables, and threats that are provided in Appendix B.

4.3.9.1 Associated Covered Species and Special Management Species

Covered Species that will benefit from the Swainson's Hawk Conservation Strategy include burrowing owl and tricolored blackbird. Special management species that will also benefit are short-eared owls and northern harriers (Table 4.1).

4.3.9.2 Key Conservation Elements

The following key conservation elements are identified for Swainson's hawk:

- Foraging habitat
- Swainson's hawk nest records
- Location of existing and potential wind resource areas

Foraging Habitat. Potential foraging habitats for Swainson's hawk within the Plan Area include irrigated and non-irrigated agriculture, valley floor and vernal pool grasslands, oak savanna, and Inner Coast Range grasslands (Figure 3-4). However, not all of the potential foraging habitat types provide equal value to Swainson's hawk. Based on records within the Plan Area and studies by Estep (1989) in the Central Valley, irrigated agriculture, specifically irrigated agricultural land in alfalfa/pasture, grain and hay crops, and row or truck crops, represents the primary foraging habitat for Swainson's hawk within the Plan Area. Valley floor grassland and vernal pool habitats provide less suitable habitat for Swainson's hawk. Swainson's hawk records indicate that the oak savanna and grassland habitats within the Inner Coast Range are the least often used.

Swainson's Hawk Nest Records. Within Solano County, available nest records and observations indicate that most Swainson's hawks nest in isolated, individual trees and groves of nonnative trees (e.g., eucalyptus), with only a few nests occurring in riparian areas and scattered oak trees on the valley floor. Most known Swainson's hawk records are concentrated in the irrigated agricultural area in northeastern and eastern Solano County, with a few scattered records in the Valley Floor Grassland. One nest record is located within the riparian area along Cordelia Slough and is

surrounded by grazed annual grassland. Another record is located within the Lagoon Valley area between Vacaville and Fairfield (Figure 4-21).

Location of Existing and Potential Wind Resource Areas. Because wind turbines represent a potential source of Swainson's hawk mortality, lands within 2 mi of the existing Solano Wind Resource Area (WRA), as well as proposed future WRA expansion lands, are excluded from the high-value conservation areas defined below.

4.3.9.3 Conservation Areas

Swainson's hawk records within the Plan Area are not uniformly distributed corresponding to differences in the quality of potential foraging habitat. Consequently, not all potential habitat within the County contributes equally to the conservation of Swainson's hawks. Thus, it was necessary to define specific Swainson's hawk conservation areas based on the value of foraging habitat and distribution of Swainson's hawk records within the Plan Area. Three Swainson's Hawk Conservation Areas were identified: the Irrigated Agriculture Conservation Area; Valley Floor Grassland Conservation Area; and the Inner Coast Range Conservation Area.

- **Irrigated Agriculture Conservation Area:** The Irrigated Agriculture Conservation Area was identified by reviewing the known nesting distribution in the County, and mapping high quality irrigated and non-irrigated agricultural lands and adjacent grasslands. This Conservation Area encompasses all of the irrigated and non-irrigated agricultural land and some grassland habitat in the northeastern and eastern portions of the Plan Area, and contains the majority of known Swainson's hawk records (Figure 4-21). Areas below sea level (approximately 5 ft in elevation and protected by dikes from regular inundation) were excluded from this Conservation Area.
- **Valley Floor Grassland Conservation Area:** The Valley Floor Grassland Conservation Area consists of the Valley Floor Grassland and Vernal Pool habitat in the central portion of the Plan Area, and the lands west of I-505 (Figure 4-21). Despite the large amount of open space, relatively few Swainson's hawk nests have been observed in this Conservation Area. This may be due to a lack of survey coverage and/or lower habitat quality. As such, the potential for this area to support additional Swainson's hawk pairs and significantly contribute to conservation of the population is unknown. Additional tree planting (i.e., potential nest trees) and maintaining existing open grasslands in this area may provide an opportunity to expand the Swainson's hawk population.
- **Inner Coast Range Conservation Area:** Grassland and oak savanna habitat within the Inner Coast Range may provide suitable foraging and nesting habitat for Swainson's hawks, despite few records from these areas (Figure 4-21). One pair was observed in Lagoon Valley and another was recorded in Cordelia. However, if population expansion exceeds the carrying capacity of the Irrigated Agriculture and Valley Floor Grassland Conservation Areas, hawks may disperse into these currently unoccupied areas of the County. Therefore, preserving grassland and oak savanna habitat in the Inner Coast Range may provide habitat for future populations of Swainson's hawk.

4.3.10 Burrowing Owl

This section presents the conservation analysis for burrowing owl including identification of key conservation elements and conservation areas. The conservation analysis is based on background information for this species, including habitat types, natural community associations, distribution, ecological processes, habitat variables, and threats that are provided in Appendix B.

4.3.10.1 Associated Covered Species and Special Management Species

Special Management Species that could potentially benefit from conservation measures for burrowing owl include the short-eared owl and northern harrier. These species are associated with the same open grasslands and agricultural lands in which burrowing owl often occur.

4.3.10.2 Key Conservation Elements

The following key conservation elements were identified for the burrowing owls:

- Suitable foraging habitat
- Burrowing owl records

Suitable Foraging Habitat. 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 Valley Floor Grassland and Vernal Pool Natural Community, grassland and oak savanna habitat within the Inner Coast Range, pasture, grain/hay crops, row crops, and other irrigated agriculture lands, vacant or fallow fields, and diked historic tidal wetlands within the Coastal Marsh Natural Community are all considered suitable habitat for this species.

Burrowing Owl Records. The primary natural habitats for this species are the valley floor and low foothill grasslands, and the grassland and oak savanna habitat within the Inner Coast Range; however, most burrowing owl records in Solano County are from agricultural and urban areas (Vacaville in particular). Within agricultural and urban areas, burrowing owls occur where ground squirrel burrows or debris piles provide suitable nesting habitat, along ditches and canal banks, in vacant lots, weedy fields, and utility, railroad, and road/highway rights-of-way, and other remnant areas. A few owl records also occur around the periphery of Suisun Marsh, San Pablo Bay, and the Napa Marshes. Similar to agricultural areas, owls occur along levees, canals, and drainage ditches created in diked historic tidal wetland areas within the Coastal Marsh Natural Community. The majority of the remaining grasslands in the Valley Floor are associated with the vernal pool environments in the Jepson Prairie region of the County. In this area, burrowing owl nesting appears to be limited by the availability of natural burrows. Ground squirrel populations are limited because of the seasonally high water tables. Similar to the agricultural areas, ground squirrels are primarily limited to raised mounds or grades associated with utility, railroad, and road/highway rights-of-way.

4.3.10.3 Conservation Areas

Burrowing owls are an open-country species, naturally inhabiting grasslands, open shrublands, and open woodlands, but have also adapted to human-modified landscapes such as agricultural lands, disturbed fields, roadsides, and railroad rights-of-way. As a result, Solano County has an abundance of land known to or could support burrowing owls (Figure 4-22) and provides opportunities to protect and expand burrowing owl populations without greatly inhibiting future development and agricultural practices. Burrowing owl conservation is tied to the preservation and management of open agricultural lands, similar to Swainson's hawk habitats, as well as Valley Floor Grassland and Vernal Pool and low-lying grassland communities associated with the Inner Coast Range. These three areas represent the main conservation areas for burrowing owls throughout the Plan Area and are the areas in which future preservation and management practices will be directed.

4.4 LANDSCAPE LEVEL CONSERVATION ANALYSIS

The Landscape Level Conservation Analysis combines key conservation elements identified for each Natural Community and Covered Species to identify conservation "hot spots" throughout the Plan Area. A key conservation element is defined as a habitat feature or characteristic of the environment that can be physically mapped within the Plan Area and reflects the conservation value and/or at least one habitat quality of the Natural Community. The results of this analysis are used to identify priority areas for acquisition and provide an overall reserve design vision for the Solano HCP. The relationship between the Landscape Level Conservation Analysis and the biological goals and objectives of the Conservation Strategy (Chapter 5.0) is also discussed.

4.4.1 Methods

To identify conservation "hot spots" throughout the Plan Area, a grid of equal-area hexagonal cells, with sides 0.25 mi long and averaging 2,286 ft (0.433 mi) between centers, was overlaid onto the Plan Area (Figure 4-23). The key conservation elements identified for each Natural Community was assigned a value of one, except for the RWRI (see detailed list of key conservation elements below). For each key conservation element that overlapped a hexagonal cell, the point assigned to that key conservation element was added to the value of that cell so that the "value" of a cell equaled the sum of the points assigned to each key conservation element. For example, if a hexagonal cell overlapped with oak woodland vegetation, it received a point value of 1. If that same cell also overlapped with California red-legged frog potential breeding and hydration habitat, the cell received another point, increasing its "value" from 1 to 2. All cells with a value of 1 or more correspond to an area associated with at least one key conservation element and can be considered to have conservation value. Cells with a value of 2 or more represent an area encompassing two, three, four, or more key conservation elements (Figure 4-23). Cells with higher point totals do not necessarily have more conservation value, rather they contain more than one key conservation element and are, therefore, more likely to meet multiple conservation goals and objectives if preserved.

The key conservation elements from each Natural Community assessed in the Landscape Level Conservation Analysis are:

- **Landscape**
  - Corridors (Figure 4-2)
  - RWRI for all Covered Species and Special Management Species within the Plan Area (Figure 4-3; all green hexagons were assigned a value of 1 and all blue hexagons were assigned a value of 2 reflecting the relative irreplaceability of the cell)
- **Valley Floor Grassland and Vernal Pools**
  - Disturbance levels
    - Low disturbance areas on claypan soils (Figure 4-4)
    - Low and moderate disturbance areas on hardpan soils (Figure 4-4)
  - Contra Costa goldfields known core populations (Figure 4-5)
  - Unique environmental features
    - Playa pools (Figure 4-7)
    - Hardpan soil (Figure 3-7)
- **Inner Coast Range**
  - Keystone vegetation/habitat types (Figure 3-6)
    - Oak woodland
    - Oak savanna
    - Riparian vegetation as listed under the Riparian, Stream, and Freshwater Marsh Section
  - Valley Oaks as mapped by FRAP (Figure 4-9)
- **California Red-Legged Frog**
  - California red-legged frog potential breeding and hydration habitat (Figure 4-15), with a 300 ft terrestrial buffer
- **Callippe Silverspot Butterfly**
  - Johnny jump-up known occurrences (Figure 4-13)
  - Major ridgelines connecting known Johnny jump-up and callippe silverspot butterfly occurrences buffered by 300 ft
- **Riparian, Stream, and Freshwater Marsh**
  - Riparian vegetation (Figure 4-16)
  - Watersheds or subwatersheds with less than 10 percent developed or irrigated agriculture (Figures 4-11 and 4-12)
  - Priority drainages buffered by 300 ft (Figure 4-10)
- **Giant Garter Snake**
  - Giant Garter Snake Priority Conservation Area (Figure 4-18)
- **Coastal Marsh**
  - Marsh habitat (Figure 3-6)
  - Boundaries of the Suisun Marsh Protection Plan, including secondary management areas (Figure 4-19)
- **Swainson's Hawk**
  - Swainson's hawk nest records buffered by 0.25 mi
  - All suitable foraging habitat within the Swainson's hawk irrigated agriculture primary conservation area (Figure 4-21)
- **Burrowing Owl**
  - Burrowing owl records buffered by 0.33 mi

4.4.2 Results

The results of the Landscape Level Conservation Analysis (Figure 4-23) indicate that most of the Plan Area has some conservation value (i.e., contains one or more key conservation elements) (Figure 3-1). The vegetation types with the most conservation elements are marsh, vernal pool, valley floor grassland, and riparian (Figure 4-24). Only the Montezuma Hills, just west of Rio Vista (Figure 4-23) exhibit little conservation value (i.e., hexagons with a value of 0) that may be due to the lack of available survey data or the types of conservation criteria (i.e., key conservation elements) used in the analysis. Selection or addition of different criteria, such as important foraging habitat for migratory raptors, would likely change the conservation value of this area. The analysis is designed to show the relative conservation value for those species and natural communities covered under the Solano HCP. That is why the vegetation types with the most conservation elements are marsh, vernal pool, valley floor grassland, and riparian (Figure 4-24), because these are the vegetation types associated with the most Covered Species.

In general, two areas are rich in key conservation elements (i.e., values of 3 or more): Jepson Prairie and Suisun Marsh. Other areas that contain three or more conservation elements include:

- The northern hardpan vernal pool conservation subarea 1K (Figure 4-8) and the oak woodland/oak savanna area adjacent to this subzone in the area identified as the North Vacaville corridor (Figure 4-2);
- The majority of the Jameson Canyon-Lower Napa River Core Recovery Area for California red-legged frog (Figure 4-15);
- The Callippe Silverspot Butterfly Conservation Area north of Vallejo (Figure 4-13); and
- The Suisun Valley, Putah, Ulatis and Alamo Creek riparian corridors.

The results of the Landscape Level Conservation Analysis, which is depicted on Figure 4-23, provides an overall vision for the design of reserves in the Plan Area. The reserve system at minimum should encompass all of the areas highlighted with at least three key conservation elements. Priority areas for acquisition and restoration under the Solano HCP correspond to cells with four or more overlapping key conservation elements. Cells with values of 1 or 2 also contain conservation value relative to the biological goals and objectives of the HCP, and should be incorporated or considered in the reserve system. Conservation of areas with one or two key conservation elements may be necessary to provide connectivity and buffers (Reserve Design Principles 6 and 8; Section 4.2) or to preserve habitat for specific Covered Species/Special Management Species. The results of this analysis outline a list of priority conservation efforts. Prior to final acceptance in the HCP reserve system, biological resources in each area must be verified by appropriately timed field surveys conducted by qualified biologists.

The results of the Landscape Level Conservation Analysis can be used to assess the Plan's ability to achieve the biological goals and objectives outlined in the Conservation Strategy (Chapter 5.0), which are closely linked to the Conservation Analysis (Figure 4-1). The majority of the goals and objectives correspond to one or more key conservation elements. For example, Callippe Silverspot Butterfly Objective CSB 1.4 is to maintain connectivity between core breeding sites and existing subpopulations within the Callippe Silverspot Butterfly Conservation Area by preserving 300 ft corridors along hilltops and ridgelines. Major ridgelines connecting known Johnny jump-up and callippe silverspot butterfly occurrences buffered by 300 ft is one of the key conservation elements incorporated into the Landscape Level Conservation Analysis. The preservation of high value cells

containing more than one key conservation element is more likely to meet multiple conservation goals and objectives; therefore, these cells should be given a higher priority for acquisition. The Landscape Level Conservation Analysis will be updated as new information becomes available from adaptive management, monitoring, and targeted studies to determine if conservation efforts need to be redirected as the Plan progresses during the implementation phase. The analysis will be used to identify gaps in the reserve system as the Solano HCP is implemented.

4.5 CONSERVATION TARGETS

The most difficult task in conservation planning is determining the extent of habitat/proportion of an ecosystem needed to sustain viable populations of targeted species, preserve ecological processes, and maintain native species composition and structure (Groves 2003). A variety of methods, including population viability analyses (Morris et al. 1999) and other established ecological theories such as island biogeography (Simberloff and Wilson 1969), have been developed to address this question in the context of conservation planning. In this section, various methods, including the species-area relationship model, recovery plans, and expert opinion, are employed to determine "how much is enough" for each Natural Community.

These conservation targets were initially calculated to address the California Natural Community Conservation Planning Act (NCCPA) standards that require a commitment from Plan Participants to conserve Covered Species and Natural Communities in the Plan Area at the level of recovery. However, the Solano HCP is not a Natural Community Conservation Plan (NCCP) and the recovery targets calculated in this section are more stringent than the conservation objectives described in the HCP Conservation Strategy (Chapter 5.0), which are designed to avoid, minimize, and fully mitigate the impacts of the Covered Activities under the HCP. This section relates to broader conservation issues beyond the commitments of an HCP. Despite this, Plan Participants incorporated these higher recovery standards into the Conservation Analysis for the Solano HCP and will work with State, Federal, and private agencies for additional funding and/or land acquisition to achieve these larger conservation targets.

4.5.1 The Species-Area Relationship Model

The species-area relationship was one of the first ecological relationships to be established empirically (Arrhenius 1921) and is commonly expressed as:

$$S = cA^2$$

where S is the number of species, A is equal to area, and c and z are constants fitted to the data (Meffe and Carroll 1997; Figure 4-25). This relationship between number of species and area plots as a straight line on a logarithmic scale. On a logarithmic scale, c is the y-intercept and z is the slope. The constant z represents the rate at which new species will be encountered, or added to the sample, as more area is surveyed. In other words, from a reserve design perspective, as the value of z increases, a larger area is required to capture a higher proportion of the total species diversity (Figure 4-25). Studies from different regions for several species types suggest that values for z usually fall between 0.15 and 0.35 (Groves 2003; Meffe and Carroll 1997). Several speculations have been made as to what affects the value of z. Values of z have been shown to depend on the size of the surrounding region, degree of isolation, evolutionary history (Anderson and Marcus 1993; Rosenzweig 1995; Rosenzweig and Ziv 1999), and all factors influencing species

distribution. For large regions, rates of species turnover also influence the value of z. The size of the species range and its adaptability (i.e., extent of habitat specialization) determine the rate at which the species composition of communities changes across environmental gradients (Meffe and Carroll 1997).

Conservation planners have applied the species-area relationship to determine conservation targets to identify the amount of habitat that must be maintained to avoid significant species loss (Boecklen and Simberloff 1986; Groves 2003). These relationships suggest that conservation targets ranging from 20 to 40 percent of any given community or ecosystem type are likely to conserve, on average, 70 to 90 percent of the species in these habitats in continental situations (Groves 2003; Figure 4-25).

The actual percentage will vary depending on the value of z, which is related to the regional distribution of the community targeted for conservation. Generally, conservation targets (i.e., 20, 30 or 40 percent) are assigned for each species or vegetation community based on their distribution. For example, the Nature Conservancy's ecoregion-based conservation blueprint for the Great Basin Ecosystem aimed to preserve 30 percent of the historic distribution of endemic large patch and matrix-forming terrestrial ecosystems. This goal was reduced to 20 percent for more widespread terrestrial ecosystems (Nachlinger et al. 2001).

Where applicable, the Solano HCP uses the species-area relationship to identify conservation targets for preservation of each Natural Community based on its regional distribution and the average range size of species associated with it. The distribution classes assigned to each Natural Community in the Plan Area include endemic, widespread, and peripheral (Table 4.8). Natural communities classified as endemic or restricted, such as vernal pools and tidal marsh, contain species or vegetation communities that primarily occur within one ecoregion, either entirely endemic to the ecoregion or more than 80 percent of its range within the ecoregion (Anderson et al. 1999; Marshall et al. 2000). Natural communities that were classified as widespread, such as oak woodlands and valley floor grassland, contain species or vegetation communities that occur in several ecoregions and are distributed relatively equally among those ecoregions (Anderson et al. 1999; Marshall et al. 2000). Widespread does not necessarily mean "common". For example, the total acreage of riparian vegetation is small and the occurrences are widely separated, but the species and vegetation communities found in riparian areas are in fact widely distributed. Natural communities and/or species classified as peripheral, such as tule marsh and the callippe silverspot butterfly, are more commonly outside of the Plan Area (i.e., less than 10 percent of its total distribution falls within the Plan Area [Anderson et al. 1999; Marshall et al. 2000]). In determining conservation targets for peripheral communities, it is assumed that most of the conservation of this Natural Community will be focused in other ecoregions. However, these peripheral occurrences may represent separate evolutionarily significant units with high conservation value.

When the use of the species-area relationship model was infeasible and/or conservation targets derived from the model were impractical, conservation targets were derived from recovery plans, other conservation plans, and expert opinion. The species-area relationship model could not be directly applied to the Riparian, Stream, and Freshwater Marsh Natural Community, the Coastal Marsh Natural Community, California red-legged frog, burrowing owl, and Swainson's hawk. The historic distribution of the Riparian, Stream, and Freshwater Marsh Natural Community could not be calculated and a significant amount of riparian habitat has been lost, so the conservation target reflects the amount of restoration needed to preserve habitat values. Similarly, because only

Table 4.8: Definitions of Distribution Types Found within the Solano HCP Plan Area[1]

Distribution Type	Definition
Endemic or restricted	Species or vegetation community occurs primarily in one ecoregion; it is either entirely endemic to the ecoregion or has more than 80% of its range within the ecoregion.
Limited	Species or vegetation community occurs in the ecoregion, but also within a few other adjacent ecoregions (i.e., its core range is in one or two ecoregions yet it may be found in several other ecoregions).
Widespread	Species or vegetation community is distributed widely in several to many ecoregions, and is distributed relatively equally among ecoregions. Widespread does not necessarily mean "common." For example, some wetland types are distributed widely, although total acreage is small and the occurrences are widely separated.
Peripheral	Species or vegetation community is more commonly found in other adjacent ecoregions (less than 10% of its total distribution is in the ecoregion of interest). Peripheral occurrences may or may not represent significant variation relative to occurrences in adjacent ecoregions. Goals for peripheral communities should account for the fact that most of their conservation will take place in other ecoregions. Opportunistic capture of these types often may be sufficient. Selection of examples for conservation should be informed by consideration of how they compare in size, quality, and variation with those in the adjacent or other ecoregions.

[1] Definitions of distribution types are modified from Marshall et al. 2000 and Anderson et al. 1999.

16 percent of the historic tidal marsh remains in the Plan Area, the conservation target for this Natural Community was expressed as a restoration target based on the restoration target identified by CALFED. The species-area relationship model could not be applied to California red-legged frog, burrowing owl, or Swainson's hawk because these species utilize man-made or artificial environments, such as agricultural resources, for which no historic distribution could be calculated. Therefore, the USFWS Recovery Plan was used to define a conservation target for California red-legged frogs, and expert opinion was used to define conservation targets for burrowing owl and Swainson's hawk.

4.5.2 Valley Floor Grassland and Vernal Pool Natural Community

The Valley Floor Grassland and Vernal Pool Natural Community is dominated by two, typically intermixed associations: vernal pool system grasslands, and grassland associated with low hills (i.e., Montezuma Hills and Potrero Hills) and upper terraces along the valley floor. Vernal pool ecosystems harbor a different suite of species than the average valley floor grassland ecosystem. As a result, separate conservation targets were developed for vernal pools and the valley floor grassland community. Conservation targets for these two vegetation types and a conservation target for Contra Costa goldfields are discussed below.

4.5.2.1 Vernal Pool Ecosystems

Vernal pool ecosystems have high numbers of endemic species and habitat specialists with relatively small range sizes and high levels of among-population genetic variation (Elam 1998). Based on these characteristics, vernal pools were classified as having an endemic distribution type. Meaning that vernal pool habitats contain species or vegetation communities that primarily occur within one ecoregion, either being entirely endemic to the ecoregion or having more than 80 percent of its range within the ecoregion. The USFWS Vernal Pool Recovery Plan defines 16

vernal pool regions within California. Out of the 32 species mentioned in the Recovery Plan, 24 species occur in fewer than four vernal pool regions, and 12 of those species occur in one vernal pool region (USFWS 2004a). For the Solano-Colusa region, these species are Solano grass, Delta green ground beetle, and bearded popcorn flower (*Plagiobothrys hystriculus*), all of which are found specifically within the Plan Area. The justification for an endemic classification for vernal pool habitats assumes that each vernal pool region may also harbor genetically distinct populations of each species.

As an endemic habitat type, the conservation target for vernal pools was set at 40 percent of the historic distribution within the Plan Area (Table 4.8). The historic distribution of vernal pools was derived from the range of vernal pool soil types within the Plan Area and was estimated to be 118,230 ac (Figure 3-7). Based on the habitat mapping conducted for the Solano HCP, 50,760 ac of vernal pool habitat remain in the County. Forty percent (47,290 ac) of the historic vernal habitat equates to 93 percent of its current distribution (Table 4.9). Within Solano County, approximately 16,540 ac are currently protected (Table 4.9). To meet the conservation target of 40 percent (47,290 ac), an additional 35,440 ac would need to be protected.

The 40 percent conservation target closely matches the USFWS recovery goal in the Vernal Pool Recovery Plan of 95 percent of suitable vernal pool habitat within the Jepson Prairie Core Recovery Area (USFWS 2005a; Figure 4-7). The amount of remaining vernal pool habitat is sufficient to meet the 40 percent conservation target; however, much of this habitat has been highly disturbed (see Section 4.3.2.3 and Figure 4-4) and will require considerable restoration in order to achieve its historical levels of productivity and value.

4.5.2.2 Contra Costa Goldfields

Contra Costa goldfields have an extremely limited distribution, and each remaining population is under intense development pressure (i.e., all remaining occurrences within the Plan Area fall within the urban limits of Fairfield and Suisun; Figure 4-5). Contra Costa goldfields need a separate conservation target, as a sub-component of the vernal pool conservation target, because of their extremely limited distribution.

The species-area relationship model, when applied to a single species, would not determine the amount of habitat needed to preserve species richness, but rather the amount of habitat needed to maintain genetic diversity. Using the species-area relationship model for a single species, with a preservation target of 40 percent of the species' historic distribution, would capture, on average, 70 to 90 percent of its genetic diversity. For this analysis, the historic range for Contra Costa goldfields is assumed to coincide with the historic vernal pool areas within the San Francisco Bay Drainage Province (Figures 3-4 and 3-7) minus the historic vernal pools south of SR-12. This lower terrace area appears to support the majority of saline clover occurrences within the Plan Area (Appendix B) and corresponds to 39,760 ac of historic species habitat. Within this area, 17,470 ac of vernal pool habitat remain, corresponding to 44 percent of its historic range.

Not all of the 17,470 ac of vernal pool habitat are currently occupied by Contra Costa goldfields. Approximately 6,140 ac occur within known Contra Costa goldfields core population areas. In addition, 1,280 ac of valley floor grassland and 120 ac of open water are mapped within the core population areas, approximately 7,550 ac in total. However, the extent of vernal pool grassland habitat provides a rough estimate of the amount of habitat currently occupied by Contra Costa

Table 4.9: Conservation Targets for Natural Communities, Vegetation Types, and Covered Species

Natural Community/ Vegetation Type	Distribution Type[1]	Historic Distribution[2]	Current Distribution[3]	Conservation Target Percentage	Conservation Target (ac)	Percent of Current Distribution	Acres Currently Protected	Additional Conservation Needed (ac)	Acres at Low Risk
Vernal Pools	Endemic	118,230 (Historic Vernal Pool Soils)	50,760	40%	47,290	93%	11,850	35,440	3,710
Contra Costa Goldfields	Endemic	39,760 (Historic Vernal Pool Soils)	7,540	85–95% of current distribution	7,140	85–95% of current distribution	890	6,250	2,610
Valley Floor Grassland	Widespread	249,420	115,340	20%	49,880	43%	16,540	33,340	13,730
Oak Woodland/ Oak Savanna	Widespread	73,850	36,910	20%	14,770	40%	7,180	7,590	19,610
Chaparral/Scrub	Widespread	47,250	11,260	20%	9,450	84%	1,880	7,570	9,280
California Red-Legged Frog	Widespread	155,800	31,520	20%	31,160	99%	8,320	22,840	8,700
Callippe Silverspot Butterfly	Peripheral	29,640	35,240	10%	2,970	8%	6,140	--	6,290
Riparian Vegetation	Widespread	34,720	3,600	20%[4]	720[5]	20%	280	720[5]	200
Giant Garter Snake Habitat (Tule Marsh)	Peripheral	52,190	5,870	10%	5,220	89%	1,100	4,120	10
High-Elevation Tidal Marsh	Restricted	62,990 (1999 SFEI EcoAtlas)	9,840 (1999 SFEI EcoAtlas)	40%	25,200	256%	5,720	4,125 plus 15,352 of restoration	9,840

[1] See Table 4.8 for definitions of distribution types.
[2] Historic distributions were based on Kuchler's (1977) map of the natural vegetation of California, unless stated otherwise.
[3] Current distribution based on vegetation mapping conducted for the Solano HCP/NCCP, unless stated otherwise.
[4] Conservation Target is the percentage of the current distribution of riparian vegetation to be restored.
[5] Acres of riparian vegetation to be restored.

ac = acres
HCP = Habitat Conservation Plan
NCCP = Natural Community Conservation Plan
SFEI = San Francisco Estuary Institute

goldfields, since the uplands are not occupied. Currently occupied habitat represents approximately 36 percent of its current potential range (42 percent if non-vernal pool valley floor grassland habitat is included) and 16 percent of its potential historic range (19 percent if non-vernal pool valley floor grassland habitat is included).

Given that a 40 percent conservation target is no longer practicable for Contra Costa goldfields, the next logical approach for developing a conservation target for this species is to use the recovery targets set in the Vernal Pool Recovery Plan developed by the USFWS (2005a). The Recovery Plan identifies two distinct recovery targets: one to preserve a certain percentage of occurrences, and the other to preserve a certain percentage of suitable species habitat within designated core areas.

The Vernal Pool Recovery Plan sets a conservation target of protecting 90 percent of known Contra Costa goldfields occurrences, where occurrence is defined as "an occupied area at least 0.4 kilometers (km) (0.25 mi) away from the next occupied area" (USFWS 2005a). Based on the USFWS definition of occurrence, eight extant Contra Costa goldfield occurrences are known within Solano County. However, in urban areas, locations isolated by existing development and roads also need to be included when defining an occurrence. Combining multiple Contra Costa goldfield records that are within a 0.25 mi of each other results in one large occurrence in northeast Fairfield that is better separated into three occurrences because they are isolated from each other by existing development and roads. Therefore, Subareas 1B, 1D, and 1E, though within 0.25 mi of each other, are considered separate occurrences (Figure 4-5), thereby making a total of 10 Contra Costa goldfield occurrences within the Plan Area. To meet a conservation target of 90 percent, 9 of these 10 known occurrences would need to be protected.

Two Core Recovery Areas are located within the range of Contra Costa goldfields in the Plan Area: the Jepson Prairie Core Recovery Area and the Suisun Marsh Core Recovery Area. The conservation target for the Jepson Prairie Core Recovery Area is protection of 95 percent of suitable species habitat; and the conservation target for the Suisun Marsh Core Recovery Area is protection of 85 percent of suitable species habitat. Within Solano County, seven geographically distinct subareas containing Contra Costa goldfields have been identified (see Appendix B and Figure 4-5). Five of these core population areas fall within the Jepson Prairie Core Recovery Area and two fall within the Suisun Marsh Core Recovery Area. The 95 percent and 85 percent conservation targets[1] were applied to these areas assuming that they represent the remaining suitable habitat for Contra Costa goldfields within each Core Recovery Area. Table 4.10 lists the conservation target for each Contra Costa Goldfields Conservation Area based on the 95 percent and 85 percent recovery criteria.

4.5.2.3 Valley Floor Grassland

Valley floor grassland is more widespread than the vernal pool ecosystem subcomponent and is largely dominated by introduced annual grasses. Based on the definition of a widespread community, valley floor grassland contains species or vegetation communities that are distributed widely in several ecoregions. As a widespread habitat type, the conservation target for valley floor

[1] The Vernal Pool Species Recovery Plan (USFWS 2005a) provides for adjusting conservation objectives/ alternative conservation mechanisms under regional HCPs provided certain criteria are met.

Table 4.10: Conservation Targets for Contra Costa Goldfields

CCGF Conservation Area	Total Potential Habitat Area (acres)[1]	Conservation Target (%)	Conservation Target (acres)[1]
Subarea 1B - McCoy Basin Core Area	610	95	580
Subarea 1C – Upper Union Creek Core Area	1,380	95	1,310
Subarea 1D – Vanden Core Area	100	95	95
Subarea 1E – Walters/Air Base Parkway Core Area	170	95	160
Subarea 1F – Lower Union Creek	4,990	95	4,740
Subarea 1G – Ledgewood Creek	280	85	240
Subarea 1H – Cordelia	15	85	13
Total	**7,545**	**N/A**	**7,138**

[1] Acres include vernal pool grasslands, surrounding non-vernal pool valley floor grasslands, and open water habitat within each subarea.

CCGF = Contra Costa goldfields

N/A = not applicable

grassland is 20 percent (Table 4.8). The historic distribution for the valley floor grassland community is based on the distribution of "California Prairie" classified by Kuchler (1977). Kuchler (1977) identifies roughly 249,420 ac of potential California Prairie in Solano County, resulting in a conservation target of 49,880 ac. Based on vegetation mapping conducted for the Solano HCP (see Section 3.3.1), approximately 115,340 ac of valley floor grassland, or roughly 46 percent of historical California Prairie, remain in Solano County. To achieve the 20 percent conservation target of 49,880 ac, 43 percent of the remaining valley floor grassland would need to be preserved. Within the County, approximately 16,540 ac are currently protected (Table 4.9); therefore, an additional 33,340 ac would need to be protected.

Unfortunately, the current valley floor grassland classification does not correspond to the historic California Prairie habitat defined by Kuchler (1977). Most of the land classified as valley floor grassland is regularly cultivated but nevertheless retains many of its ecosystem functions and provides important habitat for wildlife, thus it is worth preserving. The vernal pool grassland community, a subset of the valley floor grassland, is likely the closest remaining habitat type to what was historically considered California Prairie, and even this region is dominated by introduced annual grasses and forbs. As a result, the majority of the valley floor grassland conservation target will consist of vernal pool grassland (47,000 ac out of approximately 50,000 ac, or roughly 95 percent). Additional conservation efforts will focus on native grassland restoration.

4.5.3 Inner Coast Range

The Inner Coast Range consists of a mosaic of habitat types: oak woodland, oak savanna, mixed chaparral/scrub, and grassland. A conservation target was not developed for the Natural Community as a whole but was developed for individual vegetation types (i.e. oak woodland and chaparral/scrub). The entire area recognized in the Solano HCP as the Inner Coast Range was historically dominated by blue oak-foothill pine forest, mixed hardwood forest, chaparral, and coastal prairie-scrub mosaic (Figure 3-3) as identified by Kuchler (1977). For this analysis, the historic distribution of oak woodlands in the Plan Area were determined by combining areas of blue oak-foothill pine forest and mixed hardwood forest identified by Kuchler (1977). The current distribution of this habitat type was determined by combining the oak woodlands and oak savanna

habitat mapped for the Solano HCP. Oak savanna habitat functions differently from dense stands of oak woodlands, but still provides significant habitat value to wildlife and has the potential for restoration. The historic distribution of chaparral/scrub habitat mapped for the Solano HCP was based on the area identified as chaparral and coastal prairie-scrub mosaic (Kuchler 1977; Figure 3-3).

Both the oak woodland and chaparral/scrub vegetation types were classified as widespread, occurring in several different regions throughout California. In addition, species occurring in both oak woodland and chaparral/scrub habitat are distributed relatively equally over several ecoregions. For example, raptor species dependent on the woodland resources within the Plan Area, such as Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter striatus*), and golden eagle (*Aquila chrysaetos*), have very widespread distributions. Additionally, most of the reptile and mammal species associated with these two habitat types, such as western fence lizard (*Sceloporus occidentalis*), western skink (*Eumeces skiltoneanus*), gopher snake (*Pituophis catenifer*), dusky-footed woodrat (*Neotoma fuscipes*), and western gray squirrel (*Sciurus griseus*), have widespread distributions.

As widespread habitat types, the conservation targets for oak woodland/oak savanna and chaparral/scrub communities were set at 20 percent of the historic distribution of each community within the Plan Area (Table 4.8). Based on Kuchler's (1977) map of the natural vegetation of California (Figure 3-3), historically, 73,845 ac of oak woodland habitat were located within Solano County. Presently, 36,910 ac of oak woodland/oak savanna habitat remain. To achieve a conservation target of 20 percent of the historic distribution of oak woodland habitat, 40 percent (14,770 ac) of the current oak woodland/oak savanna habitat in the County would need to be preserved (Table 4-9). Approximately 7,180 ac of oak woodland/oak savanna are currently protected (Table 4.9); therefore, an additional 7,590 ac of this vegetation type would need to be protected. Kuchler's (1977) map of potential natural vegetation does not differentiate or identify an oak savanna type for Solano County. As such, this conservation target analysis tends to underestimate the conservation needs for oak savanna, which is a far more imperiled community in Solano County as well as statewide. Focusing oak woodland/savanna conservation efforts on Moderate to Very High risk categories as shown on Figure 3-12 would focus conservation on preserving a substantial portion of the 9,200 ac of oak savanna in Solano County.

Based on Kuchler's (1977) map of the natural vegetation of California (Figure 3-3), 17,610 ac of chaparral and 29,640 ac of coastal prairie-scrub mosaic were located within Solano County. Presently, 11,260 ac of chaparral/scrub habitat remain. To achieve a conservation target of 20 percent of its historic distribution, 84 percent (9,450 ac) of the current chaparral/scrub habitat in the County (Table 4-8) would need to be preserved. Approximately 1,880 ac of chaparral/scrub habitat are currently protected (Table 4.9); therefore, an additional 7,570 ac of this vegetation type would need to be protected.

4.5.4 California Red-Legged Frog

Before the settlement of Europeans on the west coast, the California red-legged frog was probably common throughout the Coast Range and the northern Central Valley (Zeiner et al. 1988; Jennings and Hayes 1985; Hayes and Krempels 1986). Historic records of this frog occur on the floor of the Central Valley, but these populations likely did not persist due to extensive flooding during heavy winter storms or spring snowmelt (Fellers 2005). In Solano County, California red-legged frog likely occupied the drainages within the Inner Coast Range with populations extending into parts of

the valley floor, particularly within the riparian forest areas of Solano County. For this analysis, the historic range was determined using habitat historically mapped as chaparral, coastal prairie-scrub mosaic, blue oak-foothill pine forest, mixed hardwood forest, and riparian forest (Kuchler 1977). This historic distribution totals 155,800 ac and corresponds to the area in the Solano HCP classified as the Inner Coast Range, with an addition of the riparian forest area along Putah Creek. The current distribution encompasses the Jameson Canyon and Lake Berryessa Core Recovery Areas for California red-legged frog, totaling approximately 31,520 ac.

As a widespread species, a 20 percent conservation target was established for California red-legged frogs. To achieve the 20 percent conservation target, 31,160 ac, or 99 percent of the Core Recovery Areas identified in the USFWS Recovery Plan, would need to be preserved. Approximately, 8,320 ac are currently protected; therefore, an additional 22,840 ac would need to be preserved. The largest threat to the persistence of California red-legged frog in the Plan Area is the spread of introduced predators and competitors. Even if the conservation target is achieved, these conservation lands must be properly and actively managed to extirpate populations of invasive species and prevent their invasion into adjacent habitat areas in order to ensure the long-term viability of the California red-legged frog population.

4.5.5 Callippe Silverspot Butterfly

The historic range of the callippe silverspot butterfly encompassed the Inner Coast Range on the eastern shore of San Francisco Bay, from northwestern Contra Costa County to the Castro Valley in Alameda County. On the west side of San Francisco Bay, it ranged from San Francisco south to La Honda in San Mateo County. Currently, extant colonies are known only from San Bruno Mountain in San Mateo County, a city park in the Oakland Hills in Alameda County, and the hills between Vallejo and Cordelia in Solano County.

The status, distribution, and population levels of the callippe silverspot butterfly in Solano County are largely unknown. Western Solano County is an area of overlap and intergradation of the characters that distinguish three subspecies: *callippe callippe*, *callippe comstocki*, and *callippe liliana* (Noss et al. 2002). The darker color morph, representative of *callippe callippe,* occurs less frequently among populations from southwestern Solano County than those from San Bruno Mountain (San Mateo County), and more frequently than it occurs among populations of the other subspecies (*callippe comstocki* and *callippe liliana*). Most populations in Solano County exhibit the higher frequency of the darker color morph; therefore, USFWS treats these populations as the listed subspecies *callippe callippe* at least until additional taxonomic work proves otherwise (USFWS 1997). Based on the known distribution of this species in Solano County, it was classified as being peripheral; meaning that less than 10 percent of its total distribution falls within the Plan Area. Most of the conservation efforts for this species are happening in other portions of its range (e.g., San Bruno HCP in San Mateo County).

Habitat for the callippe silverspot butterfly is grassland, often with a significant component of native grasses, and characterized by shallow rocky soils or numerous rock outcrops. For the subspecies *callippe callippe*, the darker coloration, which is a distinguishing characteristic, is speculated to be an adaptation to living in foggy areas (such as San Francisco and southwestern Solano County) enabling them to warm up more quickly on foggy days. Fog is an important environmental factor in California coastal prairie grassland systems (Corbin et al. 2005); therefore, coastal prairie-scrub mosaic, mapped by Kuchler (1977), was likely the extent to which fog was a strong environmental factor shaping the ecological community. For this analysis, the historic

distribution of callippe silverspot butterfly is assumed to encompass the southwestern portion of the Inner Coast Range mapped by Kuchler (1977), as coastal prairie-scrub mosaic, or 29,640 ac. As a peripheral distribution type with a conservation target of 10 percent, the acreage conservation target for callippe silverspot butterfly in the Plan Area is approximately 2,970 ac.

The current distribution of this species in Solano County is likely confined to the hills between Vallejo and Cordelia (i.e., the Tri-City/County Planning Area). However, additional potential habitat for this species occurs in Nelson Hill in Cordelia and the Rockville Hills, although no records occur from these areas (Figure 4-13). The current distribution corresponds to roughly 28,570 ac of potential habitat with an additional 6,220 ac of upland grassland habitat preserved within the Conservation Area. The current distribution for this species is more widespread than it was historically based on Kuchler's vegetation map (i.e., the area mapped by Kuchler [1977] as mixed hardwood forest in the hills between Vallejo and Cordelia, which is now dominated by introduced annual grassland), indicating that the 10 percent conservation target has already been achieved. However, the *callippe callippe* subspecies may not occupy all of this area, and environmental conditions may not be suitable to sustain a higher frequency of the darker color morph. In addition, only one of the three known occurrences of this species are preserved, the other two known occurrences fall within the UGB of Vallejo and are under high risk of development (Figure 3-12). Additional conservation is needed to protect remaining known occurrences of this species within their historic range.

4.5.6 Riparian, Stream, and Freshwater Marsh

The Riparian, Stream, and Freshwater Marsh Natural Community provides food, cover, breeding sites, and water for a diversity of wildlife. Overall, riparian or streamside vegetation provides important habitat for over 225 species of fish, amphibians, reptiles, birds, and mammals in California (RHJV 2000). Riparian habitats are considered to be particularly valuable for neo-tropical migratory songbirds, and function as important corridors between coastal (or bayshore) marsh habitats, floodplains, upland grasslands, and oak woodlands. Despite the high species diversity found in riparian areas, the average range size of the species that occupy this habitat is widespread (e.g., neo-tropical migratory songbirds). In addition, the dominant plant species that comprise this Natural Community are also widespread. Riparian vegetation is classified as having a widespread distribution with a conservation target of 20 percent. Riparian vegetation makes up a relatively small portion of the total acreage of the Plan Area, and the occurrences are widely separated, but the species and vegetation communities, characteristic of riparian areas, are widely distributed.

The methods used to calculate conservation targets for vernal pools and oak woodlands could not be applied to this habitat type because the historic distribution of riparian vegetation could not be accurately calculated. The only riparian forest mapped by Kuchler (1977) occurred along Putah Creek, with a large riparian forest floodplain extending southeast towards Dixon (Figure 3-3). Historically, riparian vegetation was likely more extensive throughout Solano County than is depicted by Kuchler (1977) and more extensive within the Plan Area than it currently is. Based on Kuchler's (1977) map, 34,720 ac of riparian forest historically existed along Putah Creek, currently only 694 ac of riparian vegetation remain in this same area, representing a 98 percent loss of this habitat type. To achieve the 20 percent conservation target, 6,940 ac of riparian habitat would need to be preserved; however, only 690 ac are left to be preserved. Currently 3,430 ac of riparian vegetation exist throughout the Plan Area. Preservation of all these lands would not be sufficient to

meet the 20 percent conservation target; therefore, approximately 3,500 ac of riparian vegetation would need to be restored (Table 4.9).

Rather than preservation, the conservation target for riparian and stream habitat is to restore or enhance 20 percent of the existing 3,430 linear miles of streams within the Plan Area, roughly 685 linear miles of stream habitat (Table 4.9). For riparian vegetation, the conservation target aims to increase the extent of riparian vegetation within the Plan Area by 20 percent of current levels (3,600 ac), resulting in an additional 720 ac of riparian vegetation within the Plan Area.

4.5.7 Giant Garter Snake

The giant garter snake historically inhabited wetlands in the Central Valley of California (USFWS 1999b) and currently occupies a variety of agricultural, managed, and natural wetlands including their waterways and adjacent upland habitats. Based on a visual assessment of potentially suitable habitat (aquatic habitats with some emergent and bank vegetation), many of the Plan Participants' irrigation and flood control facilities in eastern Solano County appear to provide suitable habitat for giant garter snake (Figure 4-18). However, a more refined habitat model indicates that the extent of higher quality habitat for the giant garter snake encompasses the lower portions of Putah, Ulatis, and Alamo Creeks, Hass Slough, the tidally influenced portions of RD 2068 drains that empty into Hass Slough and Duck Slough, some of the interconnected irrigation canals and ditches, and the associated Delta sloughs in southeastern Solano County (LSA 2004a; Figure 4-18). The area identified as potentially supporting giant garter snakes (Figure 4-18) corresponds to the historic distribution of tule marsh habitat mapped by Kuchler (1977), minus Suisun Marsh (Figure 3-3). This area in southeastern Solano County historically supported giant garter snakes prior to agricultural development. Therefore, the historic distribution of tule marsh, representing the historic distribution of giant garter snake habitat as well, was used to calculate the conservation target for this species.

Based on Kuchler (1977), the entire Central Valley of California was dominated by tule marshes, roughly 1,894,260 ac. Based on this information, the distribution type for this vegetation type and for giant garter snake, which is so closely associated with it, would likely be classified as restricted, occurring primarily within one ecoregion: the Central Valley. Out of 1,894,260 ac of historic tule marsh mapped by Kuchler (1977), only 58,670 ac (approximately 3 percent) fall within Solano County, a small percentage compared to Sacramento, Yolo, and San Joaquin Counties, which historically contained 8 percent, 10 percent, and 12 percent, respectively, of the historic tule marsh in California. Additionally, the historic distribution of tule marsh occupies less than 10 percent of the Plan Area, as opposed to 26 percent, 27 percent, and 31 percent for Sacramento, San Joaquin and Yolo Counties, respectively. Because only a small portion of this habitat type and therefore the historic range of giant garter snake occurs within the Plan Area, the distribution of giant garter snake is defined as peripheral, with a conservation target of 10 percent (Table 4.8).

Historically, 58,670 ac of tule marsh were located within the Sacramento-San Joaquin River Delta of Solano County (i.e., within the historic range of the giant garter snake). To achieve the 10 percent conservation target, 5,867 ac of remaining aquatic habitat would need to be preserved for this species. Currently, 5,520 ac of aquatic habitat occur within the historic range, including riparian vegetation (710 ac), open water (4,480 ac), and remaining marsh habitat (330 ac). The 10 percent conservation target of 5,870 ac exceeds the amount of aquatic habitat remaining within these areas; therefore, an additional 350 ac of aquatic habitat would need to be created to meet the conservation target. Existing aquatic habitat for giant garter snake is significantly different from the

historic tule marsh habitat classified by Kuchler (1977). In addition to the creation of 350 ac of aquatic habitat, habitat restoration and enhancement would be required within existing areas to achieve its historical levels of productivity and value for giant garter snake.

4.5.8 Coastal Marsh

Coastal salt marsh is a highly "productive" plant community consisting of plants that are tolerant of saline soils and regular tidal inundations. Coastal salt marsh is restricted to the upper intertidal zone of protected shallow bays, lagoons, and estuaries. For this analysis, coastal salt marsh or tidal marsh habitat has been classified as a restricted distribution type (Anderson et al. 1999; Marshall et al. 2000) with a conservation target of 40 percent (Table 4.9).

The SFEI, as part of the EcoAtlas project, mapped the historic and current extent of vegetation types throughout the San Francisco Estuary. Historically, approximately 62,990 ac of high elevation tidal marsh occurred within the Plan Area (Goals Project 1999), resulting in a conservation target of 25,200 ac. Presently, only 9,840 ac of high elevation tidal marsh remain within the Plan Area, corresponding to 16 percent of historic tidal marsh. The majority of existing marsh habitat consists of managed wetlands. Substantial restoration, including a 24 percent increase in marsh habitat (15,350 ac), and preservation of remaining marsh habitat would be required to achieve the 40 percent conservation target (Table 4.8).

The CALFED Bay-Delta Program and the Suisun Marsh Conservation Plan established marsh restoration targets within the Plan Area. The 2000 CALFED Record of Decision (ROD) called for the creation of an additional 5,000 to 7,000 ac of tidal wetlands in Suisun Marsh. Based on these restoration targets, the conservation target for tidal marsh habitat in Solano County would be between 24 percent and 27 percent (14,800 to 16,800 ac). Although restoration of tidal marsh habitat is difficult to achieve, once the conservation target is reached, an additional 8,000 ac of marsh habitat may be restored.

4.5.9 Swainson's Hawk

The historic range of nesting Swainson's hawks in California was widespread and included the Southern Transverse Ranges, Central Coast Ranges, Central Valley, Great Basin, and Mojave-Colorado Desert (Bloom 1980). These regions included desert, shrubsteppe, grassland, agricultural, canyon, foothill, and interior valley habitats. Today, Swainson's hawks are still locally common in the Central Valley and the Great Basin (Woodbridge 1998), with populations centered in Sacramento, San Joaquin, Yolo, and eastern Solano Counties. Populations also remain within Butte Valley, the Klamath Basin, Antelope Valley (Los Angeles County), Owens Valley, Lassen County, and the east side of the Sierra Nevada.

The Swainson's hawk population within the Plan Area is primarily dependent on the irrigated agricultural resources of central and northeastern Solano County. The highest nest densities and the majority of Swainson's hawk records are found in this region of the County. As a result of the Swainson's hawk dependency on irrigated agricultural land as a foraging resource, the species-area relationship model could not be applied to develop a conservation target for Swainson's hawk because agricultural lands do not have a naturally occurring "historic" distribution. In addition, because of the lack of substantial data available for this species, a population viability analysis (PVA), another method used for setting conservation goals for target species, could not be used.

Since the quantitative methods for setting Natural Community conservation targets or PVA are not appropriate for this species at this time, a qualitative assessment has been made based on expert opinion and the known needs of the species. Members of the Swainson's hawk technical advisory committee and the Solano HCP Science Advisors believe that maintenance of the current population levels in the County (estimated to be 120 to 130 pairs) should be the recovery priority. Maintaining the long-term viability of this population of Swainson's hawks will require conservation of the majority (likely on the order of 80 to 90 percent or 100,000 to 110,000 ac) of agricultural lands in appropriate crop types (i.e., alfalfa, tomatoes, other specific row crops) in reasonable proximity to nest sites (M. Bradbury, pers. comm.[1]). If these lands and current crop patterns are maintained, the Swainson's hawk population will likely remain at its current level, and may rise to a level that meets recovery standards.

In addition to the conservation of agricultural resources, conservation of the Valley Floor Grassland and Vernal Pool Natural Community and lower-lying grassland communities associated with the Inner Coast Range Natural Community will also benefit Swainson's hawk populations. Therefore, conservation targets set for these two habitat types also apply to Swainson's hawks.

4.5.10 Burrowing Owl

Like the Swainson's hawk, burrowing owl conservation is tied to the preservation of open agricultural lands. Therefore, estimating conservation targets based on the species-area relationship model is difficult, and little data are available for the parameterization of a PVA. As a result, no quantitative or qualitative methods exist for estimating a conservation target for burrowing owl within the Plan Area. However, the conservation of irrigated agricultural lands for Swainson's hawk also provides habitat protection for burrowing owls. Burrowing owls use a variety of natural habitats, including Valley Floor Grassland and Vernal Pool habitats, and the grasslands and oak savanna habitat within the Inner Coast Range. Any of these habitat types can support burrowing owls if burrows are available for cover and nesting and the prey are present. As such, the conservation targets developed for these natural communities also apply to burrowing owls.

4.6 RESERVE DESIGN AND CONSERVATION APPROACH

The results of the Conservation Analysis (Sections 4.3 and 4.4), Risk Analysis (Section 3.6), Conservation Targets (Section 4.5) and the Reserve Design Principles (Section 4.2) combine to form an overall vision for the design of reserves in the Plan Area and specific reserve design criteria for each Natural Community. Based on the species-area relationship curve and distribution types (Table 4.8), Section 4.3 identifies conservation targets for each Natural Community to capture the diversity of species throughout the Plan Area. To maintain species diversity, the reserve system must also incorporate the reserve design principles outlined in Section 4.2.

The key to fulfilling the overall reserve design vision is to maintain existing habitat either through protection of these areas in preserves/reserves or preservation of existing land uses. Working farms and ranches provide several thousands of acres of valuable habitat for Covered Species.

[1] Michael Bradbury, Solano HCP Science Advisor, California Department of Water Resources, personal communication with Steve Foreman, Principal, LSA Associates, Inc. (2009).

Maintaining the economic viability of these farms and ranches should be an objective of the HCP. Based on a biosphere reserve design model, lands managed for a range of uses from complete protection to sustainable agricultural production are important for achieving long-term conservation goals.

4.6.1 Valley Floor Grassland and Vernal Pool Natural Community

As described in Section 4.3, the Valley Floor Grassland and Vernal Pool Natural Community has been divided into low, medium, and high value conservation categories (Figure 4-8) based on the key conservation elements identified in Section 4.3.2.2. The Conservation Strategy (Chapter 5.0) uses these categories to establish mitigation ratios for the entire Natural Community. This section focuses primarily on the reserve design and conservation approach for vernal pool grasslands.

Vernal pool grassland habitat within the High and Medium Value Conservation Areas were separated into four categories based on their restoration and management needs, including: (1) conservation areas with high preservation potential, (2) conservation areas with high preservation and restoration potential, (3) Contra Costa goldfield potential reserve areas, and (4) potential outlier areas (Figure 4-26). Conservation areas with high preservation potential correspond to minimally disturbed vernal pool grasslands (Figure 4-4). Conservation areas with high preservation and restoration potential correspond to moderately to highly disturbed vernal pool grasslands and some agricultural lands on historic vernal pool soils. The degree to which preservation and/or restoration applies to individual sites will vary with the level of disturbance. Some of these areas may also contain transition habitat between Natural Communities and unique habitat features. Contra Costa goldfield potential reserve areas correspond to the core population areas for Contra Costa goldfields and surrounding watershed lands identified in Figure 4-5. These areas were distinguished from the previous two categories because several of these areas contain small isolated parcels that will require special management and restoration. Potential outlier areas represent isolated patches of vernal pool grassland habitat within the agricultural lands of the Plan Area. These areas will be considered as potential reserves if they are found to contain unique habitat features, rare or range limited species, or genetically distinct population segments of Covered Species. These areas would also require special management and restoration due to their relatively small size and isolation.

Reserve Design Principle 15 identifies restoration as an important component of the Solano HCP reserve system. In addition, Section 4.5 (Conservation Targets) identifies the need for considerable restoration of existing vernal pool grasslands to achieve its historical levels of productivity and value, even though sufficient habitat remains to meet the 40 percent conservation target. The conservation measures outlined in the Conservation Strategy (Chapter 5.0) include restoration to mitigate for impacts to vernal pool habitat. Restoration efforts should occur adjacent to existing high quality preserves in order to contribute to the overall value of the reserve system and increase the potential for successful restoration. Figure 4-26 identifies the appropriate location for preservation and restoration efforts necessary to properly implement the reserve design principle.

Reserve Design Principle 14 identifies long-term management or stewardship as critical to maintaining the biological values of preserved lands. All reserves and preserves established under the Solano HCP will be required to implement long-term management plans. However, some reserves, particularly those established to preserve isolated populations of extremely rare or range-limited species, will have special management needs due to their small size and proximity to incompatible land uses such as urban development and agriculture. Both the Contra Costa goldfield

conservation areas and potential outlier reserve areas may have special management requirements. These special management requirements will be considered during the development of the reserve's Resource Management Plan (see Chapters 7.0 and 10.0).

4.6.2 Inner Coast Range

The conservation target for oak woodland/oak savanna/chaparral/scrub habitat is roughly 24,000 ac. Of the 48,000 ac of existing habitat, 9,000 ac are currently protected, and an additional 28,900 ac are within the low risk category (Table 4.8), encompassing roughly 79 percent of the total habitat and 120 percent of the conservation target. However, to meet other reserve design principles (Section 4.2) for preserving corridor habitat, a range of environmental conditions, transition areas, and areas of high diversity, roughly 8,000 ac of oak woodland/oak savanna habitat at lower elevations within the moderate to very high-risk classes would also need to be preserved. Since the majority of the habitat is at low risk, conservation efforts should be directed towards preserving oak woodland/oak savanna habitat within corridor areas at lower elevations and within moderate to very high risk classes. This strategy meets the additional reserve design criteria and provides for preservation of a range of community conditions (e.g., vegetation cover and interspersion, soils, elevation, and topography).

The Inner Coast Range conservation approach focuses on: avoiding and minimizing impacts to sensitive areas, such as key watershed lands and areas occupied by Covered Species; enhancing existing preserves through restoration and adaptive management; and, if funding from governmental agencies of nongovernmental organizations becomes available, protecting additional Inner Coast Range habitat that provides important corridors between Natural Communities. Priorities for acquisition include California Red-Legged Frog and Callippe Silverspot Butterfly Conservation Areas and, if resources permit, linkages and corridor habitats in the Vacaville/Fairfield Green Belt and between the English Hills and Valley Floor Grassland and Vernal Pool High Value Conservation Subarea 1K (the hardpan pools near Vacaville).

4.6.3 California Red-Legged Frog

In 2002, the USFWS published a recovery plan for the California red-legged frog that designated core recovery areas throughout the species' current and historic range. The core recovery areas represent a system of areas that, when protected and managed, will allow for long-term viability of existing populations and reestablishment of populations within the historic range (USFWS 2002a). Portions of two core recovery areas fall within Solano County: the Jameson Canyon-Lower Napa River Core Recovery Area (27,270 ac, located in the hills west of Green Valley and into the Tri-City/County Planning Area), and the Lake Berryessa Tributaries Core Recovery Area (4,253 ac, located in the extreme northwestern corner of Solano County, in the area of the University of California's Stebbins Cold Canyon Preserve) (USFWS 2002a; Figure 4-15).

Section 4.5.4 identifies a conservation target of 20 percent (31,160 ac) of the historic range of California red-legged frog within Solano County, approximately 99 percent of the Core Recovery Areas established in the Recovery Plan (USFWS 2002a). The Tri-City and County Cooperative Plan for Agriculture and Open Space Preservation aims to protect approximately 10,000 ac of open space among the Cities of Benicia, Fairfield, and Vallejo in Solano County, falling within the Jameson Canyon-Lower Napa River Core Recovery Area. Currently, 6,842 ac of land are protected. In addition, 8,700 ac fall within the Secondary Marsh Management Zone of the Suisun

Marsh Protection Plan (i.e., falls within a very low risk category; Figure 3-12). Within the Lake Berryessa Tributaries Core Recovery Area, 1,596 ac are protected within existing preserves and reserves, and the remaining area is zoned as watershed land (i.e., falls within a very low risk category; Figure 3-12). If the Tri-City County Open Space Joint Powers Authority (JPA) is able to protect 10,000 ac, a total of 24,500 ac of land within both Core Recovery Areas would either be protected within reserves/preserves or in very low risk areas, achieving close to 79 percent of the conservation target identified in Section 4.5.4. However, none of this habitat is being managed for California red-legged frogs.

The network of reserves currently being developed by the Tri-City County Open Space JPA, in conjunction with the Solano Land Trust, meets the following Solano HCP Reserve Design Principles (see Section 4.2):

- Preserve large blocks of habitat (1[1])
- Conserve target species throughout the Plan Area (2)
- Prioritize habitat with high conservation value at high risk of being developed (3)
- Incorporate a range of environmental gradients (4)
- Preserve blocks of habitat close together (7)
- Preserve ecotone and transition areas (11)
- Minimize human disturbance (13) (see Section 4.2 for details)

To add to the overall quality and value of the existing reserve network, the Conservation Strategy for the Solano HCP focuses on addressing the additional reserve design principles:

- Protecting regional water quality (5)
- Maintaining connectivity (6)
- Incorporating sufficient buffer zones between reserves and new development (8)
- Minimizing edge effects (9)
- Incorporating adaptive management and monitoring (14)
- Restoring and creating additional habitat within preserve areas (15)

The overall strategy for the recovery of the California red-legged frog as identified in the Recovery Plan (UFWS 2002a) involves:

- Protecting existing populations by reducing threats;
- Restoring and creating habitat that will be protected and managed in perpetuity;
- Surveying and monitoring populations and conducting research on the biology and threats of the subspecies; and
- Re-establishing populations of the subspecies within its historic range.

The overall conservation approach for California red-legged frog addresses both the reserve design principles outlined in Section 4.2 and the overall recovery strategy identified in the Recovery Plan. Existing populations will be protected through avoidance and minimization measures, and preventing the expansion of invasive exotic predators (e.g., bullfrog, crayfish, and warm water fish species) into currently undeveloped and unoccupied areas. Passive control of invasive species includes conservation measures to avoid creating perennial ponds, small lakes, and excess urban

[1] Numbers correspond to the Reserve Design Principles in Section 4.2.

runoff leading to the "perennialization" of intermittent creeks. Implementation of the conservation measures will also result in the creation and restoration of additional breeding habitat within the Core Recovery Area that will be managed for the benefit of California red-legged frog.

4.6.4 Callippe Silverspot Butterfly

The overall conservation goal for the callippe silverspot butterfly is to preserve multiple populations in secure core areas and provide connectivity between these preserved areas. The conservation approach for callippe silverspot butterfly is to permanently protect existing butterfly populations where they occur (primarily through avoidance and minimization), minimize activities that could lead to the expansion of invasive plant species, and provide appropriate funding for land management to maintain and possibly improve the distribution and abundance of the larval host plant, Johnny jump-up.

Section 4.5.5 identifies a conservation target of 10 percent (2,965 ac) of the historic habitat for callippe silverspot butterfly. Currently 6,222 ac of habitat in the Callippe Silverspot Butterfly Conservation Area are preserved. However, not all of this habitat may be occupied by the species. Preserved lands do not contribute to the conservation and recovery of the species unless they are occupied and contain sufficient resources to maintain viable populations (i.e., large stands of the larval host plant, *Viola pedunculata*, and sufficient densities of adult nectar plants on ridgelines and hilltops for mating and dispersal purposes).

Limited information is available on the distribution and status of callippe silverspot butterfly in Solano County. As part of the Conservation Strategy, a population assessment involving appropriately timed surveys for adults and larvae will be conducted to help fill this data gap and prioritize conservation actions. If survey results identify additional occurrences within preserve lands, resources should be directed towards habitat enhancement within existing preserves to expand current populations. However, if no or limited additional occurrences are found, conservation resources should be directed towards preserving remaining known occurrences.

Acquisition priorities for callippe silverspot butterfly are the areas just northeast of Vallejo and other locations that support *Viola pedunculata* patches large enough to support callippe silverspot populations (Figure 4-13). Other key core areas and interconnecting ridgelines are already protected in the Kings and Swett Ranches Open Space Areas and have been identified as priorities for the reserve/preserve system because they fall within the UGB of Vallejo and are at high risk of development (Figure 3-12).

4.6.5 Riparian, Stream, and Freshwater Marsh

The conservation approach for this Natural Community involves preservation, restoration, invasive species control, and protection of water quality and hydro-geomorphic processes. Section 4.3.6.3 identifies Priority Drainages and Watersheds based on specific conservation criteria (Figure 4-10) and further subdivides them into specific conservation areas based on targeted conservation actions. These conservation actions define the overall conservation approach for the Riparian, Stream, and Freshwater Marsh Natural Community.

Due to the extensive loss of riparian and freshwater marsh vegetation, preservation is a key component of the conservation approach. Preservation of existing Riparian, Stream, and

Freshwater Marsh habitat will be accomplished primarily through habitat avoidance and minimization measures. Permanent impacts to Riparian, Stream, and Freshwater Marsh habitats will be mitigated either through preservation and enhancement of existing habitat or major restoration/creation of new in-kind habitat. Implementation of the conservation measures will result in a net increase in the quantity and quality of Riparian, Stream, and Freshwater Marsh habitat within the Plan Area.

Preservation and enhancement of existing habitats will occur within the Priority Drainages and Watersheds in Conservation Area RSM 1 (Figure 4-10). Major restoration or creation efforts, such as restoration of a two-stage floodplain corridor, will be targeted within Priority Drainages and Watersheds in Conservation Area RSM 3, including the stream reaches that meander through the alluvial fans, terraces, basins, and Delta marshlands of the County (Noss et al. 2002; Figure 3-2). Residential, commercial, and agricultural development has significantly altered the Riparian, Stream, and Freshwater Marsh habitat within this portion of Solano County. Urban development occurs on, or upslope, of the alluvial fans, terraces, and basins, and upslope of the Delta marshlands. The majority of the palustrine wetlands, floodplains, and riparian forests that historically bordered the larger rivers and adjacent sloughs and waterways in these areas have been drained and converted into farmland over the last century or more. Priority Drainages and Watersheds highlighted within Conservation Area RSM 3 represent the drainages within the alluvial fans, terraces, basins, and Delta marshland geographical provinces of the County that have been the least altered by residential, commercial, and agricultural development and have the highest restoration potential.

In general, the Solano HCP targets both the upper and lower reaches of Priority Drainages for preservation and restoration (Conservation Areas RSM 1 and 3). For example, Ulatis Creek, upstream of Gibson Canyon Road, falls within Conservation Area RSM 1; and the Old Ulatis Creek channel east of Leisure Town Road to the Vacaville UGB falls within Conservation Area RSM 3. Similarly, Alamo Creek from the confluence with Encinosa Creek and up, falls within Conservation Area RSM 1; and Old Alamo Creek east of Leisure Town Road to the Vacaville UGB falls within Conservation Area RSM 3 (Figure 4-10). The portions of Alamo and Ulatis Creeks between Conservation Areas RSM 1 and 3 fall within Conservation Area RSM 2. Riparian and stream habitat designated as Conservation Area RSM 2 represent key urban streams that provide connectivity between other high value conservation areas within Solano County.

The conservation approach for Conservation Area RSM 2 (i.e., riparian and stream habitat within and near urban areas) focuses on maintaining and enhancing the quality of the riparian corridor and protecting water quality and hydro-geomorphic processes. Much of the “riparian” habitat within and near cities (i.e., within Conservation Area RSM 2) is very narrow and characterized by nonnative trees and shrubs. Maintaining and enhancing the quality of the remaining riparian corridor will be accomplished through implementation of setbacks and buffer zones within new urban development projects, targeted revegetation of severely degraded areas, removal and control of aggressive invasive species, and removal of in-stream barriers to dispersal and migration. With restoration and control of invasive species, urban riparian vegetation, particularly along parts of Ulatis and Alamo Creeks, will provide important corridor habitat linking the Vaca Mountains to the valley floor. In addition, Plan Participants will develop and implement programs to remove in-stream barriers at existing facilities and prevent the creation of new in-stream barriers associated with development along the lower reaches of Jameson Canyon, Lynch Canyon, Ledgewood, Suisun, and Green Valley Creeks and their tributaries.

Maintaining water quality and hydro-geomorphic processes within Conservation Area RSM 2 primarily involves minimizing and mitigating for impacts resulting from new urban development upstream in Conservation Area RSM 1. Conservation measures include providing appropriate native vegetated buffers between development and stream corridors to protect water quality, avoid excessive erosion, and maintain base flood elevation and 24-hour storm event discharge, and minimizing impervious surface areas directly connected to storm drain systems. These conservation measures, in addition to National Pollutant Discharge Elimination System (NPDES) permit requirements established by the Regional Water Quality Control Board (RWQCB) to minimize non-point source pollution, are designed to maintain water quality and the natural hydro-geomorphic processes of Riparian, Stream, and Freshwater Marsh habitat throughout the Plan Area.

4.6.6 Giant Garter Snake

Giant garter snakes occur within the eastern Plan Area beyond the limits of urban expansion as identified in the HCP. Section 4.3.7.3 identifies the Giant Garter Snake Conservation Area. This area encompasses the lower portions of Putah, Ulatis, and Alamo Creeks, Hass Slough, the tidally influenced portions of the drains of RD 2068 that empty into Hass Slough and Duck Slough, some of the interconnected irrigation canals and ditches, and the associated Delta sloughs in the southeastern portion of the Plan Area (LSA 2004a; Figure 4-18).

Because suitable habitat for this species falls outside of anticipated urban expansion, primary concerns for this species involve indirect effects associated with increased urban runoff in downstream receiving waters and flood control channels, and direct impacts resulting from the operation and maintenance of Plan Participant facilities. Therefore, the main conservation approach for giant garter snakes is to implement avoidance and minimization measures to minimize these direct and indirect impacts. However, certain operation and maintenance activities, such as clearing waterways, cannot be accomplished during the time frames necessary for avoiding and minimizing impacts to this species (Conservation Measure GGS 3). To mitigate for the take of giant garter snakes resulting from routine operations and maintenance activities, Plan Participants will preserve and restore 95 ac of aquatic and associated upland habitat in the Giant Garter Snake Conservation Area (Figure 4-18). Conservation areas will be located to maintain interconnected blocks of habitat that support natural movement patterns, provide opportunities to reestablish populations in Solano County, and will be appropriately restored and managed to achieve historical levels of productivity and value for giant garter snakes.

4.6.7 Coastal Marsh

As described in Section 3.5, significant ongoing conservation efforts are directed toward estuarine marsh protection. CDFG owns and manages large portions of Suisun Marsh and the Napa Marshes in Napa and Solano Counties, and plans to restore these areas to tidal marsh for the purpose of endangered species restoration and recovery. USFWS owns and manages the majority of the tidal marshes fronting San Pablo Bay and plans to restore approximately 1,560 ac to tidal marsh. In the Delta region, CDFG owns and manages the Calhoun Cut Ecological Reserve that contains the upper portions of marsh and riparian habitats.

Because of public ownership in the Suisun Marsh, Southampton Marsh, and Napa and San Pablo Bay Marshes, combined with special regulatory restrictions governing Suisun Marsh, over

95 percent of the coastal marsh habitats in Solano County are protected from conversion to other land uses (Figures 3-10 and 4-20). The conservation approach for coastal marsh habitat focuses on avoiding and minimizing impacts associated with Covered Activities and facilitating ongoing conservation and restoration activities in marsh habitat within Solano County.

4.6.8 Swainson's Hawk

In this section, the conservation areas identified in Section 4.3.9.3 and conservation targets from Section 4.5.9 are further refined to identify potential reserve areas, criteria for agricultural reserves, and requirements for planting future nest trees.

4.6.8.1 Potential Reserve Areas

Based on specific reserve design criteria, the conservation areas identified in Section 4.3.9.3 were further refined to identify potential reserve areas, including Irrigated Agriculture, Valley Floor Grassland and Vernal Pool, and Inner Coast Range Potential Reserve Areas (Figure 4-27). These reserve areas were established because not all potential foraging habitats equally benefit Swainson's hawk conservation.

The majority of Swainson's hawk records are located within the irrigated agricultural areas in northeastern Solano County; therefore, the conservation approach for Swainson's hawk focuses on expanding and increasing the value of suitable foraging and nesting habitat within the Irrigated Agriculture Potential Reserve Area (Figure 4-27). As discussed in Section 4.5.9, recovery of the Swainson's hawk population (e.g., maintenance of their current population levels) estimates that 100,000 to 110,000 ac of agricultural lands need to be provided in appropriate crop types (i.e., alfalfa, tomatoes, other specific row crops). The Irrigated Agriculture Potential Reserve Area includes all irrigated agricultural land excluding areas within the UGBs of the Plan Participants, areas zoned for development under the 2008 General Plan Update (Solano County 2008) and areas below sea level. Exclusion of these areas, even those in proximity of a nest, was largely based on recommendations from CDFG. CDFG encourages cities to focus development within urbanized areas, since small disjunct parcels of habitat seldom provide the foraging habitat needed to sustain reproduction of Swainson's hawk pairs. Delta areas below sea level were also excluded based on the potential for loss of these areas as foraging habitat due to levee failures and subsequent long-term flooding.

The Valley Floor Grassland Potential Reserve Area includes portions of the Valley Floor Grassland Conservation Area (Figure 4-8), minus the wind resource area in the Montezuma Hills. Because wind turbines represent a potential source of Swainson's hawk mortality, lands within the existing Solano WRA, as well as proposed future WRA expansion lands, are excluded from the Valley Floor Grassland Potential Reserve Area. Habitat management within WRAs discourages raptor foraging near wind turbines; therefore, these lands should not be managed to enhance Swainson's hawk foraging habitat, nor should additional nest trees be planted within 2 mi of the WRA. The Inner Coast Range Potential Reserve Areas encompass key corridor areas between the valley floor and the Coast Range, the North Vacaville Corridor and the Vacaville-Fairfield Green Belt (see Section 4.3.1.1), and grassland habitat within the core recovery areas for California red-legged frog (Figure 4-14).

Not all foraging habitats equally benefit Swainson's hawk, so mitigation for impacts to habitat within the Irrigated Agriculture Conservation Area can occur only within the Irrigated Agriculture Potential Reserve Area. Mitigation for impacts to foraging habitat within the Valley Floor Grassland Conservation Area can occur within the Irrigated Agriculture or Valley Floor Grassland Potential Reserve Areas. Finally, mitigation for impacts to the Inner Coast Range Conservation Area can occur within the Irrigated Agriculture, Valley Floor Grassland, or Inner Coast Range Potential Reserve Areas.

4.6.8.2 Criteria for Establishment of Agricultural Reserves

The reserve design criteria for Swainson's hawks are different from the Reserve Design Principles (Section 4.2) and were established based on the needs of Swainson's hawks and on potential logistical issues associated with maintaining and managing agricultural reserves. Typical existing regional conservation strategies for Swainson's hawk have focused on providing a core, highly managed reserve system roughly equal in size to the impacted area addressed in the regional plan (e.g., ratios for existing or in-preparation regional conservation plans are 0.5:1 to 1:1). Using these previous conservation plans as a template, a core reserve system of 5,700 to 6,000 ac, which is approximately equal to the projected loss of irrigated agricultural lands under the HCP, is assumed.

To identify the best reserve design scenario under this conservation scenario, three conceptual, core reserve design models were evaluated:

1. **Several Small Reserve Design:** This model consisted of seventy-five 80 ac parcels/reserves dispersed throughout the Irrigated Agriculture Potential Reserve Area.
2. **Multiple Medium Reserve Design:** This model consisted of six 1,000 ac reserves dispersed throughout the Irrigated Agriculture Potential Reserve Area.
3. **Single Large Reserve Design:** This model consisted of one 6,000 ac reserve strategically centered in the Irrigated Agriculture Potential Reserve Area.

Of these conceptual reserve designs, the multiple medium reserve design was determined to most benefit Swainson's hawks. Several small reserves would be difficult to manage and monitor and would create a scattered pattern of reserves that might not be beneficial to foraging Swainson's hawks. The small size of each reserve would provide limited foraging opportunities due to similar planting, harvest, irrigation, and land disturbance patterns that would occur throughout the reserve. Swainson's hawk foraging activities typically track harvest activity; therefore, reserves with staggered planting, harvest, irrigation, and land disturbance patterns would be more beneficial for Swainson's hawk by providing them with temporally spaced foraging opportunities. The single large reserve design would concentrate protected habitat in one area, and would provide foraging for a limited number of hawks. The multiple medium reserve design would provide a number of larger reserves with a range of crop types and/or variable patterns of disturbance (harvest, planting, irrigation, etc.), thereby extending periods of high prey availability.

The logistical disadvantage to both the multiple medium and single large reserve designs is the practicability of obtaining large reserves (1,000 ac or larger). Typical parcel sizes in northeastern Solano County, within the Irrigated Agriculture Potential Reserve Area, range from 80 to 160 ac with few farming operations large enough to qualify as a medium or large reserve (less than1,000 ac). Since the reserve program under the Solano HCP relies on willing sellers to establish reserves, the most likely reserve design scenario lie somewhere between conceptual

designs 1 and 2, with most reserves ranging from 80 to 600 ac. However, larger reserves will be preferred over smaller reserves and would allow for a multiple range of crop types and disturbance patterns.

Given the unpredictability of size and location, minimum habitat criteria must be defined for a reserve to receive credit for Swainson's hawk conservation. These criteria are based on known foraging and nest-site requirements of the species, summarized in Appendix B. For a site to qualify as mitigation for impacts to Swainson's hawk habitat or as conservation lands (i.e., mitigation bank, conservation easement, habitat reserve), the following minimum criteria must be met:

- Reserves must contain crop types suitable for Swainson's hawk foraging, including in order of suitability: alfalfa, dry-land pasture, fallow fields, wheat, barley, oats, tomatoes, beets, beans, potatoes, and irrigated pasture (Estep and Teresa 1992). At least 50 percent of each reserve should be grown in alfalfa or other irrigated hay crops.
- Suitable nest trees must be located within 1 mi of the proposed reserve. Sites where nest trees are already present (i.e., on or immediately adjacent to the parcel under review) should receive higher priority for reserve designation. In addition, higher priority should be placed on sites within 2 mi of known Swainson's hawk nests to better serve existing nesting populations (2 mi being within the average home range of a nesting Swainson's hawk as measured by Estep [1989] and Babcock [1995]).
- Reserves should be a minimum of 80 ac in size [Note: Minimum reserve size is limited by parcel size] and should not exceed 1,000 ac to avoid concentrating too much foraging habitat into one area.
- No reserves should be established within 1 mi of existing or planned development to avoid future abandonment of nest territories due to increased human disturbance.
- No reserves should be established within 2 mi of existing or planned wind turbines to avoid potential mortality to hawks.
- Reserves should incorporate filter strips or other areas of natural vegetation to serve as nesting and foraging habitat for other Covered and Special Management Species and to contribute to improvement of water quality in the Plan Area.

4.6.8.3 Tree Planting Criteria

Another important component of the Swainson's hawk conservation approach is the establishment of potential nest trees as mitigation for loss of known and/or potential nest trees. Swainson's hawks are not selective about the species of tree for nesting. However, in the Central Valley, native trees most commonly used for nesting include Fremont's cottonwood (*Populus fremonti*), willows (*Salix* sp.), sycamores (*Platanus* sp.), valley oaks, and walnut (*Juglans* sp.). Important design considerations include:

- Having sufficient high-quality foraging habitat protected near the nest site,
- Providing trees that are tall enough (usually above 30 ft) and that have gaps in the canopy yet have sufficient foliar cover for protection and shelter for young and limbs strong enough to support a nest,
- Having sufficient nesting material nearby to construct and repair the nest,

- Providing alternate nest trees in the same nesting location, and
- Providing a lookout roost nearby.

Tree plantings should be conducted to ensure long-term success of the trees themselves and to provide nesting habitat for 15 to 30 years from the time of planting. Riparian plantings are preferred over long linear rows of trees along or adjacent to farm roads. Trees situated along farm roads are disturbed by farm equipment, road maintenance, and widening/resurfacing/repaving projects. In addition, these trees can become disfigured by tree trimming to protect utility lines, and their root systems can be compromised during the widening and maintenance of drainage ditches, both of which may result in the decline and ultimate mortality of the planted trees. Ideally, trees should be planted to expand an existing riparian area or other type of native tree stand. Plantings should consist of a mix of three or four native species, ideally from local stock, suitable for the area's hydrology and soils. Trees should be planted in clusters, or in a matrix design, to minimize edge habitat and should be located within at least 2 mi of foraging habitat, either grassland or cropland. Preferably, trees should be planted in areas where they are needed, have been removed historically, are within or immediately adjacent to dense nesting areas, are on fully protected landscapes (e.g., designated reserves) that can support them edaphically and hydrologically, or where they can be assured survival for the longest term possible for that tree species and preferably within riparian areas.

4.6.9 Burrowing Owl

Solano County has an abundance of land that has potential support for burrowing owls (Figure 4-22). As a result, significant opportunities exist for land protection and changes in land management to protect existing burrowing owl populations and provide habitat for a larger population without greatly inhibiting future development and agricultural practices. The primary approach to the conservation and expansion of the burrowing owl population within the Plan Area is to increase the availability of suitable nesting habitat (i.e., burrows) through design of agricultural reserves, management practices, and addition of artificial burrow complexes.

Unfortunately, the persistence of owls in these agricultural settings is dependent on the management practices of private landowners and local irrigation districts (Rosenberg and Haley 2004). Owls nesting in burrows along irrigation canals are extremely susceptible to road grading operations, dredging of drains, flooding, and other operation and management practices (Coulombe 1971; Rosenberg and Haley 2004). In addition, small mammal species (i.e., California ground squirrel) that create suitable burrows are usually targeted for extermination in agricultural areas, creating unique challenges for burrowing owl conservation in northeastern Solano County.

Since ongoing agricultural operations in these areas do not result in direct loss of foraging habitat, primary concerns related to Covered Activities are the loss of agricultural foraging habitat and active nest burrows to development and the destruction of active nest burrows during operation and maintenance activities. To compensate for the loss of agricultural foraging habitat, agricultural reserves will be established outside of the UGBs of the Plan Participant cities. These reserve areas will also contribute to the conservation of Swainson's hawk. A portion of the reserve area will be preserved to provide suitable cover and breeding habitat for burrowing owls. Although existing rodent control programs within agricultural areas indirectly affect burrowing owls via the reduction of burrow availability, these programs are firmly established within current agricultural practices, and the Solano HCP does not intend to alter or abolish these practices. The HCP also includes a

Good Neighbor Policy (see Section 10.5.6) that includes provisions for rodent control on reserves within 250 ft of active agricultural lands. Instead, artificial burrow complexes will be installed to provide additional suitable cover and breeding habitat and to alleviate threats associated with the destruction of burrows along irrigation canals, levees, and drainage ditches as a result of maintenance activities.

Despite the creation of additional cover and breeding habitat, burrowing owls will continue to occupy burrows along irrigation canals, levees, and drainage ditches. Rosenberg and Haley (2004) state that conservation of burrowing owls in the Imperial Valley will require collaboration among the Imperial Irrigation District, State and Federal agencies, and landowners to develop strategies that allow maintenance of the irrigation system while minimizing nest destruction. Similarly, burrowing owl conservation in northeastern Solano County will require collaboration between SCWA and the three agricultural irrigation districts (Solano Irrigation District [SID], Maine Prairie Water District [MPWD], and RD 2068) as the key public entities whose operations affect owls. As such, Chapter 6.0 contains avoidance and minimization measures for impacts to active burrowing owl nest burrows, further alleviating the threats associated with occupying burrows along irrigation canals, levees, and drainage ditches.

Although substantial effort needs to be devoted to conserving burrowing owls in agricultural portions of the County, additional conservation efforts must focus on promoting expansion of the existing owl population in association with preservation of valley floor grasslands, vernal pool complexes, and foothill grassland associations. Population expansion in these habitats will require increased nesting habitat and cover (i.e., burrows) through reducing ground squirrel control measures, installing artificial burrows, and minimizing vegetation height on Valley Floor Grassland, Vernal Pool, and Inner Coast Range Preserves/Reserves (see Chapter 6.0). Long-term conservation focuses on re-establishing fossorial mammal populations within preserve lands; however, in instances where the re-establishment of populations is not feasible due to rodent control concerns/good neighbor policies, and in the interim before fossorial mammal populations increase, artificial burrow systems will be an integral part of the Solano HCP conservation strategy. Artificial burrows have been shown to provide effective management tools for providing long-term nest sites for burrowing owls with a high rate of re-occupancy equal to or higher than natural burrows (Belthoff and Smith 2003).

In summary, the approach to conserving and expanding burrowing owl populations varies by Natural Community but relies on maintaining suitable foraging habitat and increasing suitable cover and breeding habitat. In agricultural areas, small areas within reserves will be set aside to establish suitable cover and breeding habitat adjacent to suitable foraging habitat via the installation and maintenance of artificial burrow complexes. Avoidance and minimization measures will be implemented to reduce impacts to active burrowing owl nest burrows associated with routine operation and maintenance of irrigation canals, levees, and drainage ditches. In valley floor grasslands, vernal pool complexes, and foothill grassland habitat, conservation efforts to promote the expansion of burrowing owl populations will focus on providing increased nesting habitat and cover (i.e., burrows) through reducing ground squirrel control measures, installing artificial burrows, increasing/restoring upland mounds, and minimizing vegetation height on preserves. The conservation approach combines conservation and management activities in agricultural, valley floor grassland, vernal pool, and foothill grassland habitats to expand existing owl populations.

Figure 4-1: Overview of the Conservation Analysis

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Figure 4-2: Key Corridors within the Plan Area

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Figure 4-3: Rarity Weighted Richness Map of Covered Species and Special Management Species within the Plan Area

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Figure 4-4: Vernal Pool Disturbance Results, Barriers and Development

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Figure 4-5: Contra Costa Goldfield Population Areas

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Figure 4-6: California Tiger Salamander Known and Potential Range

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Figure 4-7: Distribution of Playa Pools and Vernal Pool Critical Habitat

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Figure 4-8: Vernal Pool Conservation Areas

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Figure 4-9: FRAP Vegetation Data, Barriers and Development

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Figure 4-10: Priority Drainages and Watershed Conservation Areas

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Figure 4-11: Percent of Development within Each Watershed/Subwatershed

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Figure 4-12: Percent of Irrigated Agriculture within Each Watershed/Subwatershed

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Figure 4-13: Callippe Silverspot Butterfly Conservation Areas

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Figure 4-14: California Red-Legged Frog Conservation Area

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Figure 4-15: California Red-Legged Frog Potential Breeding and Hydration Habitat

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Figure 4-16: Location of Major Riparian Vegetation Stands Within the Plan Area

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Figure 4-17: Covered Species, Special Management Species, and Streams

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Figure 4-18: Giant Garter Snake Conservation Areas

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Figure 4-19: Suisun Marsh Protection Plan Map and Suisun Tidal Wetland Restoration Projects

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Figure 4-20: Coastal Marsh Conservation Areas and Designated Critical Habitat for Associated Covered Species.

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Figure 4-21: Swainson's Hawk Conservation Areas

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Figure 4-22: Burrowing Owl Conservation Areas

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Figure 4-23: Conservation Analysis

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Figure 4-24: Vegetation Categories by Conservation Class

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Figure 4-25: Relationship Between Habitat Area and Number of Species

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Figure 4-26: Vernal Pool Potential Preserve and Reserve Areas

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Figure 4-27: Swainson's Hawk Potential Reserve Areas

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