Appendix E
# Conservation Strategy Rationale

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This document provides the rationale for the RCIS/LCP conservation strategy, focusing on information supporting the conservation objectives. For the focal species, this document also describes how landscape- and natural community-level objectives contribute to the conservation of each species. After the goal and objective rationale for each focal species, a section is provided describing how the goals and objective address climate change for each focal species. See Chapter 5, *Literature Cited*, for all citations provided in this appendix.

## E.1 Landscape-Level Strategy, Rationale

### E.1.1 Goal L1: Large interconnected landscapes

#### E.1.1.1 Objective L1-1: Landscape Connectivity

***Rationale.*** Generally, large, interconnected blocks of land are preferred for conservation. The connectivity may include smaller habitat corridors or "stepping stones", however, where broader connections are infeasible or constrained due to incompatible land uses. The RCIS Program Guidelines define *habitat connectivity* as "the capacity of areas of intact habitat to facilitate the movement of species and ecological processes." The RCIS/LCP seeks to conserve continuous and contiguous habitat areas that span elevations from the valley floor into the mountains, and provide adequate cover and feeding habitat for dispersing or migrating species.

Rivers and creeks in Yolo County provide important connections and are shown in Figure 3-3. The Sacramento River, Putah Creek, and Cache Creek are primary landscape connections at local, regional, and statewide scales. To provide major landscape connections, the Sacramento River (including Yolo Bypass and Tule Canal/Toe Drain), Putah Creek, and Cache Creek require habitat areas that are adequately wide and contiguous. Some of the elements in these connections will provide riparian functions related to the river/stream zones; other elements may be oak woodlands, chaparral, California prairie, or other upland natural community types that support local and regional wildlife movements. Secondary landscape connections include Enos Creek/Dry Creek, Dry Slough, Salt Creek/Chickahominy Slough, Cottonwood Creek, Willow Slough, Thompson Canyon/Salt Creek, Oat Creek, Bird Creek, and Buckeye Creek.

The California Essential Habitat Connectivity Project (Spencer et. al 2010) identifies, at a coarse spatial scale, several linkages between large blocks of intact habitat or natural landscapes that could provide wildlife movement corridors in Yolo County (Figure 3-3). These consist of the following Essential Connectivity Areas (ECA): the English Hills - Blue Ridge/Rocky Ridge ECA; Blue Ridge/ Rocky Ridge-Capay Hills ECA; Dunnigan Hills/Smith Creek-Dunnigan Hills ECA; Stone Lake-Yolo Bypass ECA; Yolo Bypass-Sacramento Bypass ECA; and the Little Holland Tract/Yolo Bypass-Yolo Bypass ECA.

Important connectivity within the Yolo Bypass-Sacramento Bypass ECA is related not only to connectivity of land cover types that support natural communities and focal and conservation species, but also aquatic connectivity. Tule Canal is a critical habitat corridor that provides the primary north-south aquatic linkage in the Yolo Bypass. The CVFPP Conservation Strategy emphasizes the need to maintain flows to provide connectivity for fish species, improve connectivity to the Tule Canal, and to eliminate barriers to fish passage (DWR 2016).

### E.1.1.2 Objective L1-2: Areas to support sustainable populations

***Rationale.*** Larger land areas provide for species, such as large mammals and raptors, with more extensive home range sizes (tens to hundreds of acres, depending on the species), and also tend to protect a diverse array of species habitats at varied elevations. Selecting larger land areas also provides more interior land area that protects conservation resources from potential detrimental effects of adjacent land uses, minimizing potential conflicts between conservation management activities and other uses on adjacent lands. Large units are often better buffered from adjacent land use disturbance (for example, developed uses) and can be managed more efficiently and effectively.

### E.1.1.3 Objective L1-3: Environmental Gradients

***Rationale:*** Achieving this objective will provide a range of habitat characteristics, food resources, and complexity for native species, including focal and conservation species. A variety of environmental gradients may allow shifting species distributions in response to potential future environmental changes, such as climate change, and can facilitate species' responses to transformative events such as high-severity fire or extreme environmental fluctuations such as flood or drought.

Protecting a variety of environmental gradients in the reserve system is an important strategy to adapt to the expected effects of climate change (Theobald et al. 2015; Nunez et al. 2013; Beier 2012; Spencer et al. 2006). Changes in temperature range and precipitation patterns resulting from climate change may cause some areas of currently suitable habitat to become unsuitable for some species, while other areas of currently unsuitable habitat may become suitable. Climate change is expected to affect many habitats and species such that temporal dynamics and spatial distributions change in unpredictable ways. Faced with large, uncertain, and dynamic responses, it is important that a broad range of habitat characteristics is available (i.e., elevation, water depth, slope, aspect) within an interconnected reserve system (Nunez et al. 2013; Brost and Beier 2012). This is intended to ensure that, while some current habitat may be lost or altered as a result of climate change, sufficient suitable habitat will be available in response to climate change to sustain focal and other native species; in addition, a broad range of habitat elements (facets) within landscape linkages is associated with increased functional connectivity for a variety of species (Crooks and Sanjayan 2007).

### E.1.1.4 Objective L1-4: Natural Community Restoration

***Rationale.*** Many natural communities in Yolo County are severely diminished in extent as a result of human-caused conversion to development or agricultural crops. The RCIS/LCP seeks to restore natural communities to their historic conditions, where feasible, while taking into account that the species composition and processes within natural communities and their distributions in the landscape may be shifting with climate change. The intent of the RCIS/LCP conservation strategy is to restore natural communities in locations where restoration is most likely to be successful, given the soils, hydrology, other physical factors, and likely future conditions.

#### E.1.1.5 Objective L1-5: Ecotone Conservation

***Rationale.*** Ecotones are areas of transition between ecological communities, ecosystems, or ecological regions (Kark 2013). Ecotones often occur along ecological gradients created as a result of spatial shifts in elevation, climate, soil, and other environmental factors. Some areas in Yolo County that are best defined as ecotones do not fall neatly into any of the RCIS/LCP natural community categories, but their conservation may be very important. Studies have shown that species richness and abundances tend to peak in ecotonal areas, although exceptions to these patterns do occur. Ecotones are often small in size and relatively rich in biodiversity; therefore, conservation efforts in these areas may prove to be an efficient and cost-effective conservation strategy (Kark 2013).

### E.1.2 Goal L2: Ecological Processes and Conditions

#### E.1.2.1 L2-1: Hydrologic and Geomorphic Processes

***Rationale.*** Important geomorphic processes in riparian areas include lateral channel migration, channel cutoff and formation of multiple channels, bed mobility, and fine and coarse sediment transport. These processes influence floodplain dynamics such as channel, bank, and floodplain formation (CVFPP 2016). Sediment scouring, erosion and deposition, and prolonged inundation disturb existing vegetation. These disturbances create opportunities for cottonwoods, willows, and other early successional riparian species to establish from seed, thus promoting establishment of riparian vegetation, addressed in Section 1.1.1.6, *Riparian* (DWR 2016). All these processes influence habitat conditions for fish and other aquatic and riparian species, as described in Section 3.3.2, *Focal Species.*

As described in the CVFPP Conservation Strategy, natural, eroding banks often have cavities, depressions, and vertical faces that support bank-dwelling species such as bank swallow, northern rough-winged swallow, belted kingfisher, mink, and river otter, and that provide cover and shelter for fish. Bank-dwelling species may use these banks and their cavities to access the water or for nesting. Erosion of natural bank substrates provides instream spawning substrate for aquatic species, including salmonids. Natural fluvial processes also result in diverse substrate sizes and irregular banks that provide habitat complexity for fish and wildlife, and can support a high diversity and abundance of invertebrate and fish species.

The CVFPP Conservation Strategy also describes how a diversity of flows, suitable sources of sediment, and a sufficiently broad river corridor to allow stream meandering are necessary to sustain riverine habitats and the wildlife species that depend on them. The targeted CVFPP ecosystem processes for this objective are floodplain inundation and riverine geomorphic processes (DWR 2016).

Floodplain inundation occurs when river flows exceed channel capacity and water overflows onto adjacent land. The ecosystem responses to floodplain inundation depend on flow timing, frequency, magnitude, and duration. Floodplain inundation helps create side channels, sloughs, and oxbow lakes through erosion and deposition of fluvial sediments. Sustained overbank flows also generate food for downstream aquatic wildlife. Floodplain inundation for 1–2 weeks or longer allows for the growth of microorganisms and the animals that feed on them (Opperman 2012, in DWR 2016), including anadromous fish and other native aquatic species.

### E.1.2.2 Objective L2-2: Fire

***Rationale.*** The ability to maintain, reestablish, or mimic natural disturbance is important to maintaining biological diversity and habitat conditions for specific species. Fire, in particular, is a source of natural disturbance in the Hill and Ridge Landscape Unit. Disagreement over the natural role and frequency of fire is the main impediment to the application of prescribed fire regimes. The use of prescribed fire for ecosystem management also is constrained by the presence of human assets, such as adjacent development, low-density homesteads, and agricultural development, which increase risk of loss and the cost of protection during prescribed fire. The relevance of herbivory as a disturbance factor has changed since precolonial conditions. Increased intensity and duration of grazing by domestic livestock contributed to a higher proportion of grazing-adapted nonnative species in grassland communities. When properly managed, grazing can be a useful tool to control undesirable nonnative species (See RCIS/LCP Objective CP1.3, *Grazing regimes*).

## E.1.3 Goal L3: Landscape-level Stressors

### E.1.3.1 Objective L3-1: Invasive Species

***Rationale.*** Achieving this objective will minimize the spread of invasive species and thereby promote species diversity and contribute to natural community resilience and resistance to disturbances.

### E.1.3.2 Objective L3-2: Pollutants and Toxins

***Rationale.*** As stormwater runoff flows through watersheds in Yolo County, it accumulates sediment, oil and grease, metals (e.g., copper and lead), pesticides, and other toxic chemicals. Unlike sewage, stormwater is often not treated before discharging to surface water. Despite stormwater regulations limiting discharge volumes and pollutant loads, many pollutants still enter Strategy Area waterways in stormwater. Of particular concern for focal species is the overuse of pesticides, some of which can have deleterious effects on the aquatic food chain (Weston et al. 2005; Teh et al. 2005). For example, pyrethroid chemicals are used as pesticides on suburban lawns. Even at very low concentrations, these chemicals can have lethal effects on low trophic levels of the food chain (plankton), and mainly sublethal effects on the focal fish species (Weston and Lydy 2010). Pesticide use is also thought to be responsible for the decline of tricolored blackbird populations in California (Meese 2013). Other urban pollutants that can be transported to the waterways directly or indirectly by stormwater runoff include nutrients from failing septic systems and viruses and bacteria from agricultural runoff.

Mercury present in watersheds in Yolo County has been deposited by tributaries and rivers that drain former mining areas in the mountains. While mercury in its elemental form does not pose a risk to aquatic organisms, exposing soils to periodic wetting and drying results in a process called methylation, which converts mercury to a more toxic form, methylmercury. Restoration actions may increase the acreage of intermittently wetted areas in Yolo County (particularly in Yolo Bypass) by converting cultivated lands and other upland areas to open water and floodplain habitats, potentially increasing methylmercury production. Some of this increased production is likely to be taken up by organisms and to bioaccumulate through the food web. However, some of it will also be sequestered within the restored natural communities.

### E.1.3.3 Objective L3-3: Hazardous Human Land Uses

***Rationale.*** Human land uses can have many adverse effects on natural communities and focal and conservation species. These may include, but are not limited to, noise, lighting effects, visual disturbance, harassment by humans or pets, pollution from run-off, impediments to wildlife movement, and mortality due to vehicle strikes or predation by domestic pets.

## E.1.4 Goal L4: Biodiversity, Ecosystem Function and Resilience

*Maintain and improve biodiversity, ecosystem function, and resilience across landscapes, including agricultural and grazed lands. Maintain landscape elements and processes that are resilient to climate change which will continue to support a full range of biological diversity in Yolo County.*

***Rationale.*** The RCIS/LCP bases this goal on the principles for maintaining biodiversity, ecosystem function, and resilience in landscapes that include agricultural use (Fischer et al. 2006; Wiens et al. 2011; Lawler et al. 2014; Theobald et al. 2015). Agricultural landscapes should include patches of native vegetation with corridors and stepping stones distributed throughout a structurally complex landscape matrix, and provide buffers around sensitive areas.

The RCIS/LCP envisions a program of adaptive management, based on best available science in combination with research, to monitor developing conditions in the strategy. The RCIS/LCP focuses predominantly on effects of climate-driven changes on focal species as an indication of effects on other species in Yolo County; on changes in habitat areas and habitat values within Yolo County; and on elements and processes occurring at a landscape level, which determine the countywide and regional applicability and utility of the RCIS/LCP conservation program.

### E.1.4.1 Objective L4-1: Heterogeneity within Agricultural Matrix

***Rationale.*** While the Hill and Ridge Landscape Unit consists mostly of natural lands, the Valley Landscape Unit has mostly been converted to agricultural uses. To prevent local extinctions and promote biodiversity and ecological resilience in a fragmented landscape such as this unit, it is important to maintain a landscape that includes natural lands within the agricultural matrix, which allows wildlife movements between patches of natural lands, both within and outside protected lands (Rouget et al. 2006; Vandermeer and Perfecto 2007; Green et al. 2005; Fischer et al. 2008; Lawler et al. 2015). Natural habitat areas within agricultural landscapes have been shown to be associated with enhanced pollination services for agriculture in Yolo County (Kremen et al. 2007; Morandin and Kremen 2013). This objective differs from the objectives under RCIS Goal AG1, *Cultivated land habitat conservation,* in that it focuses on nonagricultural lands within a larger agricultural matrix.

### E.1.4.2 Objective L.4-2: Resilience to Climate Change

***Rationale.*** Climate change is predicted to alter characteristics of California landscapes, changing large-scale patterns in fire, rainfall, and other factors (Cayan et al. 2006; Ackerly et al. 2915;

Thorne et al. 2015). This is expected to change landscape connectivity and permeability for wildlife movements and ecological processes (Thorne et al. 2016). Climate change is predicted to alter characteristics of natural communities and species habitat in Yolo County (Stralberg et al. 2009; Wiens et al. 2009; Sork et al. 2010; Barbour and Kueppers 2012; McLaughlin and Zavaleta 2012; Ackerly et al. 2015; Thorne et al. 2016). An adaptive strategy for providing landscape, natural community, and species-level conservation benefits is needed in order to provide landscape resilience (Wiens et al. 2011; Lawler et al. 2015; Theobald et al. 2015). The RCIS/LCP establishes a framework for conservation throughout Yolo County based on existing conditions and climate.

### E.1.4.3 RCIS/LCP Objective L4.3: Population viability and biodiversity resilience with climate change

***Rationale.*** Climate change is predicted to adversely affect populations of focal and conservation species in Yolo County (Gardali et al. 2012; Langham et al. 2015; Shuford and Dybala 2017). An adaptive strategy may be needed for maintaining viability in these populations and the resilience of native biodiversity in Yolo County.

# E.2 Natural Community-Level Strategy, Rationale

## E.2.1 Goal CL1: Cultivated land habitat conservation

### E.2.1.1 Objective CL1.1: Protect Cultivated Lands with Habitat Values

***Rationale.*** Cultivated lands in Yolo County consist of a dynamic matrix of different land cover types, including perennial, semiperennial, and seasonally or annually rotated crops. The large extent of rotated crops results in a cover type matrix that is subject to change based primarily on agricultural economic conditions.

Although the conversion of natural vegetation to cultivated lands has eliminated large areas of native habitats, some agricultural systems continue to support wildlife with compatible habitat needs, and can still meet important breeding, foraging, and roosting habitat needs for some resident and migrant wildlife species. Upland and seasonally flooded cultivated lands and wetlands in Yolo County, for example, support waterfowl populations that annually winter in California (CALFED 1998; Central Valley Joint Venture 2006; Shuford and Dybala 2017). Covered species that use cultivated lands include Swainson's hawk, giant garter snake, and sandhill crane. These species have come to rely on the habitat value of certain cultivated lands, farming practices, and crop types. Swainson's hawks in the Central Valley and Delta rely on cultivated lands for foraging, given the lack of grassland foraging habitat remaining in California (Hartman and Kyle 2010). Cultivated lands, however, support a less diverse and less dense community of wildlife compared with natural communities (Fleskes et al. 2005; EDAW 2007; U.S. Fish and Wildlife Service 2007; Kleinschmidt Associates 2008).

The dynamic cropping patterns in Yolo County result may result in changes in habitat values at the site level for cultivated land-associated covered species. These dynamic cropping patterns can be compatible with wildlife use as long as the overall acreage of crops and types of agricultural practices that provide high-value habitat for covered species remain relatively constant at the regional scale. Major regional shifts in crop types or agricultural practices may diminish wildlife habitat values at a regional level. Changes in crop production can have substantial effects on the habitat value of cultivated lands for wildlife, particularly birds. Hay, grain, row crops, and irrigated pastures support abundant rodent populations, providing a prey base for many wildlife species. Conversion of these cultivated lands to orchards and vineyards has been noted as a factor adversely affecting native wildlife, including raptors such as Swainson's hawk (Estep Environmental Consulting 2008). Orchards and vineyards develop a dense overstory canopy that generally precludes access to ground-dwelling prey by foraging Swainson's hawks, white-tailed kites, western burrowing owls, and other covered species associated with cultivated lands.

### E.2.1.2 Objective CL1.2: Incorporation of habitat features

***Rationale.*** Natural habitat elements add resilience to the agricultural landscape by enhancing the ability of the landscape matrix to provide habitat values and functions within the lands not specifically not protected by conservation easements. The RCIS/LCP defines a "landscape matrix" as the dominant land cover type in any defined (or bounded) land area (Forman 1995). With elements of these habitat functions provided by the matrix, the integrity of the reserve system elements is augmented by a matrix that is permeable to mobile species, and the matrix can also provide additional habitat values.

Achieving this objective involves incorporating habitat enhancements such as hedgerows along field edges, broadened areas of natural vegetation (for example, widened riparian vegetation areas along rivers, creeks, and irrigation canals and drainages), and other natural habitat elements into areas where connections have been weakened. The LCP may achieve this through landowner incentives provided through grant programs or mitigation funds.

### E.2.1.3 Objective CL1.3: Cultivated land pollinators

***Rationale.*** Although honey bees provide most of the crop pollination in the U.S., the number of managed honey bee hives has declined by over 60 percent in the U.S. since 1950 due to colony collapse disorder and other factors. Research on crop pollination in Yolo County (e.g., Kremen et al. 2002; Morandin and Kremen 2013) has demonstrated that native bees also make a significant contribution to crop pollination—in some cases providing all required pollination when sufficient habitat is available. Native pollinators that support habitat are increasingly important as honey bee hives become more expensive and difficult to acquire. Research demonstrates that native bees contribute substantially to the pollination of many crops, including watermelon, canola, sunflower, tomatoes, and blueberry (Appendix E, *Pollinator Conservation Strategy*).

## E.2.2 Goal CP1: Large contiguous patches of California prairie to support native species

### E.2.2.1 Objective CP1.1: California prairie protection

***Rationale.*** Large intact stretches of California prairie support a diversity of native species, such as garter snake, northern harrier, barn owl, western kingbird, Say's phoebe, western meadowlark, savannah and grasshopper sparrow, Townsend's mole, Botta's pocket gopher, western harvest mouse, and California vole.  Other native species utilize California prairie as foraging habitat, such as American kestrel, red-tailed hawk, big brown bat and black tailed deer (Kie 2005). Plant species typically consist of perennial grasses intermixed with forbs, such as California oatgrass, purple needlegrass, silver hairgrass, English daisy, soft chess, Sandberg bluegrass, Idaho fescue, red fescue, and Italian ryegrass (Kie 2005, Sawyer et al. 2008). California prairie also provides some of the most important movement corridors in the RCIS area, such as the Dunnagin Hills area (Holstein pers. comm.) With implementation of the Yolo HCP/NCCP, 16 percent of the California prairie in Yolo County will be protected. Lands to be protected through the Yolo HCP/NCCP will focus on areas that support covered species, particularly California tiger salamander and western burrowing owl. The Yolo HCP/NCCP emphasizes grassland (including California prairie)conservation in the Valley Landscape Unit, but does not conserve these areas in the Hill and Ridge Landscape Unit or in the southern portion of planning unit 5, where California tiger salamander is absent. The RICS/LCP will protect additional areas of California prairie in Yolo County, with a focus those planning units that were not prioritized in the Yolo HCP/NCCP.

### E.2.2.2 Objective CP1.2: Restore and enhance California prairie.

***Rationale***. The California prairie natural community contains about 40 percent of California's native plant species (Wigand 2007). This natural community has, however, declined dramatically in California as a result of changes in grazing patterns, introduction of invasive plant species, and conversion to agriculture and urban development.

### E.2.2.3 Objective CP1.3: Burrowing rodents

***Rationale.*** Colonial (social) burrowing rodents are important ecosystem engineers in grassland ecosystems, important in maintaining the functional capacity and resilience of prairies (Davidson et al. 2012). Habitat functions provided by social burrowing rodents in California prairie communities include providing food, thermal and predator cover, and nesting/seasonal habitat for a variety of covered vertebrate and other native wildlife species (e.g., rodents, grasshopper sparrow, western meadowlark, horned lark, northern harrier, and insects, including native pollinator species).

### E.2.2.4 Objective CP1.4: Grazing regimes.

***Rationale.*** California prairies may have evolved with intense levels of grazing and browsing. In prehistoric times, they were grazed by large herbivores including mammoths, horses, camels, llamas, and bison that became extinct in the late Pleistocene. In the last 10,000 years, tule elk, black-tailed deer, and pronghorn antelope grazed California prairies in large numbers. With the decline in native grazers such as tule elk and pronghorn antelope, cattle and sheep now often fulfill the grazing role of native ungulates. Grazing can have positive, negative, or neutral effects on grassland plants and animals, depending on species and grazing management (Hatch, et al. 1999; Hayes and Holl 2003).

### E.2.2.5 Objective CP1.5: California prairie pollinators

***Rationale.*** Pollinators in California prairies have been reduced as a result of habitat loss and fragmentation; invasive exotic plants; pesticide use; grazing, mowing, and fire; and disease and parasites from nonnative commercially reared bees used in agricultural areas (Appendix D, *Pollinator Conservation Strategy*). Pollinators are essential to a healthy California prairie natural community.

## E.2.3 Goal CH1: Chaparral conservation

Ecological relationships in chaparral communities in the northern Coast Ranges are poorly understood ecologically, particularly the role of fire and disturbances (Keeley 2002). Conservation actions for chaparral in this region will incorporate increased knowledge resulting from encouraged research about the roles of fire and climate change on chaparral communities.

### E.2.3.1 Objective CH1.1: Protect chamise chaparral for connectivity.

*Protect chamise chaparral as needed to achieve landscape connectivity.*

***Rationale.*** Chaparral communities provide habitat and migratory linkages for a diverse assemblage of wildlife species. California yerba santa, pitcher sage, and deerweed commonly occur within chamise chaparral, including the focal plant species Colusa layia and drymaria-like western flax. This natural community supports common wildlife species such as western scrub-jay, wrentit, California thrasher, and California towhee. Achieving this objective will contribute to providing a network of habitat patches that adequately represents the diversity of ecosystem functions across the landscape and contribute to achieving the landscape-level habitat corridor objectives. An estimated 49 percent of this natural community in Yolo County already occurs on protected lands, and although chamise chaparral has high wildlife value, the natural community does not provide key habitat for focal species. Accordingly, protection of this natural community is a priority primarily for landscape connectivity purposes.

### E.2.3.2 Objective CH1.2: Protect Mixed Chaparral.

***Rationale.*** Mixed chaparral supports several common wildlife species (e.g., western fence lizard, western skink, gopher snake, common kingsnake, black-tailed deer, coyote, gray fox, California and mountain quail, mourning dove, Anna's hummingbird, western scrub-jay, oak titmouse, Bewick's wren, California thrasher, wrentit, California towhee, rufous-crowned sparrow, sage sparrow, and lesser goldfinch). No wildlife species are known to be restricted to mixed chaparral (CDFW 2014). Focal species that occur in mixed chaparral are listed in Section 2.4.4.4, *Mixed Chaparral Natural Community*. The Yolo HCP/NCCP does not include protection commitments for mixed chaparral. An estimated 27 percent of this natural community in Yolo County is currently protected (Table 3-2). Protection of this natural community is not a high priority except when it supports focal species and for connectivity purposes.

### E.2.3.3 Objective CH1.3: Manage Chaparral

***Rationale.*** Promoting native plant and wildlife diversity in chaparral will maximize its resilience in the face of climate change and other stressors.

#### CH1.4: Chaparral pollinators

***Rationale.*** Maintaining pollinator populations in the chaparral natural community will help optimize the health and resiliency of the natural community and the focal and conservation species it supports. In addition, when chaparral occurs in wildlands close to agricultural lands, chaparral is a source of pollination services for croplands within the agricultural areas (Morandin and Kremen 2013).

## E.2.4 Goal WF1. Valley oak protection and restoration

The goals and objectives below focus primarily on oak woodland, oak dominated forest, savanna, and individual oak trees. Other forest natural communities in Yolo County are sufficiently widespread and/or sufficiently protected such that specific biological goals are not necessary, although these forest natural communities may be conserved as needed to meet the landscape level goals and objectives. Oak woodland and forest sometimes occur in association with drainages and therefore overlap with the riparian natural community. Section 3.4.2.6, *Riparian,* includes goals and objectives relevant to oaks in riparian areas. Also, oak savanna includes California prairie as a component; therefore Section 3.4.2.2, *California Prairie,* includes goals and objectives for the prairie component of oak savanna.

As described in the State Wildlife Action Plan, the primary conservation planning target for the **Northern California Interior Coast Ranges Ecoregion** (the USDA Ecoregion that includes western Yolo County) is "*California Foothill and Valley Forests and Woodlands*" (see SWAP section 5.1 and especially Table 5.1-1 on page 5.1-10). This SWAP conservation target identifies several CWHR habitat types that occur in the ecoregion; the majority of these CWHR habitat types are oak-dominated or co-dominated plant associations that are elements of this Woodland and Forests natural community (e.g., Blue Oak Woodland; Blue Oak–Foothill Pine; Montane Hardwood; and Valley Oak Woodland).

### E.2.4.1 Objective WF1.1: Increase valley oaks

***Rationale.*** Early maps and relict vegetation clearly indicate that woodlands dominated by valley oaks were once widespread in the county where abundant groundwater and porous soil were present; valley oak forest or woodland was formerly a more common habitat type in the county for many RCIS/LCP focal and conservation species. In addition, genetic evidence (e.g., Grivet et al. 2007, 2008; Gugger et al. 2013) suggests that valley oak forests in eastern Yolo County were part of a biogeographically and evolutionarily significant linkage between valley oak populations in the Coast Ranges and the Sierra Nevada foothills to the east. This indicates the importance of maintaining the viable valley oak populations throughout the lowlands in Yolo County, particularly with respect to climate change adaptation (Sork et al 2010; McLaughlin and Zavaleta 2012).

### E.2.4.2 Objective WF1.2: Protect valley oaks

***Rationale.*** The RCIS/LCP prioritizes protection of valley oaks because of their rarity in Yolo County compared with historic conditions, and their ecological importance (see above).

## E.2.5 Goal WF2. Upland oak protection and restoration/enhancement

Upland oak habitats include combinations of oak species; in Yolo County woodlands and savannas dominated by blue oak provide habitat for many wildlife and plant species (see Chapter 2). The majority of these upland oaks are not a component of the riparian natural community; that is, they are not directly associated with rivers, creeks, or other aquatic areas, although oaks occurring in sites with adequate surface water or groundwater often achieve larger statures and higher stand densities than oaks elsewhere. Oak-dominated woodlands and savannas occupy much of the landscape in the Hill and Ridge Landscape Unit. These upland oak-dominated habitats are an element in a landscape mosaic that also includes prairies and chaparral/shrublands, in which elements dynamically merge or locally replace one another through time as a result of fire, drought, and other natural stressors,

The status of upland oak habitats in Yolo County is a conservation concern owing to projections in regional climate models (e.g., Kueppers et al. 2005; Barbour and Kueppers 2012; Hannah et al. 2012) that oak woodlands (particularly those dominated by blue oak, but also including upland valley oak-dominated woodlands and savannas) are unlikely to remain a dominant element in western Yolo County, or could largely disappear from the county, based on the projected future lack in the county of the ecological conditions to which these species are currently adapted.

### E.2.5.1 Objective WF2.1: Protect Upland Oaks

***Rationale.*** Upland oaks occur in larger, intact tracts of land in the Hill and Ridge Landscape Unit than in the Valley Landscape Unit. These oaks in association with natural lands and on lands that provide habitat connectivity have more ecological value than those in developed areas.

### E.2.5.2 Objective WF2.2: Restore Upland Oaks

***Rationale.*** This objective is consistent with the RCIS/LCP goal of providing large, interconnected habitat areas.

## E.2.6 Goal WF3. Riparian Oak Protection and Restoration

Oaks in riparian areas are likely to be the most resilient to climate change. For additional goals and objectives related to riparian areas, see Section 3.4.2.6, *Riparian,* below.

### E.2.6.1 Objective WF3.1: Protect Riparian Oaks and Oak Woodlands

***Rationale.*** In the Hill and Ridge Landscape Unit, many of the riparian areas are dominated by oaks, particularly valley oak, interior live oak, and some oracle oak. These oaks support a diversity of riparian wildlife species, contribute to structural diversity and cover along habitat corridors, and provide shade and structure to adjacent aquatic areas.

### E.2.6.2 Objective WF3.2: Restore and Enhance Riparian Oaks and Oak Woodlands.

***Rationale.*** Oak woodland and forest in riparian areas have diminished in extent since historical times as a result of land conversion, overgrazing, and other factors. These oaks support a diversity of riparian wildlife species, contribute to structural diversity and cover along habitat corridors, and provide shade and structure to adjacent aquatic areas

# E.2.7 Goal WF4. Oak woodland management

Manage oak woodland and forest natural communities outside of riparian areas to enhance habitat quality supporting native biodiversity, and to provide enhanced ecosystem functions and services.

## E.2.7.1 Objective WF4.1. Manage and Enhance Oak Woodlands

***Rationale.*** Oak woodlands are vulnerable to loss of native biodiversity due to competition from invasive species; lack of regeneration caused by factors such as overgrazing and disturbance of the soil profile; and changing climatic conditions such as increased temperature, reduced water availability, and increased frequency and/or severity of fire and other stressors (Barbour and Kueppers 2012; McLaughlin et al. 2014; Davis et al. 2016). Climate change may be associated with the development of new associations of plant and wildlife species ("novel ecosystems"), with consequent ecological effects on native species (Langham et al. 2015).

## E.2.7.2 Objective WF4.2. Oak Woodland Pollinators

**Rationale.** Maintaining pollinator populations in the oak woodland natural community will help optimize the health and resiliency of the natural community and the focal and conservation species it supports. Where oak woodlands occur near agricultural areas, protecting pollinator habitat provides beneficial ecosystem services to the agricultural land uses.

## E.2.7.3 Objective WF4.3: Burrowing rodents

***Rationale.*** Many of the animal species that inhabit the oak woodlands are either fossorial (i.e., adapted to digging and life underground) or burrow-dependent, attributes that require access to constant underground habitats, presumably for temperature regulation and for protection from fire and predators. California ground squirrels and pocket gophers excavate burrows that provide substantial benefits to covered species, such as California tiger salamander (upland aestivation sites). However, ground squirrels and pocket gophers have been the target of widespread poisoning campaigns in California, where they threaten levees or are perceived as pests. By increasing the abundance and distribution of host burrows, many native species will benefit.

## E.2.7.4 Objective WF4.4: Grazing regimes

**Rationale.** The grassland understories that occur with oak woodland have many of the same species as California prairie, as described in Section 3.4.2.2, and may similarly respond to grazing. An inappropriate grazing regime, however, can result in loss of oak seedlings and lack of oak regeneration.

# E.2.8 Goal FW1: Fresh Emergent Wetland Conservation

As described in the State Wildlife Action Plan, the eastern two-thirds of Yolo County is identified in the USDA classification as Great Valley Ecoregion, The SWAP identifies "Freshwater Marsh" as one of the two primary priority conservation targets for this ecoregion (SWAP Table 5.4-1, p. 5.4-12). The single corresponding priority CWHR habitat element identified in the SWAP is "Fresh Emergent Wetland."

### E.2.8.1 Objective FW1.1: Protect fresh emergent wetlands.

***Rationale.*** With implementation of the Yolo HCP/NCCP, 59 percent of the fresh emergent wetlands in Yolo County will be protected. This is a relatively high percentage of protection for a natural community; therefore, the RCIS/LCP only prioritizes protection of fresh emergent wetlands where they support focal or conservation species and would not otherwise be protected under the Yolo HCP/NCCP.

### E.2.8.2 Objective FW1.2: Increase fresh emergent wetland areas

***Rationale.*** The Central Valley, including the Yolo County, historically supported vast areas of fresh emergent wetlands that were subsequently lost, largely as a result of conversion of wetland areas to uplands to support agriculture and residential development. Increasing the acreage of fresh emergent wetlands will benefit giant garter snake, western pond turtle, California black rail, tricolored blackbird, and a diversity of native species that use this natural community.

Marsh restoration will generally consist of intensive actions involving grading (e.g., creating depressions, berms, and drainage features) to create topography that supports marsh plants, provides habitat elements for focal and conservation species, and allows fish to exit as floodwaters recede. Marsh restoration also involves planting vegetation and constructing water management facilities. Within the Lower Sacramento River and Upper Sacramento River CPAS, fresh emergent wetland restoration will generally occur in the bypass system and will be implemented in conjunction with bypass expansion and construction. (from CVFPP Conservation Strategy [DWR 2016])

## E.2.9 Goal R1: Riparian conservation

As described in the State Wildlife Action Plan, the eastern two-thirds of Yolo County is identified in the USDA ecoregion classification as the Great Valley Ecoregion, The SWAP identifies “American Southwest Riparian Forest and Woodland” as one of the two primary priority conservation targets for this ecoregion (SWAP Table 5.4-1, p. 5.4-12). The single corresponding priority CWHR habitat element/natural community identified in the SWAP is “Valley Foothill Riparian.” As noted in Chapter 2, riparian areas in Yolo County vary considerably in structure and species composition. The RCIS/LCP incorporates most riparian areas into this single natural community type, although “Valley Oak Riparian” habitat is also included as an element in the Oak Woodlands natural community.

Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota (National Research Council 2002). They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams and lakes, and estuarine-marine shorelines, and often occur within a mosaic of patches of wetlands, California prairie, open water, barren soil, sand, gravel, cobble, or rock outcrop areas.

Riparian habitats associated with streams and other waterways throughout Yolo County are among the most significant natural communities in the region, and are an essential element in interconnecting the conserved landscape consistent with the landscape objectives of the LCP.

Achieving this goal will contribute to maintaining the diversity of ecosystem functions across the Yolo County landscape, as well as providing functional landscape connectivity. In addition, riparian habitat is an important element in maintaining fluvial processes in watersheds throughout Yolo County.

Functional riparian habitat values are directly related to the structure and continuity of the habitat (Hilty and Merenlender 2004; Hilty et al 2006; Merritt and Bateman 2012). The functional utility of riparian habitat associated with a watercourse is directly related to: (1) the height and structural complexity of the riparian vegetation, (2) the extent of the riparian vegetation corridor extending laterally out from the watercourse, and (3) the continuity of the riparian vegetation corridor along the length of the watercourse. The utility of a riparian habitat corridor in linking landscape elements in a conservation framework is directly proportional to the functional value of the habitat. Thus the conservation value provided by riparian habitat in Yolo County is increased when the structural complexity and continuity of the habitat is increased.

Climate-change effects on Central Valley landscapes have been projected to further fragment residual natural habitat values for native species, including those in Yolo County. Riparian habitat areas, which are associated with watercourses throughout the landscape, can provide a functional linkage network within these landscapes, Riparian habitat associated with watercourses is naturally resilient to climate change impacts owing to readily available water, is inherently linearly distributed, links the aquatic environment with the terrestrial environment, and functions as a thermal refugium for wildlife (Seavy et al. 2009a), factors which elevate the importance of riparian habitats in responding to climate change in Yolo County. Riparian areas provide a framework for uniting ecosystems at landscape scales, enhancing regional ecological resilience (Fremier et al. 2015).

See Goal WF3, above, for objectives related to oaks in riparian areas.

### E.2.9.1 Objective R1.1: Protect riparian areas

***Rational.*** Riparian communities provide habitat for many native plant and wildlife species that occur in Yolo County and the surrounding region. Achieving this objective will assist in securing habitat connectivity for native species, as well as maintaining habitat functions on adjacent agricultural lands within Yolo County for numerous focal species and other native wildlife species.

### E.2.9.2 Objective R1.2: Increase Riparian Habitat Areas

***Rationale.*** Achieving this objective will enhance the functional utility of riparian areas in Yolo County by extending the riparian vegetation corridor laterally from the watercourses, and enhancing the continuity of the riparian vegetation corridor along the length of the watercourses. Additionally, the Independent Science Advisors' Report (Spencer et al 2006) for the Yolo HCP/NCCP recommends establishing wide riparian habitat nodes along habitat corridors.

Riparian restoration actions can be either intensive (such as actions that involve grading) or less intensive. Less intensive efforts, which may still require considerable resources, involve facilitating the dispersal and establishment of native plants through maintenance practices, such as removing competing invasive plants. (from CVFPP Conservation Strategy [DWR 2016])

### E.2.9.3 Objective R1.3: Maintain or enhance riparian habitat areas

***Rationale.*** Structural complexity, including understory (low shrubs), midstory (large shrubs and small trees), and overstory (upper canopy formed from large trees), is important to meet habitat requirements for a diversity of wildlife species. Different bird species nest and forage at different vegetation heights, necessitating the presence of multiple vegetation layers. Low shrubs provide cover for many wildlife species, tall trees provide perching opportunities, and canopy cover provides shading. Multiple vegetation layers also enhance hydrologic functions, including rainfall interception, filtration of floodwaters, and flood-stage desynchronization (Collins et al. 2006). Horizontal overlap among vegetation components and over adjacent riverine channels, freshwater emergent wetlands, and grasslands increases opportunities for insects produced in riparian vegetation to be distributed into channels and other communities, contributing to aquatic and terrestrial food webs (Naiman et al. 1993; Naiman and Decamps 1997; National Research Council 2002).

Wildlife species respond to vegetation structure for breeding, foraging, and nesting. Vegetation structure can be defined as the foliage volume (or cover of foliage) by height for a given area (Riparian Habitat Joint Venture 2009). Where natural processes dominate (as in intact floodplains), riparian natural communities tend to vary widely in terms of both vegetation structure and composition, representing areas that are at different successional (temporal) stages. To meet the ecological requirements of a variety of wildlife species, riparian communities should include the full range of seral stages that are characterized by a mixture and diversity of vegetative cover at a wide range of heights and volumes (Riparian Habitat Joint Venture 2009; Seavy et al. 2009b). For example, least Bell's vireo is more likely to occur in willow-dominated, early seral stage riparian forest, whereas yellow-billed cuckoo is more likely to occur in a relatively dense, mature cottonwood/willow forest with light gaps and a heavy shrub component (Efseaff et al. 2008).

Riparian habitat in the Sacramento River Valley provides significant habitat values for a variety of resident wildlife species, and additionally supports highly diverse and abundant populations of migratory birds (Seavy et al. 2009a). Riparian habitat in Yolo County supports substantially different groups of migratory bird species during the breeding season, when most migrant species are Neotropical migrants, and winter season, when most migrants are short-distance Northern Hemisphere migrants (Motroni 1985; Dybala et al. 2015). The food requirements of the two groups differ substantially, with Neotropical migrants primarily insectivorous and the wintering migrants primarily feeding on plant seeds or fruits. Fully addressing riparian habitat needs for both groups depends on assuring that riparian habitats include a diversity of plant species, particularly shrubs and grass-like plants that produce fruits and seeds during the winter.

## E.2.10 Goal LR1: Stream conservation

See also RCIS/LCP Objective L2.1, *Hydrologic and geomorphic processes in floodplains,* regarding landscape level ecological needs within floodplains, with a focus on the Sacramento River and Yolo Bypass, consistent with the CVFPP Conservation Strategy.

### E.2.10.1 Objective LR1.1. Fluvial equilibrium

An equilibrium exists when channels are neither aggrading nor degrading and maintain stable channel cross-sectional and longitudinal profiles through time, where "equilibrium" reflects a dynamic balance between erosion and deposition through time, rather than a static, unchanging condition.

### E.2.10.2 Objective LR1.2. American beavers

American beavers provide a number of ecosystem services in streams. Their dams collect and slowly release water downstream throughout the year, and filter sediment and improve water quality downstream. They also produce aquatic and wetland habitat.

### E.2.10.3 Objective LR1.3: Native vegetation

*Rationale:* Vegetation shades and cools streams, maintains streambanks and channel forms, and provides organic material that maintains instream ecological dynamic processes.

### E.2.10.4 Objective LR1.4: Stream processes and conditions

*Rationale:* Conservation of stream processes is related to maintaining subsurface flow and groundwater that are hydrologically part of the streamflow in each watershed (Winter et al 1998). Appropriate streamflows should be encouraged to maintain aquatic life in Yolo County streams. Maintenance or reestablishment of streamflow dynamics that resemble the natural runoff patterns that sustain instream and riparian/floodplain ecosystems in Yolo County, including flow dynamics, will help support the reproduction of desired native riparian plant species. This will also encourage habitat conditions that favor native fish species.

## E.2.11 Goal AP1: Alkali Prairie Conservation

### E.2.11.1 Objective VP1.1: Protect Alkali Prairie

Protect 7 acres of alkali prairie natural community. Alkali prairie is a rare natural community that supports numerous rare plant species, including palmate-bracted bird's beak, alkali milk-vetch, Heckard's pepper-grass, brittlescale, spearscale, and Baker's navarretia.

## E.2.12 Goal VP1: Vernal pool conservation

Conserve vernal pool complexes in Yolo County.

96 percent of the vernal pools in Yolo County are already protected (Table 3-2), therefore the strategy for vernal pools focuses on management.

# E.3 Focal Species Strategies

## E.3.1 Focal Plant Species

### E.3.1.1 Rationale for Goals and Objectives

#### Goal PLANT1: Conserve Focal Plant Species Populations

Landscape and natural community-level objectives that contribute to the conservation of focal plant species:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations;* and *L1.3, Environmental Gradients,* provide for the conservation of large interconnected areas across environmental gradients to support sustainable focal plant species populations and provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species*, provides for control of invasive plant species, such as Italian ryegrass and perennial pepperweed, that threaten the focal plant populations in vernal pool and alkali prairie natural communities.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change;* and *L4.4, Population Viability and Biodiversity Resilience with Climate Change,* will further provide for monitoring and adaptive management to address threats to the focal plant species from climate change. These plant species occur in vernal pool and alkali prairie natural communities, both of which are highly restricted in distribution and particularly vulnerable to the effects of climate change.
- *Objectives VP1.1, Protect Vernal Pools,* will benefit the focal plant species dependent on vernal pools by increasing the level of protection on the species' habitat.
- *Objectives VP1.2, Vernal Pool Pollinators,* may benefit the focal plant species dependent on vernal pools by maintaining important pollinators for these species.

**Objective PLANT1.1: Protect focal plant species habitat and occurrences**

*Protect currently known but unprotected or newly discovered unprotected habitat for focal plant species, prioritizing occupied habitat.*

***Rationale.*** Habitat protection will ensure significant patches of habitat in Yolo County will be available to support existing occurrences and any future expansion of occurrences.

Although an estimated 77 percent of the alkali milk-vetch and Heckard's pepper-grass habitat is protected on Category 1–3 lands, only an estimated 25 percent of this habitat is fully protected on Category 1 lands (Table 3-3). These species would benefit by increasing the level of protection on the Category 2 and 3 lands, with an emphasis on protecting lands that support occurrences of alkali milk-vetch and Heckard's pepper-grass.

Although an estimated 76 percent of the brittlescale and spearscale modeled habitat is protected on Category 1–3 lands, only an estimated 24 percent of this habitat is fully protected on Category 1 lands. These species would benefit by increasing the level of protection on the Category 2 and 3 lands, with an emphasis on lands that support occurrences of brittlescale and spearscale.

All of the Baker's navarretia modeled habitat is protected on Category 1–3 lands, but less than one percent is fully protected on Category 1 lands. This species would benefit by increasing the level of protection on the Category 2 and 3 lands, with an emphasis on lands that support occurrences of Baker's navarretia.

The only known occurrence of palmate-bracted bird's-beak in Yolo County is in Woodland Regional Park, a property owned by the City of Woodland, and on two adjacent private parcels protected by conservation easement and managed by the Center for Natural Lands Management. The Woodland Regional Park site will be protected, managed, and enhanced for palmate-bracted bird's-beak as part of the Yolo HCP/NCCP. No further protection is needed for this species.

An estimated 96 percent of the Solano grass and Colusa grass habitat is protected on Category 1–3 lands, less than 1 percent of which is fully protected on Category 1 lands. These species would benefit by increasing the level of protection on the Category 2 and 3 lands, prioritizing those lands that support occurrences of Solano grass and Colusa grass.

#### Objective PLANT1.2. Maintain or increase focal plant species abundance

*Maintain or increase the mean annual abundance of focal plant species in protected habitat within Yolo County*.

***Rationale***. Increasing the abundance of the focal plant species on protected habitat will help ensure the species' ongoing existence in Yolo County with any future changes in environmental conditions (e.g., climate change).

#### Objective PLANT1.3. Protect Focal Plant Species Habitat.

*Protect 7 acres of modeled alkali milk-vetch, brittlescale, Heckard's pepper-grass, palmate bracted birds-beak, and San Joaquin spearscale habitat*.

***Rationale***. Protecting alkali milk-vetch, brittlescale, Heckard's pepper-grass, palmate bracted birds-beak, and San Joaquin spearscale habitat will help reduce the stressor of habitat loss, and enable the protected occurrences to be managed for sustainability.

#### Objective PLANT1.4. Enhance focal plant species habitat.

*Enhance 64 acres consisting of modeled Baker's navarretia, Colusa grass, and Solano grass habitat and surrounding uplands within the vernal pool watershed*.

***Rationale***. Enhancing 64 acres of modeled Baker's navarretia, Colusa grass, and Solano grass habitat and surrounding uplands within the vernal pool watershed habitat will help to ensure that protected habitat in Yolo County will continue to sustain focal plant species.

## E.3.1.2 Climate Change

### Focal Plant Species Vulnerability to Climate Change

Like all organisms, for populations of the focal plant species to survive climate change-related stress, they need to be able to adapt to (or tolerate) stress caused by climate change, or move away from stress caused by climate change into areas that are either still suitable or newly suitable under changed climate conditions. In general, the predicted consequence of climate change will result in shifts of suitable habitat to higher elevations and latitudes (Jump and Penuelas 2005). For example, changes in precipitation and temperature patterns could change the critically timed filling and drying periods of vernal pools that most of focal plants species rely on; changes in monthly timing of precipitation has been identified as causing decreases in species richness and germination (Bliss and Zedler 1997, Kneitel 2014). Although the specific effects of climate change are unknown, the effects of increased winter flooding and drought conditions in the spring and summer have the potential to adversely affect the focal plant species (U.S. Fish and Wildlife Service 2008). If climate change causes current habitat to become unsuitable, populations will have to either 1) migrate to suitable habitat, 2) adapt to the new conditions, or 3) go extinct. If the climate changes more rapidly than either #1 or #2, then extinction will be inevitable (Thomas et al. 2004). Under climatic changes, temperature and water availability are the two variables most often documented as influencing either genetic change or physical movement (summarized in Jump and Penuelas 2005). Where plant populations persists on only marginal habitat, the addition of drought conditions is likely to result in high rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has creased (U.S. Fish and Wildlife Service 2008).

How individual species or populations are affected by changed conditions under a different climate are largely influenced by their phenotypic plasticity and their ability to move. Phenotypic plasticity can accommodate short-term changes and potentially lead to long-term genetic change, but if changes are drastic, the ability of plasticity to accommodate the change will reach its limit and dispersal will be necessary (Murren et al. 2015). The ability to move is influenced by dispersal methods (e.g., can dispersal occur fast enough to outpace threats) and barriers, either natural barriers (e.g., ecotones, change in soil type) or human-made barriers (e.g., developed landscapes). This conservation strategy facilitates adaptation to climate change by recommending conservation actions that facilitate dispersal across the landscape.

Anacker et al. (2013) conducted a climate vulnerably assessment of 156 plant species in California. Of the eight focal plant species in the strategy area, only brittlescale and San Joaquin spearscale were included in this analysis (Table X). Both species were determined to be highly vulnerable to climate change based on life history attributes and distribution model results, as specified by the Climate Change Vulnerability Index of NatureServe. Factors considered in evaluating species' responses to climate change can be divided into four categories: direct exposure (i.e., temperature and precipitation), indirect exposure (i.e., effects due to landscape configuration and human action), sensitivity (i.e., life history) and modeled response (i.e., species distribution models). For direct exposure on brittlescale and San Joaquin spearscale, the temperature across approximately 90 percent of their ranges is expected to increase by between 3.9 and 4.4 degrees Fahrenheit by 2080 and the net change in moisture is expected to be reduced by 0.028 to 0.05 (with the remainder of their ranges being increasingly hot and dry). Factors in the other three categories that are predicted to increase climate change vulnerability on brittlescale and San Joaquin spearscale include barriers, land use changes, reliance of specific thermal and hydrologic conditions, geological restrictions, and changes in range or abundance (Table X). Although the other six focal plant species were not included in the climate vulnerability analysis, they would be expected to be affected by the same or similar factors and have a similar vulnerability rating because they have similar life histories, occur in the same locations in the RCIS strategy area, and would be subject to the same threats and stressors. All of the focal plant species are restricted to certain types of habitats which have a limited distribution in the strategy area. In addition, the large expanses of surrounding unsuitable agriculture and urban development leave these species with little ability to shift their ranges in response to climate change.

**Table F-1. Climate Vulnerability Scoring for Brittlescale and San Joaquin Spearscale (Source: Anacker et al. 2013)**[1]

| Criteria | Effect on Vulnerability | |
|---|---|---|
| | **Brittlescale** | **San Joaquin spearscale** |
| **Direct Exposure** | | |
| Temperature | +3.9 and 4.4 degrees (91 % of range) | +3.9 and +4.4 degrees (88% of range) |
| Moisture | -0.028 to -0.05 (84% of range) | -0.028 to -0.05 (92% of range) |
| **Indirect Exposure** | | |
| Natural barriers | Somewhat increase | N/A |
| Anthropogenic barriers | Increase | Somewhat Increase |
| Land use changes | Increase | Somewhat increase and increase |
| **Sensitivity** | | |
| Historical thermal niches | Neutral, somewhat increase, and increase | Neutral, somewhat increase, and increase |
| Historical hydrologic niches | Somewhat increase | Somewhat increase |
| Restrictions to uncommon geological features or derivatives | Somewhat increase | Somewhat increase |
| **Modeled Response** | | |
| Modeled future (2050) change in population or range size | Increase | Increase |
| Overlap of modeled future (2050) range with current range | Increase | Increase |

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The RCIS conservation strategy for focal plant species recommends permanent protection (via conservation easements) of habitat occupied by focal plant species, as well as suitable but unoccupied habitat, and maintaining or increasing the abundance of known populations in the strategy area through monitoring and adaptive management. Achieving these objectives will ensure that populations are large enough to persist as climate conditions change and have the ability to shift their distribution into suitable but unoccupied habitat if portions of their range are no longer suitable, as predicted by the modeled response. Protection of the largest blocks of habitat possible for the focal plant species will help ensure their long-term survival. Further, the focus of this RCIS' natural community conservation strategy is to protect additional vernal pool complexes (Goal VP1, *Vernal Pool Conservation)* and alkali prairie (Goal AP1, *Alkali Prairie*), and work to control or eradicate invasive plant species (Objective L3.1, *Invasive Plant Species*), which will enhance suitable (but potentially unoccupied) habitat for the focal plant species in the RCIS area and providing future migration opportunities.

[1] Definition for each criteria and additional information the vulnerability assessment can be found at https://www.wildlife.ca.gov/Data/Analysis/Climate

# E.3.2 Focal Vernal Pool Invertebrates

## E.3.2.1 Rationale for Goals and Objectives

### Goal VPI1: Vernal Pool Invertebrate Conservation

Landscape and natural community-level objectives that contribute to the conservation of vernal pool invertebrate species:

- *Objectives L1.1, Landscape Connectivity*; *L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients,* provide for the conservation of large interconnected areas across environmental gradients to support sustainable focal species populations and provide for shifts in distribution with climate change, if possible given narrow range of environmental requirements.
- *Objective L3.1, Invasive Species*. Achieving the objective will provide for control of invasive plant species, such as Italian ryegrass and perennial pepperweed, which degrade vernal pool habitat.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity resilience with climate change.* Achieving the objective will further provide for monitoring and adaptive management to address threats to the focal invertebrate species from climate change. Vernal pools are highly restricted in distribution and particularly vulnerable to the effects of climate change.
- *Objectives VP1.1, Protect Vernal Pools.* Achieving the objective will benefit the vernal pool invertebrate species dependent on vernal pools by increasing the level of protection on the species' habitat.

#### Objective VPI1.1: Enhance vernal pool invertebrate habitat

*Enhance 64 acres consisting of both modeled vernal pool fairy shrimp, vernal pool tadpole shrimp, California linderiella, Conservancy fairy shrimp, and Midvalley fairy shrimp habitat and surrounding uplands within the vernal pool watershed*.

***Rationale.*** Enhancing vernal pool invertebrate habitat will help ensure the species' ongoing existence in Yolo County with any future changes in environmental conditions (e.g., climate change).

## E.3.2.2 Climate Change

### Vernal Pool Invertebrate Vulnerability to Climate Change

No species-specific vulnerability analysis has been conducted for the focal vernal pool invertebrates. However, the U.S. Fish and Wildlife Service 5-Year Review for vernal pool fairy shrimp (U.S. Fish and Wildlife Service 2007a) and vernal pool tadpole shrimp (U.S. Fish and Wildlife Service 2007b) include an analysis of the effects of climate change on vernal pool invertebrates in California.

The life history of the vernal pool invertebrates (i.e., shrimp species) in the strategy area are inextricably tied to California's climate. The vernal pool invertebrates require shallow pools that fill (i.e., precipitation) and dry (i.e., temperature) over short periods of time; climate change is expected to affect vernal pool inundation patterns and temperature regimes (U.S. Fish and Wildlife Service 2007a). Vernal pools in California's Central Valley are particularly sensitive to slight increases in evaporation or reductions in rainfall due to their shallowness and seasonality (Field et al. 1999). Climate change could have a number of other effects on vernal pools including altering marginal pools towards more of less favorable periods of inundation, changes to water chemistry, decreases in water depth, and occupation by non-native species (U.S. Fish and Wildlife Service 2007a and U.S. Fish and Wildlife Service 2007b).

The ability of the vernal pool invertebrates to survive is likely to depend on their ability to disperse to pools where conditions are suitable (Bohanak and Jenkins 2003, Bonte et al. 2004). Loss and fragmentation of vernal pool habitat is thought to decrease dispersal ability (U.S. Fish and Wildlife Service 2007a). The vernal pool invertebrates may disappear from some areas to be replaced by more tolerant species or rapid extinctions of populations could occur (McLaughlin et al. 2002). Changes to water depth and the inundation period could cause pools to dry before shrimp have completed their life cycle, or cause pool temperatures to exceed those suitable for hatching or species persistence (U.S. Fish and Wildlife Service 2007c).

#### How the RCIS/LCP Conservation Strategy Addresses Climate Change

Although the exact future effects of climate change on shrimp species cannot be determined, as described above, habitat variability and connectivity are expected to be key to their survival. Protecting existing occurrences and large blocks of occupied and unoccupied habitat that provide shrimp with a range of conditions will buffer against the effects of climate change. For example, larger and deeper vernal pools will hold water even during periods of drought and can act as source populations for other shallower vernal pool. Through the conservation strategy, vernal pool shrimp will have access other habitat areas, should conditions at occupied locations change. Since the exact effects of climate change on vernal pool invertebrates are unclear (as described above), the conservation strategy recommends monitoring and adaptively managing populations of vernal pool invertebrates in the strategy area in order to most effectively maintain populations over time as conditions change.

## E.3.3 Valley Elderberry Longhorn Beetle

### E.3.3.1 Rationale for Goals and Objectives

#### Goal VELB1. Maintenance of Valley Elderberry Longhorn Beetle Populations.

The following landscape and natural community objectives contribute to the conservation of valley elderberry longhorn beetle in Yolo County.

- *Objectives L1.1, Landscape Connectivity*; *L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients*. Achieving the objective will provide for the conservation of large interconnected areas across environmental gradients to support sustainable valley elderberry longhorn beetle populations and provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species*. Achieving the objectiveprovides for control of invasive plant species that may otherwise outcompete elderberry shrubs.
- *Objectives L4.2, Landscape Resilience with climate Change*; *L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with*

*Climate Change*. Achieving the objectivewill further provide for monitoring and adaptive management to address threats to valley elderberry longhorn beetle from climate change.

- *Objectives WF1.1, Manage and Enhance Oak Woodlands*, may benefit valley elderberry longhorn beetle if enhancement includes planting elderberry shrubs in the oak woodland understory.
- RCIS/LCP Objectives R1.1, *Protect Riparian Areas;* R1.2, *Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas,* may benefit valley elderberry longhorn beetle if elderberry shrubs are present in the protected, restored, and/or enhanced riparian areas.

#### Objective VELB1.1: Protect and Manage Valley Elderberry Longhorn Beetle Populations

*Protect 10 elderberry shrubs and successfully establish 30 elderberry shrubs in protected riparian areas.* .

***Rationale.*** Protecting valley elderberry longhorn beetle colonies on conservation easements will help reduce the stressor of habitat loss, and enable the protected colonies to be managed for sustainability.

#### Objective VELB1.2: Valley elderberry longhorn beetle habitat amount, connectivity, and quality

*Increase the amount, connectivity, and quality of valley elderberry longhorn beetle habitat*.

***Rationale***. This species has distinct, relatively isolated populations in individual drainages, likely due to the beetle's limited dispersal capability (Collinge et al. 2001). The species is unlikely to colonize unoccupied drainages, even if suitable habitat is present. This necessitates siting habitat restoration within or in the vicinity of occupied drainages, consistent with Objective VELB1.1. Known occupied habitat in the Plan Area occurs in Conservation Zones 2 and 7 in three occurrences, but additional known occurrences are expected to be found as the reserve system is assembled. Some occurrences are known from agricultural ditches and railroad tracks; however, these locations do not provide opportunities to restore dense patches of elderberry shrubs within a riparian matrix directly adjacent to occupied areas. In these cases, restoration should be located within reasonable dispersal distance for the valley elderberry longhorn beetle from known occurrences.

## E.3.3.2 Climate Change

### Valley Elderberry Longhorn Beetle Vulnerability to Climate Change

No species-specific vulnerability analysis has been conducted for valley elderberry longhorn beetle. However, in the report to document to withdraw the proposed removal of the valley elderberry longhorn beetle as an endangered species (U.S. Fish and Wildlife Service 2014), the U.S. Fish and Wildlife Service discusses climate change in the Central Valley and California and the effects of these changes related to valley elderberry longhorn beetle. The findings in this document are discussed in the following paragraph.

The valley elderberry longhorn beetle is reliant on the availability of its host plants, blue elderberry (*Sambucus nigra* ssp. *caerulea*) and red elderberry (*Sambucus racemosa*), for its survival and reproduction. Like any insect-host plant relationship, the persistence of this species requires not only healthy populations but also accessible, high-quality habitat. At the natural community level, riparian ecosystems and the elderberry shrubs therein, are dependent upon the ecological processes supported by climate conditions. Climate change is predicted to change the hydrological patterns in the Central Valley due to changes in temperature and precipitation. Snowpack and snowmelt, which drives California's watersheds, is expected to be reduced and the frequency and duration of drought conditions is expected to increase. Thus, as the intensity of both wet and dry periods change, streamflow patterns and flow regimes (both in volume and timing) in California's watersheds for riverine systems, including riparian vegetation, will be altered. As the groundwater and surface water level inputs to riparian systems are modified, shifts in location and species composition of riparian vegetation can occur (U.S. Fish and Wildlife Service 2014).

#### How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the conservation strategy for valley elderberry longhorn beetle is to protect known populations, increase habitat availability and improve habitat quality. Protecting existing occurrences, enhancing those habitats to improve productivity, and protecting and managing larger blocks of habitat so that individuals will have access to other habitat areas - should conditions at historical locations change - are all important tools for land managers to provide adaptations to climate change. Because this species occurs in isolated populations in individual drainages, focusing on the protection of known occurrences and suitable habitat within and adjacent to known occurrences is a sufficient strategy for allowing valley elderberry longhorn beetle to adapt to climate change. Furthermore, habitat restoration will help to offset the effects of any habitat loss in the strategy area. The RCIS will concentrate on restoration and enhancement efforts of valley elderberry longhorn beetle habitat that will connect existing colonies to create more robust colonies that can expand and interact in the face of climate change. Shifts in habitat are expected to occur and valley elderberry long beetle may need to shift to new habitat areas, provided they are protected and accessible.

The conservation strategy recommends actions to manage riparian and stream habitat in the RCIS area (Chapter 3, Table 3-2), which will also serve to buffer these habitats from climate change. Achieving Goal R1, *Riparian Conservation*, will protect, increase, enhance riparian habitat, all of which will serve to maintain functional riparian habitat for the valley elderberry longhorn beetle in the RCIS area. Similarly, RCIS/LCP Goal LR1, *Stream Conservation*, if achieved, will conserve and enhance stream systems, including stream processes and conditions, which will help to counter the effects of climate change on hydrological processes in the RCIS area.

## E.3.4 Focal Fish Species

### E.3.4.1 Rationale for Goals and Objectives

#### Goal CVS1: Protected and Enhanced Focal Fish Species Habitat

The following landscape and natural community objectives contribute to the conservation of focal fish species.

- *Objectives L1.1*, *Landscape Connectivity*; *L1.2*, *Areas to Support Sustainable Populations*; and *L1.3*, *Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to support sustainable populations of focal fish and their food sources, and provide for shifts in distribution with climate change. Providing a range of environmental gradients will ensure the long-term persistence of a diversity of spawning and rearing conditions for delta smelt in Yolo County.

Providing a range of environmental gradients within floodplains will ensure that diverse rearing and migration conditions exist for Chinook salmon in Yolo County. Maintaining or increasing life-history diversity is particularly applicable to species such as Chinook salmon. Three races of Chinook salmon occur within Yolo County (winter-run, spring-run, and fall-run/late fall–run), each of which exhibits different life-history strategies, such as duration of rearing in freshwater environments before smoltification and migration from fresh water to the ocean. Providing a range of environmental gradients is intended to provide a range of suitable habitat conditions for the varied life-history strategies exhibited by the covered species.

- *Objective L1.4*, *Natural Community Restoration.* Achieving this objective will provide for restoration of vegetation communities associated with aquatic habitat (i.e., riparian and fresh emergent wetland) to provide cover, habitat complexity, and food sources for the focal fish species.
- *Objective L2.1*, *Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will restore natural fluvial processes to improve habitat conditions through increased lateral river channel migration and floodplain connectivity/inundation, which can increase sediment inputs. Increased sediment inputs can increase turbidity, which facilitates delta smelt foraging effectiveness and predator avoidance (Nobriga and Herbold 2009). Floodplain inundation may also contribute to a seasonal increase in primary productivity and invertebrate production (Müller-Solger et al. 2002; Lehman et al. 2008) that will contribute to a more diverse and robust forage base for adult and juvenile delta smelt.
- *Objective L3.2, Pollutants and Toxins*. Achieving this objective may benefit focal fish species by reducing pesticides and herbicides that can be highly toxic to plankton. Plankton form the base of the focal fish species' foodweb. Achieving this objective may also reduce sublethal effects (e.g., effects on behavior, tissues and organs, reproduction, growth, and immune system) (Connon et al. 2010), of contaminants such as pyrethroids and other chemicals from urban stormwater runoff. Decreasing the discharge of these contaminants is intended to improve water quality conditions in Yolo County and thereby benefit the focal species. These water quality improvements may also support a more robust foodweb and contribute to increasing food resources for focal fish species.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to the focal fish species from climate change.
- *Objectives WF3.2, Restore and Enhance Riparian Oaks; R1.1, Protect Riparian Areas;* and *R.2*, *Increase Riparian Areas.* Achieving this objective will contribute directly and indirectly to the production of food available to focal fish species in the aquatic system, which is expected to contribute to an increase in survival. It also has other benefits, such as increasing habitat complexity and thermal insulation, known to be important to juvenile salmonids. Riparian natural community contributes important functions to the aquatic system by providing large woody debris recruitment, increased bank stability, reduced erosion, flow attenuation during flood events, organic inputs, and shade and thermal insulation, all of which provide benefits to focal fish species.

- *Objectives FW1.1, Protect Fresh Emergent Wetlands;* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will help to increase primary productivity, which could result in more food available to the focal fish species. It could also provide delta smelt spawning and early rearing habitat. Fresh emergent wetland protection and restoration may also promote effective exchange throughout the marsh plain to increase transport and delivery of food to habitats occupied by focal fish species. Increasing the transport of food is anticipated to contribute to an increase in growth and fecundity.
- *Objective FW1.3*, *Minimize Submerged Aquatic Vegetation.* Achieving this objective will reduce invasive species in shallow areas that provide predatory fish an advantage over the focal fish species (Santos et al. 2011). Additionally, it may reduce the adverse effects of lowered turbidity that results from submerged aquatic vegetation, as delta and longfin smelt have evolved in and adapted to turbid waters.
- *Objective LR1.1, Fluvial Equilibrium.* Achieving this objective will improve hyporheic processes, such as groundwater recharge, which can improve water quality, provide cool water inputs, and maintain flow inputs to surface waters to benefit the focal fish species.
- *Objective LR1.3, Native Vegetation.* Achieving this objective will provide shaded cover along waterways that may support focal fish species. Achieving this objective may also contribute to an increase in organic inputs, such as terrestrial insects and plant matter, to provide a nutrient source increase for the productivity of aquatic systems. This increase in productivity may contribute to a more diverse and robust forage base.
- *Objective LR1.4, Stream Processes and Conditions.* Achieving this objective will contribute to an increase in river-floodplain connectivity and potentially improved hyporheic processes, such as groundwater recharge, which can improve water quality, provide cool water inputs, and maintain flow inputs to surface waters.

### Objective FISH1.1: Shaded riverine aquatic habitat

*Increase the area of shaded riverine aquatic habitat in Yolo County that supports focal fish species.*

***Rationale:*** Shaded riverine aquatic habitat is important for fish species because overhanging riparian vegetation provides several types of habitat values (from CVFPP Conservation Strategy [DWR 2016]):

### Objective FISH1.2: In-stream marsh habitat

*Increase the area of in-stream marsh habitat in Yolo County that supports the focal fish species.*

***Rationale.*** Increasing in-stream marsh habitat will increase primary productivity, which could result in more food available to the focal fish species. It could also provide delta smelt spawning and early rearing habitat. This may also promote effective exchange to increase transport and delivery of food to habitats occupied by focal fish species. Increasing the transport of food is anticipated to contribute to an increase in growth and fecundity. Increasing in-stream marsh habitat will also provide rearing habitat and refuge from larger predators for several focal fish species.

#### Objective FISH1.3: Passage barriers

*Remove or modify passage barriers that prevent access of focal fish species to spawning and rearing habitat, and build or modify barriers to prevent passage into detrimental locations.*

***Rationale.*** Barriers to fish passage are prevent migration through Yolo County and prevent individuals from completing critical stages of their life cycle, including spawning. Several passage barriers have been identified in Putah Creek (DWR 2005, NMFS 2014).

In addition, some barriers should be constructed to prevent individuals from entering detrimental areas. The Wallace Weir Fish Rescue Facility and Knights Landing Outfall Gate projects are two recent examples of projects completed in Yolo County to block Chinook salmon from entering areas where they would become trapped and unable to reach spawning grounds. A potential project in Yolo County for consideration is the leaky lock at the northern end of the Sacramento Deep Water Ship Channel (NMFS 2014). Adults stray into the Deep Water Ship Channel due to false cues from the Sacramento River passing through the lock (). Preventing water from the Sacramento River from leaking through the lock would reduce the risk of straying into the Deep Water Ship Channel.

#### Objective FISH1.4: Large Woody Material

*Increase large woody material in focal fish species habitat to provide complexity and predator refuges for focal fish species in streams in Yolo County.*

***Rationale.*** Channelization and clearing of vegetation along levees has led to loss of large woody material input to streams and rivers. Large woody material provides habitat complexity and cover for the focal fish species.

#### Objective FISH1.5: Yolo Bypass inundation

*Increase inundation in the Yolo Bypass so that it reaches an optimized magnitude, frequency, and duration that will benefit native fish while using an Integrated Water Management (IWM) approach. An IWM approach utilizes a system-wide perspective and considers all aspects of water management, including public safety and emergency management, environmental sustainability, and the economic stability of agricultural and recreational uses of the Bypass.*

***Rationale.*** The Yolo Bypass is an important area for multiple uses, including but not limited to flood control, agriculture, and wildlife habitat. The RCIS/LCP must therefore balance actions that benefit the focal fish species with other uses in the Yolo Bypass.

The Yolo Bypass, found at the eastern edge of Yolo County on the lower Sacramento River, is one of the largest contiguous floodplains in California. The bypass is a critical feature of the Sacramento River Flood Control Project, which conveys floodwaters from the Sacramento and Feather Rivers and their tributary watersheds.  Unlike conventional flood control systems that frequently isolate rivers from their ecologically essential floodplain habitats, the Yolo Bypass has been engineered to allow the Sacramento River Valley floodwaters to inundate a broad floodplain 40 miles long across 59,000 acres.

Yolo Bypass provides aquatic habitat for 42 fish species, 15 of which are native (Sommer et al. 2001a). The bypass seasonally supports several endangered fish species, including delta smelt and longfin smelt (both of which are found only in the lower bypass, in the Cache Slough area), Sacramento splittail, steelhead, and several runs of Chinook salmon. Typical winter and spring spawning and rearing periods for native Delta fish coincide with the timing of the flood pulse (Sommer et al. 2001b). Unlike much of the rest of the Sacramento-San Joaquin Delta (Delta), which is dominated by nonnative fish, the Yolo Bypass is less likely to be dominated by nonnative fish species because the majority of the floodplain habitat is seasonally dewatered, creating unfavorable conditions for many nonnative fish (Sommer et al. 2001b).

Fisheries biologists have noted that floodplain inundation during high-flow years may favor native aquatic species in the estuary. The Yolo Bypass is an important nursery for young fish, and may help to support the foodweb of the San Francisco Estuary. Adult fish use the Yolo Bypass as a migration corridor (i.e., Chinook salmon and sturgeon) and for spawning (i.e., Sacramento splittail) (Harrell and Sommer 2003). Inundation of the Yolo Bypass is expected to increase production of zooplankton and dipteran larvae (prey resources for covered fish species), mobilization of organic material, and primary production (Sommer et al. 2001a, Benigno and Sommer 2008, Opperman 2012).

Increased frequency of Yolo Bypass inundation will enhance the existing connectivity between the Sacramento River and the Yolo Bypass floodplain habitat. It can increase production of zooplankton and dipteran larvae (prey resources for covered fish species), mobilization of organic material, and primary production, with conditions suitable for spawning, egg incubation, and larval stages for covered fish species such as Sacramento splittail (if inundation is greater than 30 days). Seasonal flooding in the Yolo Bypass should occur when it will be most effective at supporting native fish species (i.e., when it is in synchrony with the natural timing of seasonally occurring hydrologic events in the watershed).

Increased magnitude of Yolo Bypass inundation has the potential to increase primary and secondary aquatic productivity. Flooding increases the volume of water (areal extent and depth) in the photic zone, allowing for conditions that can result in increases in phytoplankton biomass. Increased biomass may lead to an increase in the abundance of zooplankton and planktivorous fish. This increase in primary and secondary productivity in the foodweb is expected within the immediate Yolo Bypass area, but may also be exported downstream with the phytoplankton and zooplankton.

lncreased duration of inundation is expected to provide benefits to juvenile Chinook salmon and other native species (Opperman 2012). Takata et al. (2017) found that total growth rate of juvenile Chinook salmon in the Yolo Bypass was positively associated with floodplain duration. Further, Sommer et al. (2001b) noted that growth, survival, feeding success, and prey availability in the Yolo Bypass were all higher in a high flow year (1998) relative to a lower flow year (1999).

Modifications to topography and weirs are expected to improve fish passage and reduce the risk of migration delays and stranding of adult fish. Stranding of fish and subsequent predation by birds and piscivorous fish have been identified as sources of mortality for juvenile salmon rearing within the floodplain habitat (Sommer et al. 2001b, 2005; BDCP Integration Team 2009). Illegal harvest of covered fish species may also be a potential source of mortality that could be exacerbated by existing migration delays, low flows, and stranding caused by shorter inundation periods.

### Objective FISH1.6: Restore Putah Creek Fish Habitat

*Support and partner with existing efforts to restore Putah Creek habitat in Yolo County to enhance spawning, rearing, and migration of focal fish species.*

***Rationale.*** The restoration of Putah Creek for fish benefit has been the focus of several stakeholder groups, such as the Putah Creek Council and the Lower Putah Creek Coordinating Committee. These groups have identified several restoration projects to undertake in Putah Creek. Many have not been funded or completed but could be completed with additional support.

#### Objective FISH1.7: Non-native predators

*Reduce non-native predator habitat by restoring more natural hydrologic and geomorphologic processes in streams.*

***Rationale.*** Although a natural part of the estuarine ecosystem, predation has been identified as a stressor to the focal fish species (Essex Partnership 2009). Fish and wildlife whose habitats have been greatly simplified and fragmented cannot sustain naturally occurring predation rates. Habitat for fish predators generally provides a specific suite of attributes that allow them to forage more efficiently, such as dark locations adjacent to light locations or deep pools that allow the predator to hide and ambush their prey from below. Different predators each have their niche, however, so most habitats have some kind of predator that can take advantage of elevated prey vulnerability. The key examples are extensive steeply banked and riprapped channels and large beds of Brazilian waterweed (*Egeria densa*) and similar invasive submerged aquatic vegetation that have overgrown shallow areas (Santos et al. 2011).

Fish predators tend to be attracted to instream structures (Gingras 1997), and new diversion structures in the Sacramento River may attract predators (Essex Partnership 2009). Striped bass, for example, have been shown to aggregate around instream structures in the Sacramento River from Red Bluff to the Delta. New intake structures in the Sacramento River may create a local hydraulic discontinuity that may provide ambush sites for striped bass. Predation rates on Chinook salmon, steelhead, white sturgeon, and Sacramento splittail may increase as a result of installing intake structures and other instream structures (Essex Partnership 2009).

#### Objective FISH1.8: Research

*Support short-term research projects to gain an understanding of multiple benefits of seasonal inundation on agricultural lands, including providing focal fish species spawning and rearing habitat.*

***Rationale.*** Recent work has demonstrated that flood control, agriculture, and fish habitat can co-exist in the Yolo Bypass (Katz et al. 2013). There are several unknowns regarding the benefits to fish and wildlife on agricultural lands, including understanding the dynamics of fish survival on and emigration from managed agricultural floodplains and refining timing and duration of inundation to maximize fish benefits.

#### Objective FISH1.9: Restore focal fish species fresh emergent wetland habitat.

*Restore 50 acres of fresh emergent wetland in Yolo Bypass to benefit Delta smelt, white sturgeon, Central Valley steelhead, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley fall/late fall-run Chinook salmon.*

***Rationale.*** Restoring fresh emergent wetland habitat in Yolo Bypass will benefit focal fish species by increasing and improving the amount of habitat in the RCIS area.

**Objective FISH1.10: Restore and manage focal fish species riparian habitat.**

*Restore and manage at least five acres of valley foothill riparian natural community along Tule canal to benefit green sturgeon, Central Valley steelhead, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley fall/late fall-run Chinook salmon..*

***Rationale.*** Restoring and managing valley foothill riparian habitat along the Tule canal will benefit focal fish species by increasing and improving the amount of habitat in the RCIS area.

## E.3.4.2 Climate Change

### Focal Fish Species Vulnerability to Climate Change

Moyle et al. (2012) ranked the climate vulnerability of 164 California fish species (121 native fishes and 43 alien (i.e., non-native fish species). Those rankings were divided into two 10-metric modules which evaluated baseline vulnerability (Module 1) and life history characteristics (Module 2). Module 1 was based on existing environmental changes; that is, species already in decline would be more vulnerable to climate change. Module 2 evaluated those life history characteristics that would make a species more or less vulnerable to climate change. The evaluation identified the following ranges of climate vulnerability scores, with the lower values indicating greater vulnerability:

- Module 1 – scores between 18 and 42
- Module 2 – scores between 17 and 32

The combined vulnerability score indicates the degree of vulnerability (Table X); species with combined scores of 35 or less are considered extremely likely to become extinct in the wild by the year 2,100. The results of the analysis (Moyle et al. 2012) indicate that most of the focal fish species are vulnerable to climate change, with salmon and delta smelt being critically vulnerable. Sacramento splittail and both sturgeon species had scores that indicate lower vulnerability to climate change.

**Table F-2. Climate Vulnerability Scoring for the Focal Fish Species as Described in Moyle et al. 2012.**

| Criteria | Module 1 Score Range | Module 2 Score Range | Combined Score (Vulnerability) |
|---|---|---|---|
| Chinook Fall Run Salmon | 17-21 | 12-17 | 29-38 |
| Chinook Late-Fall Run Salmon | 18-24 | 11-15 | 29-39 |
| Chinook Spring Salmon | 17-22 | 11-16 | 28-38 |
| Chinook Winter Salmon | 16-18 | 10-14 | 26-32 |
| Delta Smelt | 13-17 | 11-13 | 24-30 |
| Green Sturgeon | 27-33 | 15-21 | 42-54 |
| Sacramento Splittail | 25-30 | 17-26 | 42-56 |
| Central Valley Steelhead | -- | -- | -- |
| White Sturgeon | 22-29 | 17-24 | 39-53 |

[1] 1.0-1.9 indicates the species is endangered, 2.0-2.9 indicates the species is vulnerable to becoming endangered
[2] EN= Endangered
VU= Vulnerable

In the strategy area, there is little to no spawning habitat accessible for focal fish species; Chinook fall-run salmon may spawn in Putah Creek (but are likely strays). Access to most historical upstream spawning habitat has been eliminated or destroyed by artificial structures (e.g., dams and weirs) associated with water storage and conveyance, flood control, and diversions and exports. The focal fish species already occur at low levels in the other large rivers and streams in the strategy area, with the most limited distributions being delta smelt in the Sacramento River and Stockton Deepwater Ship Channel, steelhead in the Sacramento River and green and white sturgeon in the Sacramento River, Yolo Bypass, and Stockton Deepwater Ship Channel. Much of the remaining accessible habitat has been degraded with the installation of levees, channelization, and riprap or island reclamation. For example, Chinook fall-run salmon can only migrate upstream in Cache Creek under really wet conditions using a complicated migration route and the upstream habitat is unsuitable for successful spawning.

When considering climate change, the biggest concern for fish species generally, and anadromous species specifically, is that there will be less precipitation, and thus less stream flow, or that precipitation will fall in patterns different from how it has fallen historically, and that stream flow will not be adequate during key migration and spawning periods (Moyle et al. 2012). For example, if peak flows flush young salmon from rivers to estuaries before they are physically mature, their chances of survival is greatly reduced (Thomas et al. 2009). Also, there is a concern that if the climate is drier and warmer, that will reduce in-stream habitat quality for fish, especially fish that require cold water habitats, as water temperatures become warmer. Secondarily, in a drier climate, there is the potential for an increase in fire frequency and intensity, which can result in an increased sediment load reaching streams during storm events, further reducing in stream habitat quality for fish species.

### How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the conservation strategy for the focal fish species in the strategy area is to enhance and restore habitat for the focal fish species, as well as target particular areas with site-specific actions that can greatly improve localized fish habitat. Although the anadromous fish species utilize multiple types of habitat, the oceanic portion of their life history is beyond the scope of the conservation strategy. The focus in the strategy area is where fish habitat can be increased along rivers and streams, and in the Delta, by creating more fish-friendly water release practices in the Yolo Bypass and through stream and riparian restoration actions. Riparian restoration along fish-bearing streams, for example, will provide shade, helping to moderate water temperatures even under scenarios where the temperature is warmer than in the past. Another focus of the conservation strategy is to increase access to stream habitat through removal of barriers. The conservation strategy also recommends short-term research projects to better understand the benefits to the focal fish species of inundation on agriculture lands. All of these actions are aimed at improving existing habitat or increasing access to new stream reaches and will help to mitigate the effects of declining habitat conditions due to climate change.

# E.3.5 California Tiger Salamander

## E.3.5.1 Rationale for Goals and Objectives

### Goal CTS1: California Tiger Salamander Conservation

How the landscape and natural community-level objectives contribute to California tiger salamander conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the California tiger salamander population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in California tiger salamander habitat. Increasing native vegetative cover has been shown to increase pond hydroperiod (Marty 2005), thus making aquatic habitat more suitable for California tiger salamander breeding. Additionally, consistent with this objective, the introduction and proliferation of nonnative bullfrogs and other nonnative aquatic wildlife that prey on California tiger salamanders may be reduced. Bullfrogs and predatory fish are a primary source of mortality for this species (Fisher and Shaffer 1996).
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect California tiger salamanders from adverse effects of noise, light, and vibrations from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of California tiger salamander.
- *Objectives L4.2*, *Landscape Resilience with Climate Change;* L4.3, *Natural Community and Habitat Resilience with Climate Change*; and L4.4, *Population Viability and Biodiversity resilience with*

*climate change* . Achieving this objective will further provide for monitoring and adaptive management to address threats to California tiger salamander from climate change.

- RCIS/LCP Objectives CP1.1, *California Prairie Protection;* CP1.2, *Burrowing Rodents;* CP1.3, *Grazing Regimes;* and CP1.4, *Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides upland habitat for California tiger salamander in Yolo County. CP1.2 provides for burrows, which California tiger salamanders require for shelter in upland habitat.

#### Objective CTS1.1: Protect Upland Habitat

*Protect at least 400 acres of modeled upland habitat within 1.3 miles of aquatic habitat for California tiger salamander.*

***Rationale.*** The Dunnigan Hills Planning Unit is the planning unit where most of the California tiger salamander population occurs in Yolo County. This planning unit also supports all the formally designated critical habitat for this species in Yolo County.

#### Objective CTS1.2: Protect Aquatic Habitat

*Within the protected lacustrine and riverine natural community, protect at least 7 acres of California tiger salamander aquatic habitat.*

***Rationale.*** The California tiger salamander depends on aquatic habitat for breeding and its larval stage of development. In Yolo County, the aquatic habitat consists almost entirely of stock ponds within a matrix of California prairie.

#### Objective CTS1.3: Restore and Enhance Habitat

*Increase the acreage and value of California tiger salamander habitat through restoration and enhancement.*

***Rationale.*** Restoring and enhancing habitat is critical because providing for enough of breeding sites on protected lands will ensure that in any given year there will be source populations of California tiger salamander, even when some breeding sites may be too dry.

## E.3.5.2 Climate Change

### California Tiger Salamander Vulnerability to Climate Change

California tiger salamanders have adapted a life history strategy to deal with variable environmental conditions because they evolved in an environment that experiences highly variable annual rainfall events and droughts, (U.S. Fish and Wildlife Service 2017). California tiger salamander breeding success is tied very closely to rainfall amounts and timing, however, and different breeding locations may serve as population sources in different years, buffering the overall population against inter-annual variability (Cook et al. 2005). Despite these life history strategies, climate change could result in even more erratic weather patterns to which California tiger salamanders cannot adapt quickly enough. Drought or considerable changes in rainfall amounts or timing could be detrimental to California tiger salamander populations in the RCIS area if those conditions persist over multiple breeding years.

Wright et al. (2013) estimated that the California tiger salamander was at "intermediate risk" from climate change. They based that estimate on the likelihood of persistence of current species locations in 2050 and the amount of currently suitable habitat that is likely to remain suitable by 2050. They examined both eventualities under four climate change scenarios, so there is considerable variability in their predictions. They estimated that 20% - 80% of current California tiger salamander occurrences would persist through 2050 but that 20% - 99% of modeled suitable area would no longer be suitable. They identified the following bioclimatic factors as affecting the California tiger salamander.

- Annual mean temperature
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Minimum temperature of coldest month (i.e., the minimum monthly temperature over a given year)
- Annual temperature range
- Precipitation of the wettest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)
- Precipitation of the driest quarter (3 months) (i.e. total precipitation during the driest quarter)

Across the four climate change scenarios, the prediction of future habitat varies from much of the current habitat in the strategy area remaining suitable, to scenarios where hardly any of it remains suitable and habitat is much patchier.

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the Yolo RCIS/LCP conservation strategy for California tiger salamander is to protect existing occurrences, enhance habitats to improve productivity, and protect and manage larger blocks of habitat so that individuals will have access to other habitat areas, should conditions at historical locations change. Since most of the habitat and many of the known occurrences in the strategy area are located in the Dunnigan Hills Planning Unit, this area is the focus of the conservation strategy. Since they are likely to persist through at least 2050, focusing on the protection of known occurrences, suitable habitat, and designated critical habitat, this is a sufficient strategy for allowing California tiger salamander to adapt to climate change. The conservation strategy includes objectives for both upland and aquatic habitat to support all life stages of California tiger; however restoration actions will focus on aquatic habitat to improve breeding and larval development. Aquatic habitat restoration is critical because providing for enough duplication of breeding sites on protected lands will ensure that in any given year there will be source populations of California tiger salamander, even when some breeding sites may be too dry. The RCIS recommends protecting and restoring California tiger salamander habitat in the Dunnigan Hills Planning Unit. Achieving this objective will ensure enough variability across the landscape that the population as whole will persist, even is some locations become less suitable.

# E.3.6 Western Spadefoot

## E.3.6.1 Rationale for Goals and Objectives

### Goal WS1: Maintenance of Western Spadefoot Distribution and Abundance

*Maintain the distribution and abundance of western spadefoot within its range in Yolo County.*

How the landscape and natural community-level objectives contribute to western spadefoot conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the western spadefoot population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in western spadefoot habitat. Increasing native vegetative cover has been shown to increase pond hydroperiod (Marty 2005), thus making aquatic habitat more suitable for western spadefoot breeding.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western spadefoots from adverse effects of noise, light, and vibrations from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of western spadefoot.
- *Objectives L4.2*, *Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to western spadefoot from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides upland habitat for western spadefoot in Yolo County.

#### Objective WS1.1: Upland Habitat Protection.

*Protect at least 400 acres of modeled upland habitat within 1.3 miles of aquatic habitat for western spadefoot..*

***Rationale.*** Protecting adjacent uplands will provide for western spadefoot aestivation and movement between aquatic areas.

#### Objective WS1.1: Aquatic Habitat Protection.

*Protect at least 7 acres of western spadefoot aquatic habitat*.

***Rationale.*** Protection of aquatic breeding habitat for western spadefoot is necessary to ensure ongoing reproduction.

### E.3.6.2 Climate Change

#### Western Spadefoot Vulnerability to Climate Change

Wright et al. (2013) assessed the conservation risk posed by climate change of 153 California reptile and amphibians species in California. Using species distribution modeling programs Wright et al. created species distribution models to forecast the distribution of climatically suitable habitat under four future climate scenarios for 2050. From the projects, they calculated the percentage of currently occupied localities remaining suitable in the future, the change in suitable area within currently occupied localities, and identified the species most and least vulnerable to climate shifting away from conditions that the species is known to tolerate. Vulnerability was calculated as the combined metric of numerous attributes including sensitivity to climates, dispersal ability, and the distribution of available future habitat. Depending on the ranking metric, the assessment identified approximately 60-75% of reptile and amphibian species were predicted to experience <20% direct loss of climatically suitable habitat by 2050 (Wright et al. 2013). Additionally, species ranked highest for risk include many species that are already of conservation concern and tend to be endemic species with small ranges. Wright et al. (2013) identified western spadefoot toad as an 'at-risk' species that the species will likely experience overall reduction in habitat suitability. Two of the climate models estimated that 80% to 100% of the current western spadefoot toad occurrences would remain suitable and persist through 2050, with a percent change of +20% to -20% of predicted suitable habitat within currently occupied habitat, while two other climate models estimated approximately 70% of the current toad occurrences would remain and a 30% decrease in predicted suitable habitat within currently occupied habitat. Although there is some variability across the four climate change scenarios, in general, the prediction of future habitat suitability varies from the current habitat suitability in the strategy area, where remaining suitable habitat is reduced.

The model identified the following bioclimatic factors as affecting habitat suitability for the western spadefoot toad.

- Mean annual temperature
- Mean diurnal range (mean of monthly [max temp – minimum tem])
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Temperature seasonality
- Precipitation of the wettest month
- Precipitation of the driest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)
- Precipitation of the warmest quarter (3 months) (i.e. total precipitation during the quarter with the highest temperature)

Projected effects of climate change in the Sacramento Valley Ecoregion are warmer temperatures, drier conditions with more variable precipitation (PRBO 2011). Potential effects of climate change leading to increased frequency and severity of droughts, as well as intense or extreme precipitation events, can affect the resiliency of small, isolated western spadefoot toad populations, especially those that inhabit ephemeral aquatic environments. Though all wildlife species may experience problems related to seasonal precipitation changes, species that rely on seasonal aquatic habitats for breeding are especially vulnerable. The western spadefoot toad is vulnerable to climate change because of its poor ability to disperse long distance and to colonize new sites and its dependence on specific hydrologic threshold.

### How the RCIS/LCP Conservation Strategy Addresses Climate Change

The overall intent of the conservation strategy for western spadefoot toad is to maintain existing occurrences and abundance in Yolo County. The conservation strategy includes objectives for both upland and aquatic habitat to support all life stages of western spadefoot toad. Adult spadefoot toad spend the majority of their lives in underground burrows in upland habitat until heavy spring rains. After the first rains the toads will imitate surface movements to breeding pools. Moving to find more suitable breeding pools poses increased predation risk from birds and mammals (California Department of Fish and Wildlife 2018). Managing habitat to create larger blocks of contiguous habitat (Objective L1.1, *Landscape Connectivity)*, reduces habitat fragmentation and facilitates the movement of spadefoot toad from current habitat to more suitable habitat under changing climate conditions. This will also serve to better link aquatic breeding habitat and upland habitat. In a warmer, drier climate, the quality and quantity of aquatic habitat may be diminished. Achieving Objective L3-1*, Invasive Species*, controls non-native vegetation, improving the aquatic habitat suitability for spadefoot toad breeding. Achieving Objective CP1.1, *California Prairie Protection*, and Objective CP1.2, *Restore and Enhance Native Prairie*, protects, increases, and maintains the availability of western spadefoot toad habitat by restoring upland habitat for the toads, thereby reducing stressors on these natural communities and making the natural communities that spadefoot toads use more resilient to climate change. Likewise, achieving WS1.1, *Habitat Protection*, protects spadefoot habitat in ponds and associated uplands, prioritizing occupied habitat. Additionally, achieving Objectives L4-2, *Resilience to Climate Change* and Objectives L4.3, *Natural Community and Habitat Resilience with Climate Change*, will monitor the quality of surrounding landscape and natural community and adaptively manage it in response to changing climate conditions to maintain suitable habitat and sustainable spadefoot toad populations in the strategy area. Since western spadefoot toad are likely to persist in the conservation strategy area through at least 2050, focusing on the protection of known occurrences and suitable habitat is a sufficient strategy for allowing spadefoot toad to adapt to climate change.

# E.3.7 Western Pond Turtle

## E.3.7.1 Rationale for Goals and Objectives

### Goal WPT1: Maintenance of Western Pond Turtle Distribution and Abundance

*Maintain the distribution and abundance of western pond turtle within its range in Yolo County.*

How the landscape and natural community-level objectives contribute to western pond turtle conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3*, *Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the western pond turtle population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.

- *Objective L1.5, Ecotone Conservation.* Achieving this objective provides for protection of a gradient of uplands adjacent to streams, which may provide upland habitat for western pond turtle.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western pond turtles from adverse effects of noise, light, and vibrations from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of western pond turtles.
- *Objectives L4.2, Landscape Resilience with Climate Change;* L4.3, *Natural Community and Habitat Resilience with Climate Change*; and L4.4, *Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to western pond turtles from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and CL1.2, *Incorporation of Habitat Elements.* Achieving this objective provides for patches of marsh and other suitable western pond turtle habitat within the agricultural matrix and on agricultural fields, where western pond turtles often occur in association with irrigation and drainage channels.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and FW1.2, *Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of western pond turtle aquatic habitat.
- *Objectives R1.1*, *Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving this objective will provide for the protection and restoration of western pond turtle upland habitat, and for woody riparian vegetation that will contribute to stream systems, providing western pond turtles with cover and basking sites.

### Objective WPT1.1: Protect and Manage Habitat

*Protect at least 480 acres of modeled western pond turtle aquatic habitat and sufficient adjacent uplands to sustain protected turtles occupying the protected aquatic habitat.* ***Rationale.*** Protection of aquatic breeding habitat for western pond turtle is necessary to ensure ongoing reproduction. Protecting adjacent uplands will provide for western pond turtle nesting and movement between aquatic areas.

Western pond turtles spend much of the warmer months in aquatic habitats throughout their range. Aquatic habitat provides favorable environments for foraging, mating, basking, and predator avoidance (Vander Haegen, Clark, Perillo, Anderson, & Allen 2009). Access to high-quality, disturbance-free basking sites is crucial in determining the overall health of a western pond turtle population because such sites allow the species to carry out activities necessary for survival and reproduction (Germano & Rathbun 2008). Emergent basking sites are usually composed of exposed logs, rocks, and emergent vegetation, which can be affected by altered flow regimes from dams.

### Objective WPT1.1: Protect Breeding Occurrence

*Protect at least one breeding occurrence of western pond turtle.*

***Rationale.*** Protection of at least one breeding pair of western pond turtle is necessary to ensure ongoing reproduction.

### E.3.7.2 Climate Change

#### Western Pond Turtle Vulnerability to Climate Change

Wright et al. (2013) assessed the conservation risk posed by climate change of 153 California reptile and amphibians species in California. Using species distribution modeling programs Wright et al. created species distribution models to forecast the distribution of climatically suitable habitat under four future climate scenarios for 2050. From the projects, they calculated the percentage of currently occupied localities remaining suitable in the future, the change in suitable area within currently occupied localities, and identified the species most and least vulnerable to climate shifting away from conditions that the species is known to tolerate. Vulnerability was calculated as the combined metric of numerous attributes including sensitivity to climates, dispersal ability, and the distribution of available future habitat. Depending on the ranking metric, the assessment identified approximately 60-75% of reptile and amphibian species were predicted to experience <20% direct loss of climatically suitable habitat by 2050 (Wright et al. 2013). Additionally, species ranked highest for risk include many species that are already of conservation concern and tend to be endemic species with small ranges. They estimated that generally less than 100% but great than 80% of the current Western pond turtle occurrences would persist through 2050, with a percent change of +20% to -20% of predicted suitable habitat within currently occupied habitat. Based on the models, Western pond turtle falls between low to intermediate risk from climate change. Wright et al. (2013) identified the following bioclimatic factors as affecting the western pond turtle.

- Mean diurnal range (mean of monthly [max temp – minimum tem])
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Temperature seasonality
- Minimum temperature of coldest month (i.e., the minimum monthly temperature over a given year)
- Mean temperature of the warmest quarter (3 months)
- Precipitation of the wettest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)
- Precipitation of the driest quarter (3 months) (i.e. total precipitation during the driest quarter)

Across the four climate change scenarios, the prediction of future habitat suitability varies from the current habitat in the strategy area remaining suitable, where much of the remaining suitable habitat is reduced and habitat is much patchier.

Limited information exists regarding the sensitivity of western pond turtles to climate change. This species can tolerate periods of periodic drought but severe and/or multi-year drought can impact western pond turtle populations (Hallock et al. 2016). Projected effects of climate change in the Sacramento Valley Ecoregion are warmer temperatures, drier, and reduced annual streamflows (PRBO Conservation Science 2011). Potential effects of climate change leading to increased frequency and severity of droughts can affect the resiliency of small, isolated western pond turtle populations, especially those that inhabit ephemeral aquatic environments. Though all wildlife species may experience problems related to drought conditions, species that rely on aquatic habitats are especially vulnerable. The overall intent of the conservation strategy for western pond turtle is to protect existing occurrences, enhance habitats to improve productivity, and protect and manage larger blocks of habitat so that individuals will have access to other habitat areas, should conditions at historical locations degrade and become unsuitable.

### How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy includes objectives for both upland and aquatic habitat to support all life stages of pond turtle; however, restoration actions will focus on increasing the availability of riverine and lacustrine aquatic and associated upland nesting/wintering habitat (Objective WPT1.1). When an aquatic habitat dries, the western pond turtle must either estivate under dry conditions or seek out more suitable habitat. Moving to find more suitable habitat poses increased predation risk, risks of dehydration, and starvation (Purcell et al. 2017). Managing habitat to create larger blocks of contiguous habitat (Objective L1.1, *Landscape Connectivity*, *L1.2, Areas to Support Sustainable Populations*; and *L1.3*, *Environmental Gradients)*, reduces habitat fragmentation and facilitates the movement of pond turtles from current habitat to more suitable habitat under changing climate conditions. Achieving *Objective L1.5, Ecotone Conservation,* provides for protection of a gradient of uplands adjacent to streams, which may provide upland habitat for western pond turtle, which will also serve to better link aquatic habitat and nesting habitat.

In a warmer, drier climate, the quality and quantity of aquatic habitat may be diminished. Achieving Objective FW1.1, *Protect Fresh Emergent Wetlands* and FW1.2, *Increase Fresh Emergent Wetland Areas*, and Objective R1.3, *Maintain or Enhance Riparian Habitat Areas*, protects, increases, and maintains the availability of Western pond turtle habitat by restoring riparian and freshwater emergent wetland habitat, thereby reducing stressors on these natural communities and making the natural communities that pond turtle uses more resilient to climate change. Likewise, achieving Objectives L4.2, *Resilience to Climate Change*, and Objectives L4.3, *Natura Community and Habitat Resilience with Climate Change*, will monitor the quality of surrounding landscape and natural community and adaptively manage it in response to changing climate conditions to maintain suitable habitat and sustainable pond turtle populations in the strategy area. With a decrease in water availability, there is a potential for decrease in suitable habitat within working lands due to changes in agricultural practices and land uses. Loss of suitable habitat in the strategy area would negatively impact western pond turtle population in the strategy area. Actions in the conservation strategy focused on working with private land owners on working lands, including Objective L4.1*, Heterogeneity within Agricultural Lands,* and CL1.2, *Incorporation of Habitat Features,* if achieved, would provide for patches of marsh and other suitable western pond turtle habitat within the agricultural matrix and on agricultural fields, where western pond turtles often occur in association with irrigation and drainage channels, will offset these effects. Since Western pond turtle are likely to persist in the conservation strategy area through at least 2050, focusing on the protection of known occurrences and suitable habitat is a sufficient strategy for allowing Western pond turtle to adapt to climate change.

# E.3.8 Giant Garter Snake

## E.3.8.1 Rationale for Goals and Objectives

### Goal GGS1: Giant Garter Snake Conservation

*Conserve giant garter snake in Yolo County, including the Willow Slough/Yolo Bypass subpopulation and a segment of the Colusa Basin subpopulation, and connectivity between the two subpopulations.*

How the landscape and natural community objectives contribute to giant garter snake conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the giant garter snake population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L1.4, Restore Natural Communities.* Achieving this objective will ensure habitat is restored in a manner that maximizes their success and long-term value for giant garter snake.
- *Objective L3.1*, *Invasive Species.* Achieving this objective will diminish non-native plants and wildlife in Yolo County, thus making aquatic habitat more suitable for giant garter snake. While invasive aquatic plants such as water primrose provide cover for the giant garter snake, they can impede snake movement if they become too dense. Control efforts will take into consideration the cover needs for giant garter snake. Nonnative wildlife species such as bullfrog and largemouth bass prey on young giant garter snakes and may threaten local populations. Consistent with this objective, nonnative invasive plant species that degrade giant garter snake habitat or nonnative wildlife species that prey on the giant garter snake should be controlled if monitoring determines that giant garter snake populations on managed lands are threatened by these factors.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect giant garter snakes from adverse effects of light, vibrations, and human and pet activity from nearby developed areas. It also provides for addressing conflicts related to roads and other human-made structures that could impede movement of giant garter snakes.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity resilience with climate change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to giant garter snakes from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix;* CL1.1, *Mixed Agricultural Uses with Habitat Values;* and CL1.2, *Incorporation of Habitat Elements.* Achieving this objective will encourage agricultural use that is compatible with giant garter snake habitat. Such use consists mainly of rice lands with irrigation and drainage channels that hold water during the snake's active season, and other habitat elements such as patches of fresh emergent wetland and grassland areas.
- *Objectives CP1.1, California Prairie Protection*; *CP1.2, Burrowing Rodents*; *CP1.3, Grazing Regimes*; and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective willprovide for the protection, restoration, and enhancement of the natural community that provides upland

habitat for California tiger salamander in Yolo County. CP1.2 provides for burrows, which giant garter snakes require for shelter in upland habitat.

- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of giant garter snake aquatic habitat.

#### Objective GGS1.1: Protect Giant Garter Snake Habitat .

*Protect and manage at least 280 acres of protected rice land, 232 acres of upland natural communities, 100 acres of fresh emergent wetland and 84 acres of lacustrine/riverine land cover in modeled giant garter snake habitat. Suitable emergent marsh can be substituted for rice land.*

***Rationale.*** Rice lands are one of the primary land cover types that sustain giant garter snakes in Yolo County. This objective helps to ensure that protected habitat in Yolo County will continue to sustain giant garter snakes.

#### Objective GGS1.2: Manage and Enhance Giant Garter Snake Habitat

*Manage and enhance giant garter snake habitat to maintain and enhance habitat value for giant garter snake.* ***Rationale.*** This objective provides for the protection of uplands necessary for the giant garter snakes to move between sites, bask, and seek refuge in terrestrial burrows during the active season, and to seek refuge in burrows during their dormant period in the winter. This objective is consistent with the USFWS' draft recovery plan for giant garter snake (USFWS 2016), and with the CVFPP Conservation Strategy (DWR 2016).This objective helps to ensure that protected habitat in Yolo County will continue to sustain giant garter snakes.

#### Objective GGS1.2: Protect, Manage, and Restore Giant Garter Snake Aquatic Habitat

*Protect, restore, and manage at least 100 acres of fresh emergent wetland natural community and 84 acres of the lacustrine/riverine natural community to conserve the giant garter snake.*

***Rationale.*** This objective provides for the protection and restoration of aquatic habitat necessary for the giant garter snake.

## E.3.8.2 Climate Change

### Giant Garter Snake Vulnerability to Climate Change

Wright et al. (2013) assessed the conservation risk posed by climate change of 153 California reptile and amphibians species in California. Using species distribution modeling programs Wright et al. created species distribution models to forecast the distribution of climatically suitable habitat under four future climate scenarios for 2050. From the projects, they calculated the percentage of currently occupied localities remaining suitable in the future, the change in suitable area within currently occupied localities, and identified the species most and least vulnerable to climate shifting away from conditions that the species is known to tolerate. Vulnerability was calculated as the combined metric of numerous attributes including sensitivity to climates, dispersal ability, and the distribution of available future habitat. Depending on the ranking metric, the assessment identified approximately 60-75% of reptile and amphibian species were predicted to experience <20% direct loss of climatically suitable habitat by 2050 (Wright et al. 2013). Additionally, species ranked highest for risk include many species that are already of conservation concern and tend to be endemic species with small ranges.

The models estimated that generally less than 100% but great than 80% of the current giant garter snake occurrences would persist through 2050, with a percent change of +20% to -20% of predicted suitable habitat within currently occupied habitat. Based on the models, giant garter snake falls between low to intermediate risk from climate change. Wright et al. (2013) identified the following bioclimatic factors as affecting the giant garter snake.

- Mean annual temperature
- Mean diurnal range (mean of monthly [max temp – minimum tem])
- Isothemality (i.e., how large the day-to-night temperatures oscillate relative to the summer-to-winter (annual) oscillations)
- Temperature seasonality
- Precipitation of the wettest month
- Precipitation of the driest month
- Precipitation seasonality (coefficient of variation) (i.e. variation in monthly totals)

Across the four climate change scenarios, the prediction of future habitat suitability tends to decrease overall in the Sacramento Valley Ecoregion for giant garter snake; although, much of the current natural wetlands and aquatic agricultural habitats in the strategy area remains generally suitable for giant garter snake.

However, because water availability will likely change with changing climate, and water availability is a critical part of the giant garter snake's ecological requirements, there is potential for the loss or reduction of suitable giant garter snake habitat due to actions such as water transfers in the Sacramento Valley (Shuford 2017), crop conversion of rice fields to incompatible crops (e.g. orchards, vineyards). Furthermore, the Giant Garter Snake Recovery Plan (U.S. Fish and Wildlife Service 2017) states that focused research on the impacts of climate change and drought for giant garter snake is still lacking.

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

Many of the conservation actions in this conservation strategy address appropriate habitat management for the benefit of giant garter snake. Achieving *Objectives L4-1, Heterogeneity within Agricultural Lands;* CL1.1, *Mixed Agricultural Uses with Habitat Values*, maintains, enhances, and encourages habitat features within the agricultural habitat to support giant garter snake. Likewise, achieving Objectives *FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas, Objectives CP1.1, California Prairie Protection, and CP1.2, Restore and Enhance Native Prairie* will protect, restore, as well as expand emergent wetland habitat and prairie upland habitat for giant garter snake; increased habitat availability allows garter snakes to respond to stressor by shifting distribution with climate change. Achieving Objective *L1-4, Restore Natural Communities*, will protect, increase, and maintains the availability of natural communities, thereby reducing stressors on habitats used by the snakes and make the natural communities more resilient to climate change. Achieving Objective *L1-1, Landscape Connectivity; L122, Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients* increases the functional availability of suitable habitat by connecting these habitat patches, facilitating the movement of giant garter snake from current habitat to more suitable habitat under changing climate conditions. The conservation strategy also builds upon existing protected habitat and habitat protected by the Yolo HCP/NCCP with Objective GGS1.1, *Protect and Restore Large Interconnected Blocks of Giant Garter Snake Habitat*. This is consistent with the Giant Garter Snake Recovery Plan (U.S. Fish and Wildlife Service 2017), which states that preserved perennial marshes and ricelands must be maintained and host stable populations of giant garter snake during adverse climate conditions, such as drought and extreme temperatures. Achieving *Objectives L4-2, Landscape Resilience to Climate Change and L4.3, Natural Community and Habitat Resilience with Climate Change* will monitor the quality of surrounding landscape and natural community and adaptively manage it in response to changing climate conditions to maintain suitable habitat and sustainable giant garter snake populations in the conservation strategy area. Focusing on the protection of known nesting locations and improving suitable habitat within and adjacent to known occurrences will allow giant garter snake to respond to the effects of climate change in Yolo County.

# E.3.9 Tricolored Blackbird

## E.3.9.1 Rationale for Goals and Objectives

### Goal TRBL1: Tricolored Blackbird Conservation

How the landscape and natural community objectives contribute to tricolored blackbird conservation:

- *Objectives L1.1, Landscape Connectivity; L1.2, Areas to Support Sustainable Populations*; and L1.3, *Environmental gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the tricolored blackbird population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3*, *Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect tricolored blackbirds from adverse effects of noise, light, and vibrations from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to tricolored blackbirds from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements.* Achieving this objective provides for patches of marsh and other suitable tricolored blackbird habitat within the agricultural matrix and on agricultural fields, where tricolored blackbirds often forage.
- *Objectives FW1.1*, *Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of tricolored blackbird nesting and roosting habitat.
- *Objectives R1.1, Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat areas.* Achieving this objective will provide for the protection and restoration of riparian habitat that may provide nesting and roosting habitat for tricolored blackbirds.

**Objective TRBL1.1: Protect Nesting Habitat.**

*Within the protected fresh emergent wetland natural community, site at least 40 acres in modeled tricolored blackbird nesting habitat.* ***Rationale.*** Tricolored blackbirds are well adapted to rapidly changing environments where the locations of secure nesting habitat and rich insect food supplies fluctuates (Orians 1961; Collier 1968; Payne 1969). One of the stressors for tricolored blackbirds is the loss of suitable breeding sites that provide the required combination of tall emergent vegetation above standing water connected to highly productive foraging areas with high densities of arthropods. Sites with tall emergent vegetation over standing water may become increasingly unviable for tricolored blackbirds, however, because they are often subject to severe predation by black-crowned night herons. Protecting a sufficient amount of habitat to support tricolored blackbird will ensure that nesting colonies and their surrounding foraging habitat are protected across a wide portion of Yolo County and across fluctuating foraging conditions from year to year. Nesting tricolored blackbirds can be vulnerable to disturbances from adjacent activities. Central Valley populations of tricolored blackbirds demonstrate chronic poor reproductive success relative to populations in other portions of the species' range, and this is correlated with low insect abundance. The low reproductive success in the Central Valley may be the result of the widespread use of neonicoinoid insecticides (Meese 2014). Providing foraging habitat free of insecticides for the tricolored blackbird will help reduce this potential threat on the species.

**Objective TRBL1.2: Manage and enhance habitat**

*Manage and enhance protected tricolored blackbird habitat to maintain habitat value for this species.*

***Rationale.*** High-value breeding habitat for the tricolored blackbird is represented by suitable nesting substrate, such as cattail/bulrush emergent wetland, in close association with highly productive foraging areas that support abundant insect prey, such as grasslands, seasonal wetlands, pasture lands, alfalfa and other hay crops, and some croplands. Tricolored blackbirds are highly dependent on disturbance events to maintain suitable nesting conditions at nesting colony sites. Ideal nesting substrate is represented by young, actively growing stands of bulrush/cattail emergent vegetation. As stands age, they develop an abundance of dead and dying stems and leaves, and become less attractive to the species for nesting. Under natural conditions, periodic disturbance from flooding, alluvial scouring, wildfire, and other landscape altering events serve to rejuvenate aging stands. Since much of Yolo County is isolated from the floodplain and unlikely to experience natural disturbances, active management is likely needed to sustain suitable nesting habitat characteristics for tricolored blackbirds (Kyle 2011). Therefore, mechanical habitat manipulation may be used to sustain nesting substrate for tricolored blackbirds in areas targeted to conserve this species as deemed necessary depending on habitat conditions.

## E.3.9.2 Climate Change

### Tricolored Blackbird Vulnerability to Climate Change

The Climate Vulnerability Assessment gave tricolored blackbird a score of 25, and the species is not considered a priority with respect to climate vulnerability (Table 3-1). Despite the assessment that tricolored blackbird may not be among the most vulnerable bird species to climate change, water availability and precipitation is predicted to decrease in the future, thus likely reducing fresh emergent wetlands throughout California (PRBO Conservation Science 2011). In the strategy area, a reduction of fresh emergent wetlands would result in reduced nesting and foraging habitats that the tricolored blackbird relies upon.

**Table F-3. Climate Vulnerability Scoring for Tricolored Blackbird as Described in Gardali et al. (2012)[1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10–50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 2 – moderate; taxon is expected to be exposed to some increase in extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 2 – moderate; taxon that tolerates some variability in habitat type or element |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 1 - low; year-round resident |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

2 Scores range from 1 – 3; generally low, medium, and high

3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

Climate change impacts to wetlands may also include alterations of recharge timing, changes in plant communities, and changes in the abundance of prey, further stressing the blackbirds. Marshes with emergent wetland, blackberry thickets, and riparian bramble are the primary breeding habitats in the strategy area; fresh emergent wetlands could become more ephemeral under drier conditions, reducing the availability of nesting habitat. With drier conditions and increase water demands, land use and agricultural practices are likely to change; some agricultural practices that support tricolored blackbird colonies, such as rice croplands that are abundant in insects, or dairy farms with consistent water sources (e.g. stock ponds), may be reduced. This could decrease foraging habitat for tricolored blackbird. Extreme weather, including flooding, wind, and severe spring storms may cause the mass mortality of nests, reducing or eliminating colony reproductive success.

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of tricolored blackbird occurrence in the strategy area would decrease over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Models predict a decreased distribution throughout the Sacramento Valley, with a range shift into the foothills east of the strategy area and west of the strategy area into parts of the Coast Range, with a lower overall probability of occurrence (40-60%, down from 60-80%) in the strategy area. Audubon's Climate Report (National Audubon Society 2015) similarly predicts that tricolored blackbird's range will likely decrease in the Central Valley, shifting to the hills of the Coast Range by 2080. Areas in the strategy area that are predicted to be more resilient to climate change (i.e., have a higher probability of occurrence under future climate change scenarios) and more likely to provide habitat for tricolored blackbird than other parts of the strategy area are located generally southeast of Knight's Landing.

### How the RCIS/LCP Addresses Climate Change

The conservation strategy aims to reduce the stressors of climate change by protecting known nesting locations and suitable nesting habitat, and protecting and managing foraging habitat surrounding those nesting locations. Achieving Goal L1, *Large interconnected landscapes*, aims to reduce habitat fragmentation, providing larger blocks of contiguous nesting and foraging habitat that can support tricolored blackbird.  As described above, changes in hydrologic conditions could affect tricolored blackbird habitat; achieving Goal L2, *Ecological Processes and Conditions*, would restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing blackbird populations from climate change stressors. Achieving Goal L4, Biodiversity, *Ecosystem Function, and Resilience*, aims to conserve and enhance landscapes to increase its habitat value under changing climate conditions. Similarly, Goal CL1, *Cultivated land habitat conservation*, aims to provide habitat values and features for foraging and nesting tricolored blackbird. Achieving Goal FW1, *Fresh Emergent Wetland Conservation*, aims to protect, increase, and enhance emergent wetland habitat, all of which will serve to maintain and expand functional nesting habitat for tricolored blackbird in the strategy area. Actions to actively manage ponds and wetlands to ensure that the proper nesting substrate is present and that ponds retain the proper ponding duration will help to offset negative effects that warmer and drier conditions might have on nesting habitat. Achieving Goal TRBL1, *Tricolored Blackbird Conservation*, will protect and restore occupied or recently occupied nesting tricolored blackbird habitat and manage foraging habitat for the benefit of the species, buffering the existing species population from the stressors of climate change. Achieving this goal will expand protection to recently occupied habitat surrounding known nest colony sites; doing so will build repetition into the region so that if historic nest locations are no longer viable due to warmer and drier conditions, other ponds and wetlands that remain viable, will be protected and managed for the species.

# E.3.10 Western Burrowing Owl

## E.3.10.1 Rationale for Goals and Objectives

### Goal WBO1: Western Burrowing Owl Conservation

How the landscape and natural community objectives contribute to western burrowing owl conservation

- *Objectives L1.1, Landscape Connectivity; L1.2*, *Areas to Support Sustainable Populations*; and *L1.3, Environmental Gradients.* Achieving this objective will provide for protection of habitat connectivity to allow for dispersal and genetic exchange within the western burrowing wol population in Yolo County. They will also provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.1, Invasive Species.* Achieving this objective will diminish non-native plant cover and increase native species diversity and relative cover in western burrowing owl habitat.

- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western burrowing owls from adverse effects of noise, light, human and pet activity, or other disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to western burrowing owls from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides habitat for western burrowing owl in Yolo County.

#### Objective WBO1.1: Protect Habitat

*Protect at least 600 acres of modeled western burrowing owl habitat..*

***Rationale.*** Protecting modeled western burrowing owl primary habitat (grasslands) will help maintain or increase western burrowing owl nesting success, by maintaining nesting habitat and prey availability necessary to rear and fledge young. It is important to focus protection on active western burrowing owl nest sites, as most of the suitable habitat in Yolo County is not occupied and therefore protection of suitable habitat alone would not be expected to benefit the species.

#### Objective WBO1.2: Manage and enhance habitat

*Implement management and enhancement practices to encourage burrowing owl occupancy on protected lands.*

***Rationale.*** Burrowing owls have very specific habitat requirements in order to successfully nest, hunt, and avoid predation. Vegetation height and presence of potential burrows are essential elements of burrowing owl occupancy. If modeled habitat does not meet these requirements, burrowing owls are less likely to occur. Habitat management and in some cases, enhancement, are therefore important to ensure that lands conserved for burrowing owls are actually providing conditions that meet habitat requirements. Vegetation management around occupied and potentially occupied burrows is key to maintaining suitable habitat conditions. Management should be designed to enhance vegetation conditions in the immediate vicinity of nesting burrows in order to maintain and encourage occupancy. Among the enhancement practices is the creation of artificial nest sites and debris piles. These practices, along with habitat management, are designed to encourage owl occupancy by augmenting natural habitat elements, to maintain and expand burrowing distribution and abundance in Yolo County.

## E.3.10.2 Climate Change

### Western Burrowing Owl Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), grasshopper sparrow is not considered a priority with respect to climate vulnerability, receiving a climate vulnerability score of 24 (Table 3-2). However, grasshopper sparrow could be vulnerable to the effects of climate change due to a reduction of large patches of grassland (its preferred nesting habitat), changes in land management and land use, as well as potential increased fire threats in natural vegetation (PRBO Conservation Science 2011).

**Table F-4. Climate Vulnerability Scoring for Grasshopper Sparrow as Described in Gardali et al. (2012) [1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10–50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 2 – moderate; taxon that tolerates some variability in habitat type or element |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 2 – moderate for short-distance migrants (movements primarily restricted to the nearctic zone) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that the probability of grasshopper sparrow occurrence in the strategy area will not significantly change over time as a consequence of climate change, with a stable probability of 0-20% (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). The models also predict that the distribution of grasshopper sparrow will remain the same through the Sacramento Valley floor, suggesting the habitat type utilized by grasshopper sparrow in the strategy area is somewhat less vulnerable to the effects of climate change as compared to other habitat types (e.g., wetlands). Recent climate change projections indicate that grasslands in the Sacramento Valley region could, however, decline up to approximately 20% by 2070 (PRBO Conservation Science 2011). The primary impact of climate change on this natural community is likely driven by increased variability in precipitation. Changes in perception may result in changes in vegetation community composition and structure, invasion of nonnative species, and overall changes in prey abundance. These stressors may affect grasshopper sparrow populations in the strategy area.

### How the RCIS/LCP Addresses Climate Change

The overall intent of the voluntary actions recommended in the conservation strategy for grasshopper sparrow is to protect known nesting locations, increase habitat availability and improve habitat quality. Because the grasshopper sparrow avoids highly fragmented grasslands and breeding habitat may be degraded by invasive nonnative vegetation, achieving Objective L1-4, *Natural Community Restoration*, will restore native species composition and ecological processes in grasslands to maximize ecological function, taking into consideration potential future conditions with climate change. Achieving Objective L3-1, *Invasive Species*, will manage invasive plant species and will help control the spread of invasive grassland species, reducing a significant stressor on native grasslands and further enhancing the climate resilience of this community, improving habitat quality for the species.  Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Achieving *Goal CP1, Large contiguous areas of California prairie to support native species,* will maintain and improve the extent, distribution, and density of native California prairie by restoring native grassland in areas that are degraded and dominated by exotic species, thereby improving the availability and quality of nesting habitat for grasshopper sparrow. Protecting and managing larger blocks of habitat ensures grasshopper sparrow populations will have access to other habitat areas, should conditions at historical locations degrade.  Grassland planting, as proposed under Objective CP1.2, *Restore and enhance California prairie*, will create large areas of grassland vegetation alliances, ensuring that different species are supported by variations in water availability, soil moisture, disturbance regimes, and other conditions potentially affected by climate change. Achieving Goal GRSO1, *Maintenance of Grasshopper Sparrow Distribution and Abundance*, will protect existing occurrences and enhance those habitats utilized by grasshopper sparrow to improve productivity. Because grasshopper sparrow nests semi-colonially and irregularly breeds in Yolo County, focusing on the protection of known occurrences and improving habitat within and adjacent to known occurrences is a sufficient strategy for allowing grasshopper sparrow to adapt to the effects of climate change.

# E.3.11 Swainson's Hawk

## E.3.11.1 Rationale for Goals and Objectives

### Goal SWHA1: Swainson's Hawk Conservation

Conserve Swainson's hawks in Yolo County.

How the landscape and natural community objectives contribute to Swainson's hawk conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect Swainson's hawks from adverse effects of noise, light, or other disturbances from nearby developed areas.

- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with climate change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to Swainson's hawks from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving this objective will provide for the protection, restoration, and enhancement of the natural community that provides grassland habitat for Swainson's hawks and their prey in Yolo County.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and CL1.2, *Incorporation of Habitat Elements.* Achieving this objective provides for patches of woodlands and other suitable Swainson's hawk habitat within the agricultural matrix and on agricultural fields, for Swaison's hawk nesting. While cultivated landscapes have become essential for the continued survival of Swainson's hawks in the Central Valley, agricultural practices have also historically removed other important habitats such as riparian forest, woodlands, savannahs, and grasslands that supported nesting and foraging habitat for the species. Today, other than narrow riparian corridors, nesting habitat for Swainson's hawks consists of isolated trees, tree rows along field borders or roads, or small clusters of trees in farmyards or at rural residences. Maintaining these small, isolated nesting habitats is also essential to maintaining the distribution and abundance of the species in Yolo County. Swainson's hawks also benefit from remnant patches of grassland or other uncultivated areas. These areas provide additional foraging habitat and a source of rodent prey that can recolonize cultivated fields. Swainson's hawks use grassland remnants in the cultivated lands matrix for foraging early in the season, before cultivated lands provide peak foraging value; grasslands also provide a stable habitat that is accessible during times when the management of cultivated lands results in lower prey abundance and availability. This objective is designed in part to provide a means to protect these small but essential habitats that occur within the agricultural matrix.
- *Objective CL1.1, Mixed Agricultural Uses with Habitat Values.* Achieving this objective provides for the maintenance of crop types that provide foraging value for Swainson's hawk. This includes a variety of crop types that may provide foraging habitat values during different stages of the breeding season. Foraging studies indicate a positive association with alfalfa, tomato, wheat, oat, and other annually rotated crops that maintain a relatively low vegetation profile and that are harvested during the breeding season. Availability of these suitable crop types to foraging Swainson's hawks is a function of their height and density, which changes during the course of the breeding season as crops mature and are then harvested. As a result, these types and others provide value at different times of the breeding season. Much of the agricultural landscape in Yolo County consists of annually rotated irrigated cropland interspersed with alfalfa fields, which typically remain uncultivated for 3 to 5 years. Due to seasonal and annual rotations, this results in a very dynamic, ever-changing foraging landscape. Swainson's hawks respond to these changes with highly elastic foraging ranges as they seek out suitable sites to hunt (Estep 1989, Babcock 1995). High densities of nesting Swainson's hawks, as we have in Yolo County, are generally associated with a very diverse agricultural landscape. They respond to a variety of farming activities such as cultivating, disking, mowing, harvesting, and irrigating. A less diverse landscape, such as those that are dominated by pasturelands or less crop diversity, generally support fewer nesting Swainson's hawks (Anderson et al. 2007).
- *Objectives WF1.1, Increase Valley Oaks; WF1.2, Protect Valley Oaks; WF2.1, Protect Upland Oaks; WF2.2, Restore Upland Oaks; WF3.1, Protect Riparian Oaks;* and *WF3.2, Restore and Enhance*

*Riparian Oaks.* Achieving these objectives will benefit Swainson's hawk by providing nesting habitat.

- *Objectives R1.1, Protect RiparianAareas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving this objective will provide for the protection and restoration of riparian habitat that provides nesting habitat for Swainson's hawks.

### Objective SWHA1.1: Protect Swainson's hawk habitat.

*Protect at least 2,872 acres of unprotected Swainson's hawk habitat.*

***Rationale***. Protecting modeled Swainson's hawk habitat will help maintain or increase nesting success, by maintaining nesting habitat and prey availability necessary to rear and fledge young.

### Objective SWHA1.2: Maintain Agricultural Habitat.

*Within the protected non-rice cultivated land natural community, maintain crop types that support Swainson's hawk foraging habitat.*

As described above, Swainson's hawks benefit from a variety or cultivated land crop types. Annually rotated irrigated cropland provides the bulk of the suitable foraging landscape in Yolo County, which includes a variety of field and vegetable crops subject to these seasonal changes in structure and value to foraging Swainson's hawks. For example, among these crop types are tomatoes and wheat, both historically important crop types in Yolo County, which together comprise an average of approximately 95,000 acres, or 24 percent of the available habitat in the plan area each year (Estep 2015). These types are particularly important to foraging Swainson's hawks because of their time of harvest, which increases prey accessibility. Most wheat is harvested in June during the late incubation/early fledging period, and most tomatoes are harvested in August just prior to migration (Estep 2015).

Alfalfa is considered the highest value crop type due to its more consistent vegetation structure, its semi-perennial regime (typically 3-5 years between cultivation events), and its management (mowing and irrigating) that enhances prey accessibility (Estep 1989, 2009, 2015). Other types, including irrigated pastures and dry pastures or grasslands, are also moderately suitable habitats for foraging. Perennial crop types, such as vineyards, orchards, and rice that do not support accessible prey receive significantly less use (Estep 1989, Estep 2015, Swolgaard et al. 2008) and are considered unsuitable.

***Rationale.*** Swainson's hawks rely on grassland foraging habitats, which provided the primary foraging habitat for Swainson's hawks prior to agricultural conversion. While some cultivated types are today regarded as having greater foraging value, grasslands remain an important component of the foraging landscape.

### Objective SWHA1.3: Maintain or Enhance Nest Tree Density.

*Maintain or enhance the density of Swainson's hawk nest trees on cultivated land foraging habitat to provide a minimum density of one tree suitable for Swainson's hawk nesting (native trees at least 20 feet in height, particularly valley oaks if conditions are suitable) per 10 acres of cultivated lands in the reserve system. Where existing protected trees do not meet that minimum requirement, plant suitable nest trees to meet this density requirement.*

***Rationale.*** In the absence of a comprehensive effort to maintain habitat diversity, cultivated lands tend to lose diversity over time as trees are lost and not replaced, cultivated fields are extended further into riparian corridors and oak woodlands, wetlands are plowed, and edge habitats are cultivated. Eventually, cultivated lands can become entirely devoid of trees, shrubs, or any uncultivated habitats. As this process continues, nesting opportunities for Swainson's hawks are reduced and the quality of agricultural foraging habitat declines. Where these elements have persisted within the agricultural matrix, Swainson's hawk populations have also persisted. Therefore, to successfully maintain Swainson's hawks in Yolo County, these essential habitat elements must be maintained on the landscape.

## E.3.11.2 Climate Change

### Swainson's Hawk Vulnerability to Climate Change

Swainson's hawk was given a score of 42 and moderate climate priority in the Climate Vulnerability Assessment (Gardali et al. 2012) and was therefore considered a priority with respect to climate vulnerability. Swainson's hawk is vulnerable to the effects of climate change due to an expected loss of nesting habitat in the Central Valley, loss of foraging habitat to urban development and to conversion to unsuitable agricultural practices, along with a potential increase in exposure to extreme weather events because it is a long-distance migrant.

**Table F-5. Climate Vulnerability Scoring for Swainson's Hawk as Described in Gardali et al. (2012)** [1]

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 3 – high; habitat suitability is expected to decrease by >50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 2 – moderate; taxon is expected to be exposed to some increase in extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 2 – moderate; taxon that tolerates some variability in habitat type or element |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 3 - high; long-distance migrants (migrates at least to the neotropics) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

[1] Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
[2] Scores range from 1 – 3; generally low, medium, and high
[3] Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that the probability of Swainson's hawk occurrence in the strategy area could decrease over time (Point Blue Conservation

Science and California Department of Fish and Wildlife 2011) and with a range contraction across the western U.S. (National Audubon Society 2015). The models predict significant decrease in probability of occurrence throughout the strategy area, from 60-80% currently, around Knights Land, Davis, and Esparto to an overall probability of occurrence in the future of 0-20%.

#### How the RCIS/LCP Conservation Strategy Addresses Climate Change

There are ample opportunities for implementation of the conservation strategy to lessen the potential impacts of climate change, facilitating continued nesting in the strategy area. Achieving Objective L1-4, *Natural Community Restoration*, will restore the species composition and ecological processes in a manner that maximizes their long-term function, taking into consideration potential future conditions with climate change. Achieving Goal L2, *Ecological Processes and Conditions*, will restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing Swainson's hawk nesting habitat from climate change stressors. Achieving Objective L4-2, *Resilience to Climate Change*, and Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance landscapes to increases habitat values under changing climate conditions. Similarly, Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat (nesting habitat for Swainson's hawk), which will serve to maintain and expand functional riparian habitat for the Swainson's hawk in the strategy area.  Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes in the RCIS area, reducing stressors on riparian communities, making the natural community more resilient to climate change. Additional protection, restoration, and management of riparian nesting habitat will retain, if not increase, suitable habitat for Swainson's hawk in the strategy area. Swainson's hawk have also successfully adapted to certain agricultural landscapes. With a decrease in water availability, and a potential decrease in the profitability of some crop types (e.g., alfalfa) agricultural practices and land uses may change. Loss of foraging habitat in the strategy area would make nesting attempts less successful. Actions recommended in the conservation strategy focused on working with private land owners on cultivated lands, including Goal CL1, *Cultivated land habitat conservation*, would include creating incentive programs to encourage planting of good forage crops will offset these effects. Achieving Goal 1, *Swainson's  Hawk Conservation*, protects, increases, and manages agricultural and natural foraging habitat for the benefit of the species. Likewise achieving this goal maintains and enhances associated nesting tree density. Focusing on the protection of known nesting locations and improving suitable habitat within and adjacent to known occurrences will allow Swainson's hawk to respond to the effects of climate change in the strategy area.

## E.3.12 Greater Sandhill Crane

### E.3.12.1 Rationale for Goals and Objectives

#### Goal GSHC1: Protection and Expansion of Greater Sandhill Crane

Protect and expand the greater sandhill crane winter range in Yolo County.

How the landscape and natural community objectives contribute to greater sandhill crane conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change, including sea level rise.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect greater sandhill cranes from adverse effects of noise, light, and other disturbances from nearby developed areas..
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to greater sandhill cranes from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements .* Achieving this objective provides for patches of marsh and other suitable greater sandhill crane habitat within the agricultural matrix and on agricultural fields, where greater sandhill cranes forage and roost.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving this objective will provide for protection and restoration of greater sandhill crane roosting habitat.

### Objective GSHC1.1: Protect foraging habitat

*Increase protection of high- to very high-value foraging habitat for greater sandhill crane, with at least 80 percent maintained in very high-value types in any given year. Protected habitat should be in planning unit 15, within 2 miles of known roosting sites, and should consider sea level rise and local seasonal flood events. Patch size of protected cultivated lands should be at least 160 acres.*

***Rationale.*** Since the most important stressor on greater sandhill crane in its wintering grounds is the conversion of suitable crops to unsuitable crops, the key to long-term conservation of the winter population is sustaining sufficient amounts and types of suitable cultivated lands.

Since crop patterns are subject to agricultural economic influences, the extent of the landscape that provides suitable habitat for the crane is uncertain over time. Additionally, many of the cultivated lands in the greater sandhill crane's wintering areas in the Central Valley have been converted from crop types that provide habitat for the species to unsuitable vineyards. Therefore, the strategy for the greater sandhill crane is focused on conserving cultivated lands that provide high-value habitat for the crane, to increase the stability and certainty of compatible crops in the greater sandhill crane's wintering area.

Objective GSHC1.1 requires that conservation lands providing foraging habitat be within 2 miles of known roost sites: This is because the highest levels of use are typically within approximately 2 miles of known roosts, and use (measured as a function of observed crane density) decreases beyond approximately 2 miles of a roost (Ivey pers. comm.). Objective GSHC1.1 also specifies that 80 percent of this foraging habitat will be managed at the highest habitat value in any given year (Table 3-X). Waste corn is the key food item for wintering greater sandhill cranes; therefore corn is considered the highest-value crop type. Rice is also a very high-value type. Managing protected lands to maximize food value for cranes could be important in sustaining the winter population.

Sea level rise and local seasonal flood events will be considered when siting conservation lands, because crane foraging habitat is likely to become unsuitable at lower elevations with sea level rise as these areas become flooded. Additionally, crane habitat may become unsuitable as a result of large flood events within river floodplains. The minimum patch size is relatively large (160 acres) to minimize the potential effects of human-associated visual and noise disturbances.

#### Objective GSHC1.2: Create high-value foraging habitat

*Increase the acres of high-value greater sandhill crane winter foraging habitat by protecting low-value habitat or nonhabitat areas and converting it to high- or very high-value habitat. Created habitat should be in Planning Unit 15, within 2 miles of known roosting sites, and should consider sea level rise and local seasonal flood events.*

***Rationale.*** Creating or enhancing foraging habitat by converting unsuitable crops to high-value crops will help to redress the past conversion from high-value to low-value crop types. Sea level rise and local seasonal flood events should be considered when siting conservation lands because crane foraging habitat is likely to become unsuitable at lower elevations with sea level rise as these areas become flooded. Additionally, crane habitat may become unsuitable as a result of large flood events within river floodplains.

#### Objective GSHC1.3: Create managed wetland roosting habitat

*Increase the acres of managed wetlands consisting of greater sandhill crane roosting habitat in minimum patch sizes of 40 acres within the Greater Sandhill Crane Winter Use Area[2] in planning unit 15, with consideration of sea level rise and local seasonal flood events. The wetlands should be located within 2 miles of existing permanent roost sites and protected in association with other protected natural community types at a ratio of 2:1 upland to wetland to provide buffers around the wetlands.*

***Rationale.*** Managed wetlands provide suitable foraging habitat and potential roosting habitat for greater sandhill cranes. The managed wetlands should be conserved in association with other natural community types at a ratio of 2:1 upland to wetland to provide buffers around the wetlands that will protect cranes from the types of disturbances that would otherwise result from adjacent roads and developed areas (e.g., roads, noise, visual disturbance, lighting). This is the average upland to wetland ratio for crane roosting habitat on Stone Lakes National Wildlife Refuge (McDermott pers. comm.).

#### RCIS/LCP Objective GSHC1.4: Create flooded cornfield roosting and foraging habitat

*Increase the acres of roosting habitat within 2 miles of existing permanent roost sites, consisting of active cornfields that are flooded following harvest to support roosting cranes and that provide highest-value foraging habitat. Individual fields should be at least 40 acres and can shift locations throughout the Greater Sandhill Crane Winter Use Area (see species account, Figure A).*

***Rationale.*** This type of crane roosting habitat is usually temporary as a result of seasonal changes in farm practices, crop rotational changes, or other management. This habitat type supplements the more static managed wetlands that serve as the primary roosting areas for cranes. These temporary roosting/foraging habitats allow cranes to vary their seasonal movement patterns and spread out into otherwise underused areas; it also reduces

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2 Important geographically defined greater sandhill crane wintering areas in the Central Valley (Pogson and Lindstedt 1988; Littlefield and Ivey 2000; Ivey pers. comm.) (Figure 2A.19-2).

opportunities for excessively dense roosting concentrations. This objective is designed to provide similar function by allowing fields to rotate through the crane's winter use area. This can serve as a secondary source of high-value crane roosting/foraging habitat and provide a dynamic element to crane conservation.

**Table F-6. Assigned Greater Sandhill Crane Foraging Habitat Value Classes for Agricultural Crop Types**

| Foraging Habitat Value Class | Agricultural Crop Type |
|---|---|
| Very high | Corn, rice |
| High | Alfalfa, irrigated pasture, wheat |
| Medium | Other grain crops (barley, oats, sorghum) |
| Low | Other irrigated field and truck crops |
| None | Orchards, vineyards |

## E.3.12.2 Climate Change

### Greater Sandhill Crane Vulnerability to Climate Change

According to the Climate Vulnerability Assessment, greater sandhill crane is not considered a priority with respect to climate vulnerability, receiving a climate vulnerability score of 28 (Table 3-5); however greater sandhill crane may be vulnerable to the effects of climate change due to drier conditions from less precipitation, predicted decrease in grasslands up to 20% by 2070 (PRBO Conservation Science 2011), and changes in water management decisions that affect the availability of fresh emergent wetlands and agricultural types (e.g., moist croplands with rice or corn stubble) used by sandhill cranes.

**Table F-7. Climate Vulnerability Scoring for Greater Sandhill Crane as Described in Gardali et al. (2012) [1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10–50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 3 – high; taxon uses only specific habitat type or elements |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 2 - moderate; short distance migrant (movement primarily restricted to the nearctic zone) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

[1] Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
[2] Scores range from 1 – 3; generally low, medium, and high
[3] Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

Models used to predict future habitat distributions affected by climate change predict that sandhill crane winter range in the Central Valley will decrease in extent and shift northward (National Audubon Society 2015). Greater sandhill crane winters in the strategy area where it frequents annual and perennial grassland habitats, moist croplands with rice or corn stubble, and open, emergent wetlands (Appendix C Covered Species Account). Habitat for the sandhill crane, (e.g., native prairie, floodplains, and wetlands) are likely to be impacted by climate change as drier conditions and more demand for water may result in changes in agricultural practices that result in fewer rice fields, fewer flooded fields, and potential conversion of privately managed wetlands into other land uses. Loss of wintering habitat may be a limiting factor on population growth of sandhill cranes, which could become more limiting with a changing climate.

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The voluntary actions recommended in the conservation strategy aim to reduce the stressors of climate change by protecting known winter roosting locations, providing suitable roosting and foraging habitat, and expanding protections and management of foraging habitat surrounding roosting locations. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function, taking into consideration potential future conditions with climate change. Achieving Objective L2-1, *Hydrologic and Geomorphic Process*, would increase natural floodplains and increase the availability of suitable roosting and foraging habitat for cranes by restoring riverine hydrologic and geomorphic processes. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. To offset the potential loss of foraging habitat due to decreased water availability, achieving actions in the conservation strategy promote working with private land owners on cultivated lands, including Goal CL1, *Cultivated land habitat conservation*, and creating incentive programs to encourage planting of good forage crops to offset effects of climate change. Additional protection, management, and restoration of California prairie (Goal CP1) and fresh emergent wetland (Goal FW1) will retain, if not increase, suitable habitat for greater sandhill cranes in the strategy area, allowing the cranes to adapt to changing habitat conditions under climate change. Achieving Goal GSHC1, *Protection and expansion of greater sandhill crane*, will protect, maintain, and create high value foraging habitat near roosting sites, as well as increase the availability of wetland roosting habitat, buffering the existing population from the stressors of climate change. By increasing the amount of protected habitat, and restoring foraging and roosting habitat surrounding roosting sites, the conservation strategy builds repetition into the region so that if historic roosting and foraging habitats are no longer viable due to warmer and drier conditions, other agricultural fields and wetlands, that remain viable, will be protected and managed for greater sandhill crane.

# E.3.13 Northern Harrier

## E.3.13.1 Rationale for Northern Harrier Goals and Objectives

### Goal NH1: Protected Northern Harrier Habitat

How the landscape and natural community objectives contribute to northern harrier conservation:

- *Objectives L1.1*, *Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3, Hazardous Human Uses*. Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect northern harriers from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change*. Achieving this objective will further provide for monitoring and adaptive management to address threats to northern harriers from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements*. Achieving this objective provides for patches of marsh and other suitable northern harrier habitat within the agricultural matrix and on agricultural fields.
- *Objectives CL1.1, Mixed Agricultural Uses with Habitat Values; CP1.1, California Prairie Protection; FW1.1, Protect Fresh Emergent Wetlands*; *FW1.2, Increase Fresh Emergent Wetland Areas;* and *VP1.1, Protect Vernal Pool Complexes*. Achieving this objective will provide for protection and restoration of northern harrier nesting and foraging habitat.
- *Objectives CP1.2, Burrowing Rodents;* and *CP1.3, Grazing Regimes*. Achieving this objective will provide for increases in northern harrier rodent prey on California prairie and managing these lands to optimize foraging value for the species.

#### Objective NH1.1: Protect habitat

*Protect at least 3,000 acres of modeled northern harrier habitat.*

***Rationale.*** Protection of modeled habitat for northern harrier is necessary to ensure nesting and foraging habitat is available for the species.

## E.3.13.2 Climate Change

### Northern Harrier Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), northern harrier was given a score of 12, and was not considered a priority with respect to climate vulnerability (Table 3-6); however, the northern harrier continues to show local population declines due to extensive habitat loss, as grasslands and wetland communities are converted to agriculture or development

(California Partners in Flight 2000). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows (PRBO Conservation Science 2011) affecting grassland, pastureland, and wetland habitat available to the northern harrier in the strategy area.

**Table F-8. Climate Vulnerability Scoring for Northern Harrier, as Described in Gardali et al. (2012)[1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10–50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 1 – low; taxon uses a wide variety of habitat types |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 1 - low; year-round resident |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that the probability of northern harrier occurrence in the strategy area could decrease over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Similarly, the Audubon Climate Report predicts the winter range of northern harrier to be stable, though its breeding range is predicted to contract and shift northward (National Audubon Society 2015). The Point Blue Conservation Science model predicts that areas currently with higher probability of occurrence, such as Knights Landing, Kings Farm, and northeast of Yolo (with 60-80% probability) could decrease to 0-40%, depending on the climate model used to predict future distributions. Parts of the strategy area that may be more resilient to climate change impacts (i.e., those that retain a relatively higher probability of occurrence with climate change) include areas west of Prospect Slough and east of Saxon in the southern portion of the strategy area. Additionally, a small area west of the Sacramento River, near Tule Jake Road, maintains higher probability of occurrence than the surrounding areas.

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The voluntary actions recommended in the conservation strategy aim to reduce the stressors of climate change on northern harrier by protecting and enhancing occupied habitat and protecting, enhancing, and restoring otherwise suitable nesting and foraging habitat. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term ecological function, taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases habitat values under changing climate conditions. Goal CP1, would protect, restore, and enhance California prairie through appropriate grazing management, implementing beneficial management techniques, and promoting prairie pollinators, reducing stressors on native grasslands and further enhancing the climate resilience of this natural community that provides habitat for northern harrier. This will also provide beneficial conditions for burrowing mammals and an improved prey base for northern harriers. Similarly, achieving Goal FW1, will protect, restore, and enhance fresh emergent wetlands, which will retain, if not increase suitable nesting and foraging habitat for harriers in the strategy area, allowing northern harrier populations to respond to changing habitat conditions under climate change. Achieving Goal NH1, *Northern harrier habitat*, protects habitat in and near occupied habitat and manages agricultural and natural foraging habitat for the benefit of the species. Focusing on the protection of nesting locations and improving suitable habitat within and adjacent to known occurrences will allow the northern harrier to respond to the effects of climate change in the strategy area.

# E.3.14 Bank Swallow

## E.3.14.1 Rationale for Goals and Objectives

### Goal BS1: Bank Swallow Conservation

How the landscape and natural community-level objectives contribute to the conservation of bank swallow:

- *Objectives L1.1, Landscape Connectivity*; *L1.2, Areas to Support Sustainable Populations*; and L1.3, *Environmental Gradients*. Achieving this objective provide for the conservation of large interconnected area across environmental gradients to support sustainable populations of bank swallow and their food sources, and provide for shifts in distribution with climate change.
- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains*. Achieving this objective will restore natural fluvial processes to improve habitat conditions, including natural, eroding banks that include cavities, depressions, and vertical faces to support bank swallow.
- *Objective L3.1, Invasive Species*. Achieving this objective provides for control of invasive plant species that outcompete native grasses and forbs providing the highest value foraging habitat for bank swallow (Bank Swallow Technical Advisory Committee 2013).
- *Objective L3.3, Hazardous Human Uses*. Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect bank swallows from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change*. Achieving this objective will further provide for monitoring and adaptive management to address threats to the bank swallow from climate change.

#### Objective BS1.1: Protect habitat

*Protect at least 10 acres of unprotected bank swallow habitat.* ***Rationale.*** Bank swallows depend on floodplains, which provide foraging habitat and actively erode to form steep cut-banks, the nesting habitat for nest cavity construction. Protecting channel banks from anthropogenic alterations (predominantly bank stabilization and rip-rapping) ensures that natural processes of bank habitat creation continue and bank swallow nesting habitat is maintained. Habitat formation and degradation is a natural process of stream bank cutting and channel erosion and deposition. Including channel banks that support suitable bank swallow nesting substrate and channel banks that are actively eroding within the reserve system will help ensure the continued availability of nesting habitat to support the existing breeding population. Covered activities will avoid bank swallow nests.

#### Objective BS1.2: Manage and enhance habitat

*Manage and enhance bank swallow habitat to improve bank swallow foraging habitat values.*

***Rationale.*** Achieving the objective will improve bank swallow foraging habitat on the Cache Creek floodplain. The Bank Swallow Technical Advisory Committee recommends management of floodplains supporting bank swallow to promote open grass and forb vegetation, including management actions that stimulate new plant growth and reduce invasive plant species to enhance production of insects that provide high-value food for bank swallows (Bank Swallow Technical Advisory Committee 2013).

## E.3.14.2 Climate Change

### Bank Swallow Vulnerability to Climate Change

The Climate Vulnerability Assessment gave bank swallow a score of 32, and the species is considered a low priority with respect to climate vulnerability. Bank swallow is vulnerable to the effects of climate change due to its high degree of habitat specialization and an expected decrease of habitat along all major streams in the strategy area.

#### Table F-9. Climate Vulnerability Scoring for Bank Swallow as Described in Gardali et al. (2012) [1]

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10-50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 3 – high; taxon that use only specific habitat types or elements |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |

| Criteria | Score[2, 3] |
|---|---|
| Migratory status | 3 - high; long-distance migrants (migrates at least to the neotropics) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

[1] Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
[2] Scores range from 1 – 3; generally low, medium, and high
[3] Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

In the strategy area, bank swallow is known to nest along Cache Creek and Sacramento River (Appendix C, *Species Accounts*). Already limited breeding habitat could be further stressed under hotter and drier conditions. Less water availability could result in reduced riparian and floodplain habitat, the primary breeding and foraging habitats for bank swallow. Extreme weather events may further decrease habitat suitability for bank swallow.

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of bank swallow occurrence in the strategy area would decrease over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011) and the species may shift its range northward (National Audubon Society 2015). The models predict significant decrease in probability of occurrence throughout the strategy area, down from 60-80% along Cache Creek and Sacramento River to an overall 0-20% probability of occurrence in the future. Pockets of habitat remain, with 20-40% probably of occurrence in the western portion of the strategy area in the Upper Cache Creek watershed near Wilbur Springs and south of Guinda, 20-40% probability of occurrence near El Rio Villa in the southwestern portion of the strategy area, and 20-40% near the confluence of the Feather and Sacramento River in the eastern portion of the strategy area.

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The primary threat to bank swallow in the strategy area from climate change are continued human population growth and increasing water demand, which could result in permanent or semi-permanent loss of nesting habitat from bank armoring and changes in river systems leading to the loss of nesting habitat. Nesting habitat is already limited in the strategy area, so further loss would make nesting less successful. RCIS recommended voluntary actions in the conservation strategy focused on large interconnected landscapes (Objectives L1-1 through L1-5) provides for nesting and foraging habitat connectivity and maintenance and restoration of interconnected suitable habitat. Restoring riverine hydrologic and geomorphic processes (Objective L2-1) would create nesting habitat in the strategy area and control of invasive species (Objective L3-1) would benefit existing populations, facilitating future population growth. The conservation strategy promotes landscape and natural community resilience to climate change by recommending and prioritizing strategies that (Objective L4-2 and L4-3), if followed through voluntary actions, will result in certain conservation outcomes. Voluntary actions include restoring degraded areas to desired habitat conditions, maintaining those habitat values under changing climate, and incorporating redundancies into protect areas; these actions support future habitat needs and allow bank swallow the opportunity to move from one refuge to another as climate conditions change. Bank swallows have highly specialized habitat requirements, and achieving the conservation strategies' objectives of protecting, increasing, and enhancing riparian habitat as well as stream systems in Yolo County

(Objective R1.1 through R1.3 and Objective LR1.1 and LR1.4) would improve and expand nesting and foraging habitat for bank swallow. Actions protecting channel banks from anthropogenic alterations and prioritizing protection of occupied sites, would provide suitable nesting habitat where this species is known to occur (Objective BS1.1). By strategically managing and enhancing bank swallow habitat (Objective BS1.2), the conservation strategy aims to improve and expand existing habitat so that if current nesting locations are no longer suitable due to changing climate conditions, other stream reaches will now be managed and protected for the species. Further actions to remove unnecessary rip-rap on the banks of the Sacramento River (Objective BS1.2-5) further creates suitable nesting substrate and will help offset the negative effects that climate change might have on the species.

# E.3.15 Black Tern

## E.3.15.1 Rationale for Goals and Objectives

### Goal BT1: Sustain Black Tern Habitat

How the landscape and natural community objectives contribute to black tern conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients*. Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change*. Achieving this objective will further provide for monitoring and adaptive management to address threats to black terns from climate change.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements*. Achieving this objective provides for patches of marsh and other suitable black tern habitat within the agricultural matrix and on agricultural fields.
- Objectives *CL1.1, Mixed Agricultural Uses with Habitat Values; FW1.1,* and *Protect Fresh Emergent Wetlands*; and *FW1.2, Increase Fresh Emergent Wetland Areas*. Achieving these objectives provide for protection of rice lands and protection and restoration marsh providing habitat for black tern.

#### Objective BT1.1: Protect or Restore Habitat

*Protect or restore at least 72 acres of suitable habitat for black tern.*

***Rationale.*** This objective provides for the protection and restoration of habitat necessary for the black tern.

## E.3.15.2 Climate Change

### Black Tern Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), black tern was given a climate vulnerability score of 40, and was considered a moderate priority with respect to climate vulnerability (Table 3-7). Black tern is vulnerable to the effects of climate change, primarily because it is a long distance migrant, with a highly specialized habitat preference for inland freshwater wetlands.

**Table F-10. Climate Vulnerability Scoring for Black Tern, as Described in Gardali et al. (2012)[1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10–50% |
| Food availability | 2 - moderate; food availability for taxon may decrease |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 3 – high; taxa use only specific habitat types or elements |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 3 - high; long-distance migrants (migrates at least to the neotropics) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

Models used to predict future habitat distributions affected by climate change predicts a modest loss of breeding habitat, with black tern's range shifting northward (National Audubon Society 2015). Formerly nesting in ephemeral seasonal marshes, populations of black tern have declined throughout its range, especially in the Central Valley, where black terns nest adjacent to rice fields due to the lack of suitable freshwater habitat in most national wildlife refuges and state wildlife areas during the summer in the Sacramento Valley (Appendix C Species Account). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows (PRBO 2011). Changes in the amount of precipitation, and changes in water management practices could reduce the extent of land used to grow rice, and potentially could result in the conversion of privately managed wetlands into other land uses that are incompatible with black tern habitat use. Additionally, black tern is an area-dependent species that requires large or isolated marsh complexes for nesting (Appendix C Species Account); this sensitivity makes black tern further vulnerable to the effects of climate change and habitat fragmentation.

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy aims to reduce the stressors of climate change on black tern by recommending and prioritizing strategies protecting and enhancing occupied habitat, and protecting, enhancing, and restoring otherwise suitable nesting and foraging habitat. Achieving Objectives L1-1, *Landscape Connectivity*, and L1-3, *Environmental Gradients*, will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change and reduce the stressors of habitat fragmentation. Achieving Objective L4-2, *Landscape Resilience with Climate Change* and Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will further provide for monitoring and adaptive management to address threats to black terns from climate change. Achieving Goal CL.1, *Cultivated Land Habitat Conservation*, will incorporate heterogeneity within the agricultural matrix to provide habitat elements, such as patches of marsh and other suitable black tern habitat, on agricultural fields, ensuring black terns have suitable nesting and foraging opportunities. In the likely event current habitat conditions degrade under climate change scenarios, achieving Goal FW 1, *Fresh Emergent Wetland Conservation*, will protect, maintain, enhance, and increase the extent of wetlands in the strategy area, with a goal to maintain habitat values under changing climate conditions. Protecting nesting habitat and enhancing habitat within and adjacent to occupied habitat will provide opportunities for black tern to respond to the effects of climate change in the strategy area.

# E.3.16 Western Yellow-Billed Cuckoo

## E.3.16.1 Rationale for Goals and Objectives

### Goal WYBC1: Sustain or Increase Western Yellow-billed Cuckoo Habitat

How the landscape and natural community objectives contribute to western yellow-billed cuckoo conservation:

- *Objectives L1.1, Landscape Connectivity,* and L1.3, *Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will benefit western yellow-billed cuckoo by restoring natural fluvial processes to floodplains. Because western yellow-billed cuckoo habitat is typically associated with the primary floodplain, floods may regularly reduce the cuckoo's prey base. The western yellow-billed cuckoo prey base, largely katydid and sphinx moth larvae, winters underground. In wet years, cuckoos must forage in upland areas until the prey base in the lower floodplain recovers (Riparian Habitat Joint Venture 2004). Setting back levees to provide wide floodplains is expected to provide areas in the upper floodplain that do not flood as frequently and are refuges for western yellow-billed cuckoo prey.

Natural fluvial disturbances promote regeneration of riparian structural diversity, which is expected to improve western yellow-billed cuckoo habitat. Breeding habitat for the cuckoo typically has high structural diversity, with relatively closed primary canopy and a dense shrub layer (Hammond 2011). Continuing habitat succession is identified as important in sustaining breeding populations (Laymon 1998). Riparian systems subject to natural erosional and depositional processes and channel cut-off to create oxbow lakes provide conditions conducive to the establishment of new stands of willow, which create high-value nesting habitat (Laymon 1998; Greco 2012). Habitat along channelized streams or levied systems that restrict these natural processes may become over-mature and less optimal.

- *Objective L3.1*, *Invasive Species.* Achieving this objective provides for control of invasive plant species that may degrade western yellow-billed cuckoo habitat by diminishing riparian structural diversity. This species requires structural diversity in its breeding habitat. Large, monotypic stands of invasive plants can diminish this structural diversity and render habitat unsuitable for the western yellow-billed cuckoo. The nonnative invasive Himalayan blackberry, for example, often invades riparian restoration sites and does not provide the same habitat structural complexity as other riparian plant species: this invasive species may inhibit establishment of other understory species that form important structural components of western yellow-billed cuckoo habitat (Hammond 2011).

- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect western yellow-billed cuckoos from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change; and L4.4, Population Viability and Biodiversity Resilience with Climate Change*.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to western yellow-billed cuckoos from climate change.
- *Objectives R1.1, Protect Riparian Areas; R1.2, Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas.* Achieving this objective will benefit western yellow-billed cuckoo by conserving, increasing, and maintaining and enhancing habitat for this species. This objective stresses the need for structural complexity, including understory (low shrubs), midstory (large shrubs and small trees) and overstory (upper canopy formed from large trees) in riparian vegetation. The best habitats for nesting western yellow-billed cuckoos are those with moderately large and tall trees and high canopy cover and foliage volume (Laymon et al. 1997).

#### Objective WYBC1.1: Restore western yellow-billed cuckoo habitat

*Design at least 12 acres of the restored valley foothill riparian to provide suitable habitat for western yellow-billed cuckoo.*

***Rationale.*** Riparian habitat loss and fragmentation is a key factor in the decline of the western yellow-billed cuckoo (78 FR 61622: October 13, 2013). As a result, this species currently breeds in scattered locations where fragmented suitable habitat remains. Protecting and restoring western yellow-billed cuckoo habitat will help ensure the availability of foraging habitat necessary to support migrant western yellow-billed cuckoo using Yolo County. This will also provide nesting habitat to accommodate the potential reestablishment of a breeding population in Yolo County.

## E.3.16.2 Climate Change

### Western Yellow-Billed Cuckoo Vulnerability to Climate Change

The Climate Vulnerability Assessment gave Western yellow-billed cuckoo a score of 40 and the species is considered a moderate priority with respect to climate vulnerability (Gardali et al 2012). The species is vulnerable to the effects of climate change due to its high degree of habitat specialization, expected change in habitat suitability along all major streams in the RCIS area, and with a potential increase in exposure to extreme weather events because it is a long-distance migrant.

**Table F-11. Climate Vulnerability Scoring for Western yellow-billed cuckoo as Described in Gardali et al. (2012) [1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10-50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 2 – moderate; taxon is expected to be exposed to some increase in extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 3 – high; taxon that use only specific habitat types or elements |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 3 - high; long-distance migrants (migrates at least to the neotropics) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

2 Scores range from 1 – 3; generally low, medium, and high

3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

While there are few records of Western yellow-billed cuckoo in the strategy area, the species presumably historically nested along the west side of the Sacramento River and along smaller tributary drainages, including Putah Creek, Willow Slough, and Cache Creek (Appendix C Covered Species Accounts). Currently little suitable breeding habitat remains in Yolo County for the species due to the lack of contiguous patches of riparian habitat. Already limited breeding habitat in the strategy area could be further stressed under warmer and drier conditions. Climate change may also alter the plant species composition and humidity of riparian forests over time; decrease riparian cover and drier conditions would negatively impact a species in which micro-climate is important in suitable habitat selection for yellow-billed cuckoo. Altered climate conditions may also change food availability for yellow-billed cuckoo if timing of peak insect emergence changes in relation to when the cuckoos arrive on their breeding grounds to utilize this critical food source for successful reproduction.

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distribution affected by climate change predict the probability of yellow-billed cuckoo occurrence in the RCIS area could increase over time (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Models predict an increased probability of occurrence over a larger area, with a higher probability (60-80%, up from 40-60%) along Cache Creek, Willow Slough, and Putah Creek; models also predict an increase probability for occurrence along the Sacramento River. Overall the models predict increased overall probability of Western yellow-billed cuckoo occurrence along riparian corridors in the Sacramento Valley. There are ample opportunities for the species to expand its nesting range within the strategy area based on these models predictions, particularly if the conservation strategy protects and manages riparian and stream habitat.

### How the RCIS/LCP Conservation Strategy Addresses Climate Change

To successfully nest, cuckoos require large patches of riparian corridors. Achieving Goal L1, *Large interconnected landscapes*, reduces habitat fragmentation allowing existing cuckoo populations to expand within the strategy area from current occupied habitat to areas with potentially higher habitat suitability under future conditions. A threat to yellow-billed cuckoo from climate change could be a change in hydrologic conditions; achieving Goal L2, *Ecological Processes and Conditions*, would restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing yellow-billed cuckoo populations from climate change stressors. Achieving Objective L4-2, *Resilience to Climate Change* Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat, all of which will serve to maintain and expand functional riparian habitat for the species in the strategy area. Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes. Achieving Goal WYBC1, *Western yellow-billed cuckoo habitat*, will protect and restore occupied riparian habitat, buffering the existing species population from the stressors of climate change. Focusing on the protection of nesting locations and improving suitable habitat within and adjacent to known occurrences will allow the yellow-billed cuckoo to respond to the effects of climate change in the strategy area.

# E.3.17 Least Bell's Vireo

## E.3.17.1 Rationale for Goals and Objectives

### Goal LBV1: Least Bell's Vireo Habitat

Sufficient habitat in Yolo County to support least Bell's vireos that migrate through, and to support potential future reestablishment of a nesting population.

How the landscape and natural community objectives contribute to least Bell's vireo conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objective L1.5, Ecotone Conservation.* Achieving this objective provides for the protection and management of ecotones between riparian vegetation and more upland areas. Least Bell's vireos are among many riparian species that commonly use upland habitat adjacent to riparian nesting sites; these upland areas act as both flood refugia and supplemental foraging areas. Additionally, natural uplands adjacent to restored and protected riparian natural community are important for reducing adverse effects of adjacent land use. Vireos with territories bordering on agricultural land and urban areas are significantly less successful in producing young, compared to vireos in territories bordering undeveloped uplands (Riparian Habitat Joint Venture 2004).

- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will benefit least Bell's vireo by restoring natural fluvial processes to floodplains. Least Bell's vireo will benefit from the restoration of fluvial disturbance regimes that encourage establishment of early- to midsuccessional riparian vegetation, consistent with this objective. Early- to midsuccessional vegetation comprises the dense shrub cover required by least Bell's vireo for nest concealment as well as structurally diverse canopy for foraging (Kus 2002).
- *Objective L3.1, Invasive Species.* Achieving this objective provides for control of invasive plant species that may degrade least Bell's vireo habitat by diminishing riparian structural diversity. This species requires structural diversity in its breeding habitat. Large, monotypic stands of invasive plants can diminish this structural diversity and render habitat unsuitable for least Bell's vireo. The nonnative invasive Himalayan blackberry, for example, often invades riparian restoration sites and does not provide the same habitat structural complexity as other riparian plant species: this invasive species may inhibit establishment of other understory species that form important structural components of least Bell's vireo habitat. Least Bell's vireos nest in small willows and understory shrubs, therefore understory vegetation is critical to their nesting success. This objective also provides for the control of invasive brown-headed cowbirds if they are found to be adversely affecting least Bell's vireos in Yolo County.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect least Bell's vireos from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2*, *Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving this objective will further provide for monitoring and adaptive management to address threats to least Bell's vireos from climate change.
- *Objectives R1.1, Protect Riparian Areas; R1.2, Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas.* Achieving this objective will benefit least Bell's vireos by conserving, increasing, and maintaining and enhancing habitat for this species, including maintaining and enhancing structural diversity of riparian vegetation.

### Objective LBV1.1: Protect and Manage Least Bell's Vireo Habitat

*Increase protection of least Bell's vireo habitat, in addition to the habitat protected by the Yolo HCP/NCCP, and manage that habitat for the species.*

### Objective LBV1.1: Restore least Bell's vireo habitat

*Increase the acres of least Bell's vireo habitat in Yolo County, with the land cover types that comprise the species' modeled habitat (in addition to the 600 acres of habitat restored by the Yolo HCP/NCCP).*

***Rationale.*** The least Bell's vireo is an obligate riparian breeder that typically inhabits structurally diverse woodland containing dense cover within three to six feet of the ground for nesting, and a dense stratified canopy for foraging. The least Bell's vireo has been extirpated from Yolo County as a nesting species; however, it is expanding its nesting range northward and has recently been observed in Yolo County during the breeding season (although there are no documented breeding records yet). Protecting and restoring least Bell's vireo habitat will help ensure the availability of foraging habitat necessary to support migrant least Bell's vireo using

Yolo County and the availability of nesting habitat to accommodate the potential reestablishment of breeding in Yolo County.

## E.3.17.2 Climate Change

### Least Bell's Vireo Vulnerability to Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), Least Bell's vireo was given a score of 40 and moderate climate priority. The species was considered a priority with respect to climate vulnerability (Table 3-14). Least Bell's vireo is vulnerable to the effects of climate change due a potential increase in exposure to extreme weather events because it is a long-distance migrant and it high habitat specialization on willow-dominated riparian corridors.

**Table F-12. Climate Vulnerability Scoring for Least Bell's Vireo as Described in Gardali et al. (2012) [1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 3 – high; taxon is expected to be exposed to major increase in extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 3 – high; taxa use only specific habitat types or elements |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 3 - high; long-distance migrants (migrates at least to the neotropics) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

2 Scores range from 1 – 3; generally low, medium, and high

3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict the winter and breeding range of Least Bell's vireo occurrence in the strategy area would increase over time (National Audubon Society 2015).

### How the RCIS/LCP Conservation Strategy Addresses Climate Change

There are opportunities to implement recommended actions in the RCIS conservation strategy to support predicted increased habitat suitability for Least Bell's vireo in the strategy area by protecting of known breeding locations, providing suitable nesting and foraging habitat, and expanding protections and management of foraging habitat surrounding those nesting locations.

Much of the riparian habitat throughout the range of the Least Bell's vireo has been fragmented (Kus 2002); under drier climate change scenarios, habitat fragmentation may be exacerbated by reduced precipitation and streamflows. Achieving Objectives L1-1, *Landscape Connectivity*, and L1-3, *Environmental Gradients*, will provide for the conservation of large interconnected areas of nesting and foraging habitat that can support Least Bell's vireo. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. The riparian system is adapted to periodic flooding and flooding is currently restricted in the majority of Least Bell's vireo nesting habitat (Kus 2002). Restoring riverine hydrologic and geomorphic processes, achieving Objective L2-1, *Hydrologic and Geomorphic Process*, would increase natural floodplains and increase the availability of suitable nesting and foraging habitat for vireos. Least Bell's vireo will benefit from the restoration of fluvial disturbance regimes that encourage establishment of early- to midsuccessional riparian vegetation. Early- to midsuccessional vegetation comprises the dense shrub cover required by least Bell's vireo for nest concealment as well as structurally diverse canopy for foraging (Kus 2002). Increased reproductive success would lessen the negative effects of climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Similarly, achieving Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat, all of which will serve to maintain and expand functional riparian habitat for the Least Bell's vireo in the strategy area. Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes in the strategy area, reducing stressors on riparian communities, making the natural community more resilient to climate change. Additional protection, restoration, and management of riparian nesting habitat will retain, if not increase suitable habitat for Least Bell's vireo in the strategy area. Successful implementation of actions that achieve Goal LBV1, *Least Bell's Vireo Habitat*, would protect, manage, enhance, and increase available vireo nesting habitat for the benefit of the species. It controls vireo nest parasites, thereby facilitating reproductive success and making the nesting population of Least Bell's vireo more resilient to effects of changing climate. Focusing on the protection of known nesting locations and improving suitable habitat within and adjacent to known occurrences will allow Least Bell's vireo to respond to the effects of climate change in the strategy area.

# E.3.18 White-Tailed Kite

## E.3.18.1 Rationale for Goals and Objectives

### Goal WTK1: White-Tailed Kite Habitat

How the landscape and natural community objectives contribute to white-tailed kite conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving this objective will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.

- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect white-tailed kites from adverse effects of noise, light, or other disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to white-tailed kites from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving these objectives provide for the protection, restoration, and enhancement of the natural community that provides grassland habitat for white-tailed kites and their prey in Yolo County.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements.* Achieving these objective provides for patches of woodlands and other suitable white-tailed kite habitat within the agricultural matrix and on agricultural fields, for white-tailed kite nesting.
- *Objective CL1.1, Mixed Agricultural Uses with Habitat Values.* Achieving these objectives provides for the maintenance of crop types that provide foraging value for white-tailed kites.
- *Objectives WF1.1, Increase valley Oaks; WF1.2, Protect Valley Oaks; WF2.1, Protect Upland Oaks; WF2.2, Restore Upland Oaks; WF3.1, Protect Riparian Oaks;* and *WF3.2, Restore and Enhance Riparian Oaks.* Achieving these objectives are expected to benefit white-tailed kites by providing nesting habitat.
- *Objectives R1.1, Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving these objectives provide for the protection and restoration of riparian habitat that provides nesting habitat for white-tailed kites.

The landscape and natural community objectives will provide for the conservation of white-tailed kite in Yolo County, and no species-specific conservation goals and objectives are necessary for this species.

## E.3.18.2 Climate Change

### White-Tailed Kite Vulnerability to Climate Change

The Climate Vulnerability Assessment gave white-tailed kite a score of 16, and the species is not considered a priority with respect to climate vulnerability (Table 3-9); however, the species continues to show local population declines due to extensive habitat loss as grasslands and wetland communities are converted to agriculture or development (California Partners in Flight 2000). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows (PRBO Conservation Science 2011); in the strategy area, a reduction of grassland and fresh emergent wetlands would result in reduced nesting and foraging habitats that white-tailed kite utilize. Additionally, decreased water availability may result in agricultural crop conversion, favoring less water intense crop; crop conversion to types that do not support sufficient prey or restrict accessibility to prey for white-tailed kite, may result in abandonment of traditional nesting territories.

**Table F-13. Climate Vulnerability Scoring for White-tailed Kite as Described in Gardali et al. (2012)** [1]

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10–50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 1 – low; taxon uses a wide variety of habitat types |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 1 - low; year-round resident |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
2 Scores range from 1 – 3; generally low, medium, and high
3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of white-tailed kite occurrence in the strategy area would decrease over time, but the species range may expand into the foothills east of the strategy area and westward toward the Coast Range (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Similarly, the Audubon Climate Report predicts continued potential for winter range expansion and a shift in the breeding range to areas with higher elevation in California (National Audubon Society 2015). Models predict overall lower probability of occurrence throughout the strategy area from 40-60% down to 20-40%. Areas in the strategy area that are predicted to be more resilient to climate change (i.e., have a higher probability of occurrence under future climate change scenarios) and more likely to provide habitat for white-tailed kite than other parts of the strategy area are located generally on the Sacramento River around Discovery Park.

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy aims to reduce the stressors of climate change on white-tailed kite by protecting occupied habitat, provide suitable nesting and foraging habitats, and expand protections and management of suitable foraging habitat surrounding known occurrence locations. A non-migratory species, the white-tailed kite relies on local habitat conditions to persist; achieving Objective L1.3, *Environmental Gradients*, will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote the continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving RCIS/LCP Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Achieving Objectives CP1.1, *California Prairie Protection*; CP1.3, *Burrowing Rodents*, CP1.4, *Grazing Regimes*; and CP1.2, *Restore and Enhance Native Prairie*, provides for the protection, restoration, and enhancement of the natural community that provides grassland habitat for white-tailed kites and their prey in Yolo County. Additionally, voluntary action achieving Objective CL1.1, *Mixed Agricultural Uses with Habitat Values*, provides for the maintenance of crop types that provide foraging value for white-tailed kites. Achieving Objectives WF1.1 through WF3.2, would increase, protect, and restore oak woodland habitat and increase the availability of nesting habitat for kites. Similarly, achieving Objectives R1.1, *Protect Riparian Areas*, and R1.2, *Increase Riparian Habitat Areas*, provide for the protection and restoration of riparian habitat that provides nesting habitat for white-tailed kites. By restoring degraded areas to desired habitat conditions, maintaining those habitat values under climate change, and incorporating redundancies into protected areas, these actions support future habitat needs and provides opportunities for white-tailed kite to respond to changing climate conditions.

## E.3.19 California Black Rail

### E.3.19.1 Rationale for Goals and Objectives

#### Goal BBR1: California Black Rail Habitat

How the landscape and natural community objectives contribute to black rail conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change, including sea level rise.
- *Objective L1.5, Ecotone Conservation.* Achieving this objective provides for the protection and management of ecotones between marshes and adjacent uplands. This is important to California black rails to provide upland refugia during flood events.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect black rails from adverse effects of noise, light, habitat degradation, and other disturbances from nearby developed areas or operations and maintenance activities.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to black rails from climate change.
- *Objectives FW1.1, Protect Fresh Emergent Wetlands* and *FW1.2, Increase Fresh Emergent Wetland Areas.* Achieving these objectives provide for protection and restoration of California black rail habitat.

#### Objective CBR1.1: Protect California Black Rail Habitat

*Protect at least 50 acres of fresh emergent wetland natural community providing suitable habitat for California black rail. Increase the protection of California black rail habitat in Yolo County, including patches of marsh greater than 20 acres in size, with land cover types and in locations that comprise the species' modeled habitat, prioritizing protection of occupied habitat or habitat where potential for occupancy is high (species account, Appendix A).*

***Rationale**.* Protection of habitat ensures emergent wetlands and adjacent uplands will be available for California black rail.

#### Objective CBR1.2: Restore California Black Rail Habitat

*Increase the acres of California black rail habitat in Yolo County, with the land cover types and in locations that comprise the species' modeled habitat (species account, Appendix A).*

#### Objective CBR1-3: Enhance California Black Rail Habitat

*Enhance California black rail habitat by increasing its ability to support the species.*

***Rationale.*** These objectives address the need to ensure that some of the protected and restored freshwater emergent wetland meets specific habitat requirements for California black rail. High-water and predator refugia are important components of California black rail habitat that have been eliminated or degraded in many areas where black rails occur or previously occurred. This loss subjects rails to increased flood and predation risks. The CVFPP Conservation Strategy calls for protection of California black rail habitat in patch sizes greater than 20 acres (DWR 2016).

### E.3.19.2 Climate Change

According to the Climate Vulnerability Assessment (Gardali et al. 2012), California black rail was given a score of 49, and was considered a high priority with respect to climate vulnerability (Table 3-10). California black rail is vulnerable to the effects of climate change due to expected loss of wetland habitat in the Bay Area from sea level rise, high habitat specialization of coastal wetlands and freshwater estuaries, and potential increase in exposure to extreme weather events.

**Table F-14. Climate Vulnerability Scoring for California Black Rail, as Described in Gardali et al. (2012)[1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 3 – high; habitat suitability is expected to decrease by >50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 3 – high; taxon is expected to be exposed to major increase in extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 3 – high; taxa use only specific habitat types or elements |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 1 - low; year-round resident |
| Dispersal ability | 2 – moderate for short-distance migrants (movements primarily restricted to the nearctic zone) |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

2 Scores range from 1 – 3; generally low, medium, and high

3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

The western population of black rail is generally restricted to the tidal marshlands of the northern reaches of the San Francisco Bay estuary, however, several small fragment subpopulations exist in southeastern California (Sierra foothills and Sacramento Valley) where freshwater marshlands occur (Evens et al. 1991; Richmond et al., 2008). Loss of habitat associated with water-management practices for agriculture, salt production in coastal wetlands, and filling for urbanization has significantly reduced black rail populations in western U.S. (Evens et al. 1991). The effects of climate change may further exacerbate the threats to California black rail through loss of upland habitat (used as escape cover during high tides) caused by sea level rise predicted under climate change scenarios; and diversion of freshwater inflow to San Francisco Bay as water demand increases (Eddleman et al. 1994).

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

Voluntary actions recommended in the conservation strategy aim to reduce the stressors of climate change on California black rail by protecting occupied habitat, providing suitable nesting and foraging habitat, and expanding protections and management of suitable foraging habitat. A year-round resident, California black rail relies on local habitat conditions to persist. Black rails are sensitive to isolation of wetland patches, and that with increased isolation between wetland patches can lead to local extinction, for a given patch size (as increasing patch size reduces local extinction probability). Thus, it is important to protect a network of large well-connected habitat patches (Risk et al. 2011). The conservation strategy aims to support black rail habitat needs through achieving Objectives L1.1, *Landscape Connectivity*, and L1.3, *Environmental Gradients*, by providing for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change, including sea level rise. Achieving Objective L1-5, *Ecotone Conservation*, provides for the protection and management of ecotones between marshes and adjacent uplands. This is important to California black rails to provide upland refugia during flood events. Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape, natural community, and species habitat elements in Yolo County to provide conservation benefits under conditions resulting from climate change. Similarly, achieving Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions and will further provide for monitoring and adaptive management to address threats to black rails from climate change. Additionally, protection, management, and restoration of fresh emergent wetland (Goal FW1) will retain, if not increase suitable habitat for California black rail in the strategy area, providing opportunities for California black rail to respond to changing habitat conditions under climate change. Achieving Goal CBR1, *California Black Rail Habitat*, will protect, restore, and enhance the availability and quality of emergent wetlands in or near occupied or previously occupied habitat, buffering California black rail populations from the stressors of climate change.

## E.3.20 Loggerhead Shrike

### E.3.20.1 Rationale for Goals and Objectives

#### Goal LS1: Loggerhead Shrike Habitat

Sufficient habitat in Yolo County to support the population of loggerhead shrike.

How the landscape and natural community objectives contribute to white-tailed kite conservation:

- *Objectives L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for conservation of large interconnected areas across environmental gradients to provide for shifts in distribution with climate change.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect loggerhead shrikes from adverse effects of noise, light, or other disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to loggerhead shrikes from climate change.
- *Objectives CP1.1, California Prairie Protection; CP1.2, Burrowing Rodents, CP1.3, Grazing Regimes;* and *CP1.4, Restore and Enhance Native Prairie.* Achieving these objectives provide for the protection, restoration, and enhancement of the natural community that provides grassland habitat for foraging loggerhead shrikes and their prey in Yolo County.
- *Objectives L4.1, Heterogeneity within Agricultural Matrix,* and *CL1.2, Incorporation of Habitat Elements.* Achieving these objectives provides for patches of woodlands and other suitable loggerhead shrike habitat within the agricultural matrix and on agricultural fields, for loggerhead shrike foraging, nesting, and perching.

- *Objective CL1.1, Mixed Agricultural Uses with Habitat Values.* Achieving this objective provides for the maintenance of crop types that provide foraging value for loggerhead shrikes.
- *Objectives WF1.1, Increase Valley Oaks; WF1.2, Protect Valley Oaks; WF2.1, Protect Upland Oaks; WF2.2, Restore Upland Oaks; WF3.1, Protect Riparian Oaks;* and *WF3.2, Restore and Enhance Riparian Oaks.* Achieving these objectives is expected to benefit loggerhead shrikes by providing nesting and perching habitat.
- *Objectives R1.1, Protect Riparian Areas,* and *R1.2, Increase Riparian Habitat Areas.* Achieving these objectives provide for the protection and restoration of riparian habitat that provides nesting and perching habitat for loggerhead shrikes.

#### Objective LHSH1.1: Protect Loggerhead Shrike Habitat

*Protect at least 700 acres of loggerhead shrike habitat.*

***Rationale**.* Protection of habitat ensures benefits loggerhead shrikes by providing nesting and perching habitat.

#### Objective LHSH.2: Enhance Loggerhead Shrike Habitat

*Enhance loggerhead shrike habitat by increasing its ability to support the species.*

***Rationale**.* Enhancing habitat will help provide high quality habitat for loggerhead shrike in Yolo County.

## E.3.20.2 Climate Change

### Loggerhead Shrike Vulnerability to Climate Change

The Climate Vulnerability Assessment gave loggerhead shrike a score of 12, and the species is not considered a priority with respect to climate vulnerability (Table 3-11). The loggerhead shrike may be vulnerable to the effects of climate change due to a reduction of preferred nesting habitat – grasslands, pasturelands, and farmlands. Dry conditions due to less precipitation in the Central Valley (PRBO Conservation Science 2011) may result in a reduction in prey base and lower reproductive success. Additionally while loggerhead shrikes are locally abundant in Yolo County, a decline in species distribution has been noted and the species range has contracted (Appendix C Species Account). Climate change may further contribute to species range contraction.

**Table F-15. Climate Vulnerability Scoring for Loggerhead Shrike as Described in Gardali et al. (2012)** [1]

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 1 – low; habitat suitability is expected to increase or decrease by 0–10% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 1 – low; taxon uses a wide variety of habitat types |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 1 - low; year-round resident |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

1 Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability

2 Scores range from 1 – 3; generally low, medium, and high

3 Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of loggerhead shrike occurrence in the strategy area would generally remain the same over time, with some areas showing increased probability of occurrences and other areas showing decreased probability of occurrence (Point Blue Conservation Science and California Department of Fish and Wildlife 2011).

Models predict areas with increased probability (from 20-40% up to 40-60%) include areas surrounding upper Cache Creek (west of Yolo, east of Guinda, and west of Arbuckle) and areas surrounding Woodland. Areas that show decreased probability (from 20-40% down to 0-20%) include West Sacramento, Davis, and Winters. Additionally, the models predict the loggerhead shrike range distribution slightly expands eastward toward the foothills and westward toward the Coast Range (PRBO Conservation Science 2011).

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy aims to reduce potential stressors of climate change by recommending and prioritizing strategies protecting known nesting location and suitable nesting habitat, and expanding protections and management of foraging habitat surrounding suitable nesting habitat. Achieving Objectives L4-22, *Resilience with Climate Change* and Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, will further provide for monitoring and adaptive management to address threats to loggerhead shrikes from climate change. Achieving Goal CP1, *Large contiguous areas of California prairie to support native species*, will provide for the protection, restoration, and enhancement of the natural community that provides grassland habitat for foraging loggerhead shrikes and their prey in Yolo County. Likewise, achieving Goal WF1, *Valley oak protection and restoration*; Goal WF4, *Oak woodland management*; and Goal R1, Riparian

Conservation, are expected to benefit loggerhead shrikes by providing nesting and perching habitat, if not expand potential nesting habitat for shrikes. Achieving Objective CL1.1, *Mixed agricultural uses with habitat values*, and Objectives Cl1.2, *Incorporation of habitat features*, are expected to help offset the potential negative effects of agricultural crop conversion under drier climate change conditions, ensuring sufficient prey is available for loggerhead shrike. By restoring degraded areas to desired habitat conditions, maintaining those habitat values under climate change, and incorporating redundancies into protected areas, these actions support future habitat needs and provides opportunities for loggerhead shrike to respond to changing climate conditions.

# E.3.21 Yellow-Breasted Chat

## E.3.21.1 Rationale for Goals and Objectives

### Goal YBC1: Yellow-Breasted Chat Distribution and Abundance

Sustain and increase the distribution and abundance of yellow-breasted chat within its range in Yolo County.

How the landscape and natural community objectives contribute to yellow-breasted chat conservation:

- *L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objective L2.1, Hydrologic and Geomorphic Processes in Floodplains.* Achieving this objective will benefit yellow-breasted chat by restoring natural fluvial processes to floodplains. Yellow-breasted chats will benefit from the restoration of fluvial disturbance regimes that encourage establishment of early successional riparian vegetation. The species most often forages in riparian vegetation communities early stages of succession, as opposed to young and mature forests (Melhop and Lynch 1986).
- *Objective L3.1, Invasive Species.* Achieving this objective provides for control of invasive plant species that may degrade yellow-breasted chat habitat by diminishing riparian structural diversity. This objective also provides for the control of invasive brown-headed cowbirds if they are found to be adversely affecting yellow-breasted chats in Yolo County.
- *Objective L3.3, Hazardous Human Uses.* Achieving this objective provides for buffers between natural lands and adjacent human activities, which may protect yellow-breasted chats from adverse effects of noise, light, and other human disturbances from nearby developed areas.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to yellow-breasted chats from climate change.
- *Objectives R1.1, Protect Riparian Areas; R1.2, Increase Riparian Habitat Areas;* and *R1.3, Maintain or Enhance Riparian Areas.* Achieving these objectiveswill benefit yellow-breasted chats by conserving, increasing, and maintaining and enhancing habitat for this species, including maintaining and enhancing structural diversity of riparian vegetation.

#### Objective LHSH1.1: Protect Loggerhead Shrike Habitat

*Protect at least 700 acres of loggerhead shrike habitat.*

***Rationale***. Protection of habitat ensures benefits loggerhead shrikes by providing nesting and perching habitat.

## E.3.21.2 Climate Change

### Yellow-Breasted Chat Vulnerability to Climate Change

The Climate Vulnerability Assessment gave yellow-breasted chat a score of 35, and the species is considered a priority with respect to climate vulnerability (Table 3-12). Under climate change scenarios, the Sacramento Valley ecoregion will likely experience less precipitation and decreased streamflows making the yellow-breasted chat vulnerable to the effects of climate change due from the potential loss and degradation of riparian habitat (PRBO Conservation Science 2011). Additionally, because it is a long-distance migrant that likely sensitive to changes in seasonal phonologies (e.g., changes in streamflow timing that could secondarily affect prey abundance), drier conditions could impact habitat suitability for the species.

**Table E-16. Climate Vulnerability Scoring for Yellow-breasted Chat as Described in Gardali et al. (2012[1]**

| Criteria | Score[2, 3] |
|---|---|
| **Exposure** | |
| Habitat suitability | 2 – moderate; habitat suitability is expected to decrease by 10–50% |
| Food availability | 1 - low; food availability for taxon would be unchanged or increase |
| Extreme weather | 1 – low; no evidence that taxon would be exposed to more frequent or severe extreme weather events |
| **Sensitivity** | |
| Habitat specialization | 2 – moderate; taxon that tolerates some variability in habitat type or element |
| Physiological tolerance | 1 – low; minimal or no evidence of physiological sensitivity to climatic conditions |
| Migratory status | 3 - high; long-distance migrants (migrates at least to the neotropics) |
| Dispersal ability | 1 – low; taxa with high dispersal ability |

[1] Additional information about species scoring, including the database of scores is located here: http://data.prbo.org/apps/bssc/index.php?page=climate-change-vulnerability
[2] Scores range from 1 – 3; generally low, medium, and high
[3] Climate vulnerability score = Sum of exposure score X Sum of sensitivity score

With a changing climate, habitat distributions will likely shift for many organisms. Models used to predict future habitat distributions affected by climate change predict that probability of yellow-breasted chat occurrence in the Sacramento Valley would decrease over time, but in the strategy area, the species distribution is generally resilient with a stable probability of occurrence of 0-20% (Point Blue Conservation Science and California Department of Fish and Wildlife 2011). Some riparian corridors with current probability of occurrence of 20-40%, such as Cache Creek, Upper Cache Creek, Putah Creek, and Sacramento River, respond favorably to the effects of climate change; these areas show the same probability of occurrence, but the range for species occurrence increases.

### How the RCIS/LCP Conservation Strategy Addresses Climate Change

There are ample opportunities for the to implement voluntary actions recommended in the conservation strategy to support the potential positive effects of climate change on yellow-breasted chat habitat that are predicted to occur. As a long distant migrant, landscape and habitat connectivity, would benefit the yellow-breasted chat as it returns from its wintering grounds. Achieving Objective L1-1, *Landscape Connectivity*, and L1.3, *Environmental Gradients*, will provide for larger blocks of contiguous nesting and foraging habitat that can support yellow-breasted chat. Riparian woodland habitat is an important feature for yellow-breasted chat; Achieving Objective L1-4, *Natural Community Restoration*, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Goal L2, *Ecological Processes and Conditions*, would restore and maintain ecological conditions along riparian corridor and floodplains, buffer existing yellow-breasted chat nesting habitat from climate change stressors. Achieving Objective L3.1, *Invasive Species*, provides for control of invasive plant species that may degrade yellow-breasted chat habitat by diminishing riparian structural diversity. This objective also provides for the control of invasive brown-headed cowbirds that may be adversely affecting yellow-breasted chats in Yolo County; reduced stressors from invasive species, facilitates reproductive success thereby making the breeding population more resilient to climate change. Achieving Objective L4-2, *Resilience to Climate Change* and Objective L4-3, *Natural Community and Habitat Resilience with Climate Change*, both will conserve and enhance the landscape to increases its habitat value under changing climate conditions. Similarly, achieving Goal R1, *Riparian Conservation*, will protect, increase, and enhance riparian habitat, all of which will serve to maintain and expand functional riparian habitat for the yellow-breasted chat in the strategy area. Achieving Goal LR1, *Stream Conservation*, will conserve and improve stream systems, including stream processes and conditions, which would help to counter the effects of climate change on hydrological processes in the strategy area, reducing stressors on riparian communities, making the natural community more resilient to climate change. Additional protection, restoration, and management of riparian nesting habitat will retain, if not increase suitable habitat for the yellow-breasted chat in the strategy area.

# E.3.22 Townsend's Big-Eared Bat

## E.3.22.1 Rationale for Goals and Objectives

### Goal TBEB1: Maintenance of Townsend's Big-Eared Bat Distribution and Abundance

How the landscape and natural community objectives contribute to yellow-breasted chat conservation:

- *L1.1, Landscape Connectivity,* and *L1.3, Environmental Gradients.* Achieving these objectives will provide for the conservation of large interconnected areas across environmental gradients to provide for shifts in habitat distribution with climate change.
- *Objectives L4.2, Landscape Resilience with Climate Change; L4.3, Natural Community and Habitat Resilience with Climate Change*; and *L4.4, Population Viability and Biodiversity Resilience with Climate Change.* Achieving these objectives will further provide for monitoring and adaptive management to address threats to Townsend's big-eared bat from climate change.

#### Objective TBEB1.1: Protect Roost Sites

***Rationale.*** The Townsend's big-eared bat is vulnerable to human disturbance during roosting (especially maternity roosts) and during its daily and seasonal periods of hibernation to conserve energy when inactive. Roosting habitat is limited to caves, mines, tunnels, and other features that mimic caves, such as large tree hollows, abandoned buildings with cave-like attics, water diversion tunnels, and internal spaces in bridges. Until Townsend's big-eared bat colonies are well protected, every maternal roost is important for maintaining the species in the strategy area.

## E.3.22.2 Climate Change

### Townsend's Big-Eared Bat Vulnerability to Climate Change

Climate influences many aspects of the Townsend's big-eared bat's life history including, their access to food, rate of energy expenditure, reproduction and development, timing of hibernation, and frequency and duration of torpor. Sherwin et al. (2013) suggest that bats specialized in root types, such as the cave dwelling big-eared bat, are at risk from changing vegetation and climate conditions.

The Townsend's big-eared bat life history centers on reproduction and meeting the energetic demands of a small insectivorous mammal (see Appendix C Species Account). As an insectivorous bat that gleans prey from foliage (CDFW 2018), the Townsend's big-eared bat depends on the availability of beetles and moths, whose activity is influenced by climatic condition (Burles et al. 2009). The projected impacts of climate change on the Sacramento Valley ecoregion will be warmer temperatures, reduced precipitation relative to current conditions, and reduced streamflow and water availability (PRBO 2011). Projected impacts of climate change may alter the temporal and spatial availability of prey for the big-eared bat, influencing other aspects of life history. Under drier climate conditions, the big-eared bat may experience dehydration stress from increased rate of evaporative water loss from naked flight membranes (Webb et al. 1995). Traveling further from roosting habitat, which are already scarce in California (Sherwin et al. 2013), to access water and food results in energetic losses and may alter reproductive success and survivability. Changes in climate conditions, such as temperature and humidity, are likely to affect the thermal properties of different roost types, which are used for reproduction, resting, torpor, and seasonal hibernation (Newson et al. 2008 ), which may alter roost structure selection, timing of reproduction, bouts of topor, and timing of hibernation. Climate change may affect timing of reproduction as reproduction in insectivorous bat is dependent on insect availability, can be delayed by precipitation, and warmer conditions have been shown to cause earlier parturition (Grindal et al. 1992; Burles et al. 2009).

The Townsend's big-eared bat has shown local population declines across California (CDFW 2018). Causes of population declines are most likely due to disturbance and destruction of roost sites (Western Bat Working Group YEAR ), where the distribution of the species appears to be constrained primarily by the availability of suitable roosting sites and the degree of human disturbance at roosts (see Appendix C Species Account). Like other species of bat in North America, the Townsend's big-eared bat is threatened by reduction of roosting and foraging habitat that are impacted by loss of riparian habitat, loss of genetic diversity and population connectivity due to reduced population sizes or available roost sites (Western Bat Working Group YEAR ). Climate change models additionally predict the frequency and intensity of climatic extreme will increase, exposing bats to more frequent climatic events. Although the pathology and mode of spread of fungal diseases, such as White Nose Syndrome, is not yet fully understood, research has shown that increased arousal in roosts and increased energetic stress is related to enhanced susceptibility to fungal infection (Jones et al. 2009, Boyles & Willis 2010).

## How the RCIS/LCP Conservation Strategy Addresses Climate Change

The conservation strategy is focused on increasing permeability across the landscape to facilitate dispersal to available habitat, should pressures force them out of their current ranges, and reducing habitat fragmentation. Achieving Goal L1, *Large interconnected landscapes*, reduces habitat fragmentation allowing existing Townsend's big-eared bat populations to move within the strategy area from current habitat to areas with potentially higher habitat suitability under future conditions. Townsend's big-eared bat occurs in many habitat types in California, including agriculture, riparian communities, oak woodland, and native prairies. Habitat loss and increased completion for already scarce roosting sites will result in greater pressure on natural communities. Objective L1-4, Natural Community Restoration, will restore species composition and ecological processes in a manner that maximizes their long-term function taking into consideration potential future conditions with climate change. Achieving Objective L4-2, *Resilience to Climate Change*, will promote continued capability of the landscape under conditions resulting from climate change. Similarly, achieving RCIS/LCP Objective L4.3, *Natural Community and Habitat Resilience with Climate Change*, will conserve and enhance natural communities to increases its habitat value under changing climate conditions. Achieving Objective L4-1, *Heterogeneity within Agricultural Lands*, would provide roosting habitat (such as snags and structural elements) to provide roosting opportunities within the agricultural landscape. Achieving Objective CL1.3, *Cultivated Land pollinators*, would benefit the big-eared bat by promoting prey availability, thereby reducing the stressors of climate change on forage availability.  Achieving Objectives WF1.1 through WF3.2 would increase, protect, and restore oak woodland habitat and increase the availability of potential roosting and foraging habitat for big-eared bat. Similarly, achieving Objectives R1.1, *Protect Riparian Areas*, and R1.2, *Increase Riparian Habitat Areas*, provide for the protection and restoration of riparian habitat that provides roosting habitat for big-eared bat.

In select sites in California and in other areas, depressed populations have recovered with the protection (i.e.. gating) of roosts (Western Bat Working Group YEAR ). By increasing the protection of known roosting areas, restoring degraded areas to beneficial conditions, and increasing potential roosting habitat, the conservation strategy maintains, if not increases, the availability of suitable habitat for Townsend's big-eared bat, thereby buffering the species from the stressors of climate change. Because the big-eared bat utilizes a variety of land cover types in the strategy area, even if there is a vegetation shift under climate change, habitat in the strategy area may remain suitable. However, building repetition into the region benefits the species and local population of big-eared bat, so that if current roosting and foraging habitat are no longer viable due to drier and warmer environmental conditions, other potential habitat will now be protected and managed for the species, allowing the big-eared bat to emigrate to areas of suitable climate. This, coupled with the protection and management of more habitat in the strategy area will ensure that Townsend's big-eared bat persists in Yolo County.

# E.4 Other Conservation Elements

Table E-18 lists each of the "other conservation elements" described in Section 1.5.7, *Other Conservation Elements,* and indicates which components of the Yolo RCIS/LCP conservation strategy address each conservation element.

**Table E-178. How the Conservation Strategy Addresses Other Conservation Elements**

| Conservation Element | Conservation Goals and Objectives or Other Aspects of Conservation Strategy |
|---|---|
| Biodiversity | Objective L1-3: Environmental Gradients. |
| | Objective L1-5: Ecotone Conservation |
| | Goal L4: Biodiversity, Ecosystem Function, and Resilience |
| Environmental Gradients | Objective L1-3: Environmental Gradients. |
| Existing Protected Areas | Goal L1: Large Interconnected Landscapes (L1-1.7. Incorporate existing protected areas within the system of conserved lands, and to the extent possible, prioritize additions to the system that maintain connectivity within the protected landscape.) |
| | See gap analysis regarding conservation needs in the context of existing protected lands. |
| | Enhancement and restoration may occur on existing protected areas. |
| Habitat Connectivity | Goal L1: Large Interconnected Landscapes |
| Important Ecological Processes | Goal L2: Ecological Processes and Conditions |
| | Goal L4: Biodiversity, Ecosystem Function, and Resilience |
| | Objective LR1.1. Fluvial equilibrium. |
| | Objective LR1.4: Stream processes and conditions. |
| Natural Communities and Habitat | Objective L1-4: Natural Community Restoration |
| | Goal CL1: Cultivated land habitat conservation |
| | Goal CP1: Large contiguous areas of California prairie to support native species |
| | Goal CH1: Chaparral conservation. |
| | Goal WF1. Valley oak protection and restoration |
| | Goal WF2. Upland oak protection and restoration/enhancement |
| | Goal WF4. Oak woodland management |
| | Goal FW1: Fresh Emergent Wetland Conservation. |
| | Goal R1: Riparian Conservation |
| | Goal LR1: Stream conservation |
| | Goal AP1: Alkali Prairie Conservation. |
| | Goal VP1: Vernal Pool Conservation |
| | Goal VP1: Vernal Pool Conservation |
| Water Resources | Objective L2-1: Hydrologic and Geomorphic Processes |

| Conservation Element | Conservation Goals and Objectives or Other Aspects of Conservation Strategy |
|---|---|
| | Goal LR1: Stream conservation<br>Goal FW1: Fresh Emergent Wetland Conservation |