Appendix D
Species Profiles
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Townsend’s Western Big-Eared Bat (Corynorhinus townsendii townsendii)

Status
State: Species of Concern
Federal: None
Other: Western Bat Working Group High Priority Species

Population Trend
Global: Declining (Pierson et al. 1999)
State: Declining (Pierson 1988, Pierson and Rainey 1996)
Within Inventory Area: Unknown

Data Characterization
The location database for the Townsend’s western big-eared bat (Corynorhinus townsendii townsendii) within its known range in California includes 20 data records dated from 1987 to 2000. Of these records, 6 were documented within the past 10 years; of these, 1 was of high precision and can be accurately located within the its survey area. None of these records are located within the inventory area.

A moderate amount of literature is available for the Townsend’s western big-eared bat because of its rare and declining status. Most of the information available is on the natural history, distribution, population status, and threats to this species. A conservation assessment and conservation strategy has been published.

Range
Townsend’s big-eared bats occur throughout most of western North America from British Columbia to central Mexico, east to the Black Hills of South Dakota, and across Texas to the Edwards Plateau (Hall 1981, Kunz and Martin 1982). Isolated, relictual populations of this species are found in the southern Great Plains and the Ozark and Appalacian Mountains (Hall 1981, Kunz and Martin 1982). The subspecies pallescens occurs in Washington, Oregon, California, Nevada, Idaho, Arizona, Colorado, New Mexico, Texas, and Wyoming. The subspecies townsendii occurs in Washington, Oregon, California, Nevada, Idaho, and possibly southwestern Montana and northwestern Utah (Hadley 1959, Hall 1981). In California, the boundary between pallescens and townsendii runs north-south approximately through the center of the Central Valley, with C. t. townsendii on the west side (Hall 1981). This species occurs from near sea level to well above 3,160 meters above sea level (Pearson et al. 1952, Nagorsen and Brigham 1993).
Occurrences within the ECCC HCP/NCCP Inventory Area

Townsend’s big-eared bat is found throughout California, but specific details on its distribution within the central Coast Ranges are not well known. Records of this species include sites in the coastal lowlands and agricultural areas of Marin, Napa, Alameda, and San Mateo Counties and nearby hills (Pierson 1988). However, there are no published records of Townsend’s big-eared bat within Contra Costa County. Because of the scarcity of suitable habitat including mines and caves, it is unlikely that significant maternity roosts of this species occur in the county. However, future research may show that small numbers of individual bats roost in buildings, bridges, or other structures within the inventory area.

Biology

Habitat

Townsend’s big-eared bats occur in a variety of habitats throughout California, but they are most commonly associated with desert scrub, mixed conifer forest, and pinon-juniper or pine forest habitat. Within these communities, they are specifically associated with limestone caves, mines, lava tubes, and buildings (Dalquest, 1947, 1948; Graham 1966; Pearson et al. 1952; Kunz and Martin 1982; Pierson et al. 1991; Dobkin et al. 1995).

During hibernation, Townsend’s big-eared bats typically prefer habitats with relatively cold (but above freezing) temperatures in quiet, undisturbed places. These areas are often in the more interior, thermally stable portions of caves and mines (Barbour and Davis 1969, Dalquest 1947, Humphrey and Kunz 1976, Pearson et al. 1952, Zeiner et al. 1990). Hibernating bats are often found in ceiling pockets (Pierson et al. 1991). In central California, solitary males and small clusters of females are also known to hibernate in buildings (Pearson et al. 1952, Kunz and Martin 1982). Females may roost in colder places than males during these periods (Pearson et al. 1952).

During spring and summer, females establish maternity colonies in the warm parts of caves, mines, and buildings (Dalquest 1948, Pearson et al. 1952, Twente 1955, Pierson et al. 1991). In California, some maternity roost may reach 30°C (86°F) (Pierson et al. 1991). Favored roost locations for females and young are often in a ceiling pocket or along the walls just inside the roost entrance (Pierson et al. 1991). Night roosts may include buildings or other structures, such as bridges (Pierson et al. 1996, Rainy and Pierson unpublished manuscript).

Foraging

Townsend’s big-eared bats feed primarily on small moths, but also take other insects, including flies, lacewings, dung beetles, and sawflies (Whitaker et al. 1977; Kunz and Martin 1982;). Radio-tracking studies in northern California...
have found Townsend’s big-eared bats foraging within forested habitats and along heavily vegetated stream corridors, avoiding open, grazed pasture land (Pierson and Fellers 1998, Pierson et al. 1999). Individuals may travel up to 13 kilometers from their day roost (Pierson et al. 1999).

Reproduction

Female Townsend’s big-eared bats arrive at maternity roost sites in early spring and give birth to a single offspring in late spring or early summer after an approximately 3-month gestation period (Pearson et al. 1952). In California, young are born over a 3- to 5-week period beginning in late May. Maternity colonies disperse in fall, and mating occurs in fall and winter. The peak of copulations occurs from November through February, although some females apparently mate before arriving at hibernacula (Kunz and Martin 1982). Females are sexually mature and mate in their first autumn. However, as in most bats, females store sperm, and ovulation does not occur until early spring (Pearson et al. 1952). Ovulation may occur either before or after females leave hibernation. Townsend’s big-eared bats are large at birth, weighing approximately 25% of the mother’s postpartum mass (Kunz and Martin 1982). Young grow rapidly, reaching adult size in approximately 1 month, and capable of flight in 2.5 to 3 weeks. They are fully weaned by 6 weeks (Pearson et al. 1952).

Demography

Band recoveries show longevity records of up to 16 years, 5 months (Paradiso and Greenhall 1967) and 21 years, 2 months (Perkins 1994). Pearson et al. (1952) estimated the annual survivorship for Townsend’s big-eared bats was about 50% for young and 80% for adults.

Behavior

Townsend’s big-eared bat is a relatively sedentary species for which no long-distance migrations have been documented (Pearson et al. 1952, Barbour and Davis 1969, Humphrey and Kunz 1976). The longest seasonal movements recorded for this species are 32.2 kilometers in California (Pearson et al. 1952) and 39.7 kilometers in Kansas (Humphrey and Kunz 1976).

Townsend’s big-eared bats hibernate in mixed-sex aggregations of 100 to 500 individuals. They periodically arouse during winter and move to alternate roosts. Individuals actively forage and drink throughout winter (Brown et al. 1994). Hibernation is prolonged in colder areas and intermittent where climate is predominately not freezing (Kunz and Martin 1982).
Ecological Relationships

Townsend’s big-eared bat is a lepidopteran specialist, with a diet consisting of more than 90% moths (Pierson et al. 1999). Night roosts of this species often include other bat species, including pallid bat (*Antrozous pallidus*), big brown bat (*Eptesicus fuscus*), California myotis (*Myotis californicus*), small-footed myotis (*M. ciliolabrum*), long-eared myotis (*M. evotis*), little brown bat (*M. lucifugus*), fringed bat (*M. thysanodes*), long-legged bat (*M. volans*), and Yuma myotis (*M. yumanensis*).

Threats

Townsend’s big-eared bats are highly sensitive to roost disturbance. Activities that can result in significant disturbance or loss of habitat include mine reclamation, renewed mining, water impoundments, recreational caving, loss of building roosts, and bridge replacement (Kunz and Martin 1982, Pierson et al. 1999). Pesticide contamination may also threaten this species in agricultural areas (Geluso et al. 1976).

Conservation and Management

Townsend’s big-eared bat has been classified as a High Priority species by the Western Bat Working Group for all populations throughout its range. This classification indicates that this species is imperiled or is at high risk of imperilment. In 1994, a Townsend’s big-eared bat conservation strategy was initiated as part of the Idaho Conservation Effort. This strategy was prepared by a team of experts from 8 participating states and resulted in the publication of the Species Conservation Assessment and Conservation Strategy for the Townsend’s big-eared bat (Pierson et al. 1999). The species conservation assessment summarizes the life history and habitat requirements, historical and current distribution and abundance of this species throughout its range, its current status, and threats to the species in each state. The conservation strategy is a plan that, if successful, will remove or minimize identified threats and promote restoration or recovery of the species.

Species Distribution Model

A species distribution model was not developed for Townsend’s big-eared bat because the specific habitat features for this species could not be mapped on a regional scale.
Literature Cited


Townsend’s Western Big-Eared Bat (*Corynorhinus townsendii townsendii*)


San Joaquin Kit Fox (Vulpes macrotus mutica)

Status

State: Threatened
Federal: Endangered

Population Trend

Global: Declining
State: Declining
Within Inventory Area: Unknown

Data Characterization

The location database for the San Joaquin kit fox (Vulpes macrotus mutica) within its known range in California includes 22 data records from 1975 to 1999. Of these records, none of the 7 documented within the past 10 years were of sufficient precision to be accurately located within the survey areas. Three of these 7 records are located within the ECCC HCP/NCCP inventory area. These records represent sighting within non-native grassland, grazed, and agricultural habitat. This database includes records of individual sightings and locations of occupied, vacant, and natal dens.

A moderate amount of literature is available for the San Joaquin kit fox because of its endangered status. Long-term studies have been conducted on the ecology and population dynamics of this species in core population centers at the Elk Hills and Buena Vista Naval Petroleum Reserves in Kern County and on the Carrizo Plain Natural Area in San Luis Obispo County. Numerous surveys have been conducted in the northern portion of the range, including Contra Costa County. Quantitative data are available on population size, reproductive capacity, mortality, dispersal, home-range movement patterns, and habitat characteristics and requirements. A number of models have been developed to describe the species’ population dynamics. A recovery plan for the San Joaquin kit fox has been published.

Range

The San Joaquin kit fox is found only in the Central Valley area of California. Kit foxes currently inhabit suitable habitat in the San Joaquin valley and in surrounding foothills of the Coast Ranges, Sierra Nevada, and Tehachapi Mountains, from southern Kern County north to Contra Costa; Alameda and San Joaquin counties on the west; and near La Grange, Stanislaus County on the east.

Occurrences within the ECCC HCP/NCCP Inventory Area

Fifty-three occurrences of San Joaquin kit foxes have been documented within the inventory area since 1967 (Duke et al. 1997). These records were located
from the Black Diamond Mines area and Lone Tree Valley in the north to Round Valley, Los Vaqueros Reservoir, and Brushy Creek in the south (Duke et al. 1997). Fifteen of these records were documented since 1986. The greatest density of occurrences is located in the southern portion of the inventory area.

**Biology**

**Habitat**

San Joaquin kit foxes occur in a variety of habitats, including grasslands, scrublands, vernal pool areas, alkali meadows and playas, and an agricultural matrix of row crops, irrigated pastures, orchards, vineyards, and grazed annual grasslands (Williams et al. 1998). They prefer habitats with loose-textured soils (Grinnell et al. 1937, Hall 1946, Egoscue 1962) that are suitable for digging, but they occur on virtually every soil type. Dens are generally located in open areas with grass or grass and scattered brush, and seldom occur in areas with thick brush. Preferred sites are relatively flat, well-drained terrain (Williams et al. 1998, Roderick and Mathews 1999). They are seldom found in areas with shallow soils due to high water tables (McCue et al. 1981) or impenetrable bedrock or hardpan layers (O’Farrell and Gilbertson 1979, O’Farrell et al. 1980). However, kit foxes may occupy soils with a high clay content where they can modify burrow dug by other animals, such as ground squirrels (*Spermophilus beecheyi*) (Orloff et al. 1986).

In the northern part of its range (including San Joaquin, Alameda and Contra Costa Counties) where most habitat on the valley floor has been eliminated, kit foxes now occur primarily in foothill grasslands (Swick 1973, Hall 1983, Williams et al. 1998), valley oak savanna and alkali grasslands (Bell 1994). Less frequently they occur adjacent to and forage in tilled and fallow fields and irrigated row crops (Bell 1994). These foxes will den within small parcels of native habitat that is surrounded by intensively maintained agricultural lands (Knapp 1978) and adjacent to dryland farms (Jensen 1972, Orloff et al. 1986, Williams et al. 1998).

**Foraging Requirements**

The diet of kit foxes varies, with season and geographic locality based on local availability of potential prey. In the northern portion of their range, kit foxes most commonly prey on California ground squirrels, cottontails (*Sylvilagus auduboni*), black-tail jackrabbits (*Lepus californicus*), pocket mice (*Perognathus spp.*), and kangaroo rats (*Dipodomys spp.*) (Hall 1983, Orloff et al. 1986, Williams et al. 1998). Secondary prey taken opportunistically may include ground-nesting birds, reptiles, and insects (Laughrin 1970).
Reproduction

Kit foxes can, but do not necessarily, breed their first year. Sometime between February and late March, 2 to 6 pups are born per litter (Egoscue 1956, Zoellick et al. 1987a, Cypher et al. 2000). The annual reproductive success for adults can range between 20 and 100% (mean: 61%;) and 0 and 100% for juveniles (mean: 18%) (Cypher et al. 2000). Population growth rates generally vary positively with reproductive success and kit fox density is often positively related to both current and the previous year’s prey availability (Cypher et al. 2000). Prey abundance is generally strongly related to the previous year’s effective (October to May) precipitation.

Longevity

Kit foxes in the wild can live as long as 8 years, but such longevity is rare (Williams et al. 1998). Annual survival rates of juvenile foxes generally range between 21 and 41% (Berry et al. 1987, Ralls and White 1995). In captivity, kit foxes can live up to 10 years (McGrew 1979). The annual natural mortality rate of adults is approximately 50% (Berry et al. 1987, Ralls and White 1995), but is closer to 70% for juveniles (Berry et al. 1987). Coyotes (Canis latrans) and other predators (red foxes [Vulpes vulpes], domestic dogs, bobcats [Lynx rufus] and large raptors) are the primary sources of mortality for adult and juvenile foxes (Hall 1983, Betty et al. 1987b, Ralls and White 1995, Warrick et al. 1999, White et al. 2000, Cypher et al. 2000), and vehicles are usually the secondary cause (Cypher et al. 2000).

Population Dynamics

In a long-term study of kit fox population dynamics at the Naval Petroleum Reserves in California, Cypher et al. (2000), showed that population growth rates vary positively with reproductive success, and population density is positively related to both the current and the previous year’s prey availability. Prey abundance was strongly related to the previous year’s effective precipitation (October to May).

White and Garrott (1999) note that 2 density-dependent mechanisms appear to regulate kit fox population patterns. The first, the rate of juvenile recruitment, is inversely related to the density of adult foxes because higher proportions of juveniles are generally killed by coyotes at higher fox densities. The mortality rates of adult foxes are apparently independent of population density. The second is that populations of kit foxes are bounded by their territorial spacing behavior, which limits recruitment at higher densities. These mechanisms, therefore, may act together to curtail population growth at high densities, whereas decreased juvenile mortality by coyotes can act independently to increase population growth at low densities.

Density-independent factors, particularly unpredictable fluctuations in precipitation that contribute to high-frequency, high-amplitude fluctuations in the
abundance of kit fox prey, can also result in variations in reproductive rates that cause population crashes or eruptions (White and Garrott 1999). Unpredictable short-term fluctuations in precipitation, and in turn, prey abundance could therefore generate longer-term, aperiodic fluctuations in the density of foxes that are independent of special or persistent causes such as predation or disease.

**Dispersal**

The pups emerge above ground at approximately 1 month of age and some disperse after 4 to 5 months, usually between July and September. In a study of 209 dispersing juveniles, Koopman et al. (2000) found that 33% dispersed from their natal territory, significantly more males (49%) than females (24%). The percentage of male dispersal was weakly related to mean annual litter size, and the percentage of female dispersal was weakly and inversely related to annual small-mammal prey abundance. Most of the dispersing juveniles (65%) died within 10 days of leaving their natal range. However, survival tended to be higher for dispersing males than for males that remained within their natal area. There was no difference in survival for dispersing and philopatric females. Non-dispersing offspring of both sexes may remain with their parents through the following year and help raise the next litter (White and Ralls 1993…), but this behavior is not always observed (Koopman et al. 2000).

**Behavior**

**Den Use**

San Joaquin kit foxes use numerous dens throughout the year. They are used for temperature regulation, shelter from inclement weather, reproduction, and escape from predators. Hall (1983) documented a family of 7 kit foxes that used 43 dens in 1 year, while 1 other individual used 70 dens (K Ralls, pers. comm. in Williams et al. 1998). Koopman et al. (1998) found that individual foxes within the Naval Petroleum Reserves use an average of 11.8 different dens each year, and den use does not differentiate between sexes. The number of dens used varied among seasons, with more dens used during the dispersal season than during the breeding or pup-rearing seasons. On average, kit foxes used an individual den 10% of the time throughout the year, but favored dens were used 32% of the time. Approximately 50% of the dens used by a kit fox in a 1-year period had not been used by that fox during the previous year. Male and female pups up to 18 months of age denned equally with either adult parent. They denned with siblings for up to 21 months of age. Radio telemetry studies of kit fox movement on the Carrizo Plain Natural Area (White and Ralls 1993) indicate that foxes use individual dens for an average of 3.5 days before moving to a different den. Den changes are believed to be primarily in response to a need to avoid coyotes, although local depletion of prey and increases in external parasites in the dens may also influence this behavior (Egoscue 1956 in Williams et al. 1998).
**Movement**
Kit foxes may range up to 20 miles at night (Girard 2001) during the breeding season and somewhat less (6 miles) during the pup-rearing season. Home ranges vary from less than 1 square mile up to approximately 12 square miles (Knapp 1978, Spiegel and Bradbury 1992, White and Ralls 1993). The home ranges of pairs or family groups of kit foxes generally do not overlap (White and Ralls 1993). This behavior may be an adaptation to periodic drought-induced scarcity in prey abundance.

**Social Structure**
Genetic and field studies of kit foxes on the Carrizo Plains Natural Area (Ralls et al. 2001) showed that foxes living in adjacent home ranges tended to be more closely related than foxes from more distant home ranges. This pattern emerged largely because females on adjacent home ranges were often closely related. Foxes that shared the same den were usually members of the same social group, but occasionally foxes from different social groups shared dens, possibly during pair formation. San Joaquin kit foxes can maintain enduring social relationships with adult offspring or siblings that have dispersed to new home ranges and found a mate.

**Ecological Relationships**
San Joaquin kit foxes prey upon a variety of small mammals, ground-nesting birds, and insects. They are in turn subject to predation or killing by such species as coyote, non-native red foxes, domestic dog, eagles, and large hawks (Hall 1983, Berry et al. 1987, Ralls and White 1995). White et al. (2000) determined that coyotes were responsible for 59% of kit fox deaths during a 4-year telemetry study at Camp Roberts in southern Monterey County.

**Threats**
Loss, fragmentation, and degradation of habitat by agricultural, urban, and industrial development continues to decrease the remaining habitat and carrying capacity of San Joaquin kit foxes throughout its range. Livestock grazing is not thought to be detrimental to kit foxes (Morrell 1975, Orloff et al. 1986), but it may affect the number of prey species available, depending on the intensity of grazing (Williams et al. 1998). In some areas, livestock grazing may benefit kit foxes by reducing shrub cover and maintaining grassland habitat.

Continued fragmentation of habitat is a serious threat to this species. Increasing isolation of populations and social groups through habitat degradation and barriers to movement, such as aqueducts and busy highways, can limit dispersal to and habitation of existing and former lands. This isolation also favors inbreeding depression in populations, as well as making the smaller populations susceptible to extinction from stochastic environmental events such as droughts, flooding, fire, and periodic declines in prey abundance. Invasion of fragmented, occupied kit fox habitat by coyotes, red foxes, and feral dogs can contribute to increased mortality of kit foxes.
The use of pesticides to control rodents and other pests also threatens kit fox in some areas, either directly through poisoning or indirectly through reduction of prey abundance. Historically, measures such as hunting and rodenticides have been used extensively in the inventory area to control rodents and reduce conflicts with livestock. This has greatly decreased the populations of these species, reducing prey availability for their predators. In 1975, California ground squirrel, which is the main prey item for San Joaquin kit fox in Contra Costa County, was thought to have been eradicated countywide after extensive rodent eradication efforts (Bell et al. 1994; U.S. Fish and Wildlife Service 1998). California ground squirrel populations have been increasing in Contra Costa County since then; however, their abundance may still limit San Joaquin kit fox presence and abundance in the eastern portion of the County (Orloff pers. comm.).

Conservation and Management

The San Joaquin kit fox is listed as both state and federally endangered. A recovery plan for this species was completed in 1983 that outlines objectives to halt the decline of the species and increase population sizes above the 1981 level (Williams et al. 1998). Subsequent conservation actions have included acquisition of important habitat by the U.S. Bureau of Land Management (BLM), California Department of Fish and Game (CDFG), California Energy Commission, Bureau of Reclamation, U.S. Fish and Wildlife Service (USFWS), and Nature Conservancy. Substantial long-term research has been conducted on populations in the Naval Petroleum Reserves and in the Carrizo Natural Area in southern California. These studies have provided important information on kit fox habitat requirements, behavior, demographics, and threats.

In 1998, a recovery plan for upland species of the San Joaquin Valley was completed (Williams et al. 1998), which included a revised recovery strategy for the San Joaquin kit fox. The goal of this recovery plan is to maintain a viable metapopulation of kit foxes on private and public lands throughout its geographic range. This will include preservation of existing core and satellite populations. Areas where core populations are found include the Carrizo Plain Natural Area in San Luis Obispo County; the natural lands of western Kern County, including the Naval Petroleum Reserves, the Lokern Natural Area, and adjacent natural lands inhabited by kit foxes; and the Ciervo-Panoche Natural Area of western Fresno and eastern San Benito Counties. Camp Roberts and Fort Hunter Liggett also provide important habitat for kit foxes in the Salinas and Pajaro river watersheds. Additional lands in the San Joaquin Valley that have kit foxes or the potential to have them include refuges and other lands managed by the CDFG, California Department of Water Resources, Center for Natural Lands Management, Lemoore Naval Air Station, Bureau of Reclamation, and USFWS, as well as various private lands in these areas. While kit foxes have been documented in numerous locations in East Contra Costa County, no conservation areas were identified for this species in the 1998 recovery plan. However, the recovery plan identifies the protection of existing kit fox habitat in the northern portion of its range and protection of existing connections between habitat in Contra Costa County and habitat farther south as primary recovery actions.
**Status Assessment**

San Joaquin kit foxes are known to occur within the ECCC HCP/NCCP inventory area, with greater numbers occurring in the southern portion of the area. However, compared with populations in southern California, little is known about the ecology and habitat needs of kit foxes in the northern part of their range. Researchers have consistently indicated that the behavioral ecology of kit foxes in this region is poorly known and may be different from the ecology of foxes in the southern part of their range (Laughlin 1970, Swick 1973, Morrell 1975, Orloff et al. 1986, Sproul and Flett 1993, Bell 1994). The northern populations of kit foxes appear to use different prey (ground squirrels instead of kangaroo rats), and their denning habitat appears different (Orloff et al. 1986). In addition, habitat (ground cover, dominant vegetation, land use practices, rainfall, and in some cases relief) is substantially different in the north than in the south, where kit foxes are more abundant and well studied. Because of these differences, some geographic differences may exist in the demographic characteristics of these populations. However, the threats of habitat loss; degradation and fragmentation; predation by coyotes, red foxes, feral dogs, and other predators; and vehicular mortality are likely to be comparable in both regions of their range.

**Modeled Species Distribution**

**Model Description**

**Assumptions**

1. The following land cover types were considered core habitat for the San Joaquin kit fox:
   - Annual grassland suitable for all kit fox activities including foraging, denning, shelter and movement corridors that is connected to known kit fox movement routes;
   - Oak savanna contiguous with annual grassland;
   - Alkali grassland within annual grassland;
   - Seasonal wetland within annual grassland or oak savanna;
   - Ruderal areas within annual grassland or oak savanna; and
   - All wind turbine areas within annual grassland.

2. The following land cover types were considered low use habitat for San Joaquin kit fox:
   - Cropland, pasture, and orchard land cover types within 1 mile of core habitat as defined above;
Mammals

San Joaquin Kit Fox (*Vulpes macrotus mutica*)

- Ruderal areas contiguous with low-use cropland, pasture, or orchard habitat; and
- 100-feet from suitable core habitat into oak woodlands.

3. Grassland and oak savanna patches isolated from large contiguous tracts of annual grassland by oak woodland or chapparal/scrub were considered non-habitat.

**Rationale**

**Core Habitat:** In the northern part of its range (including Contra Costa County), where most habitat on the valley floor has been eliminated, kit foxes now occur primarily in foothill grasslands (Swick 1973, Hall 1983, Williams et al. 1998), valley oak savanna and alkali grasslands (Bell 1994). They prefer habitats with loose-textured soils (Grinnell et al. 1937, Hall 1946, Egoscue 1962, Morrell 1972), suitable for digging, but occur on virtually every soil type. Dens are generally located in open areas with grass or grass and scattered brush, and seldom occur in areas with thick brush (Morrell 1972). Preferred sites are relatively flat, well-drained terrain (Williams et al. 1998, Roderick and Mathews 1999). They are seldom found in areas with shallow soils due to high water tables (McCue et al. 1981) or impenetrable bedrock or hardpan layers (Morrell 1975, O’Farrell and Gilbertson 1979, O’Farrell et al. 1980). However, kit foxes may occupy soils with a high clay content where they can modify burrow dug by other animals such as ground squirrels (*Spermophilus beechii*) (Orloff et al. 1986).

The geographical separation of suitable and unsuitable habitat of annual grassland and oak savanna was based on the location of large tracts of oak woodland separating large contiguous tracts of these land cover types from smaller isolated patches at higher elevations to the west. While kit foxes may occasionally use oak woodland habitat, at least along the margins adjacent to core grassland habitat (Orloff, pers. comm.), they are not likely to frequently pass through these areas due to higher predation potential from other canids (coyotes, gray foxes, red foxes) and reduced prey availability. Isolated patches of grassland and oak savanna beyond these oak woodland tracts were therefore considered not suitable habitat for this species.

**Low Use Habitat:** San Joaquin kit foxes also less frequently occur adjacent to and forage in tilled and fallow fields and irrigated row crops (Bell 1994, Williams et al. 1997). These foxes will den within small parcels of native habitat that is surrounded by intensively maintained agricultural lands (Knapp 1978) and adjacent to dryland farms (Jensen 1972, Orloff et al. 1986, Williams et al. 1998). Kit foxes are known to use agricultural areas within the inventory area in these ways.

**Model Results**

Figure 2 shows the modeled potential habitat of the San Joaquin kit fox within the ECCC HCP/NCCP inventory area. The habitat includes approximately two-
thirds of the inventory area and is primarily located within the low elevation grassland areas between the agricultural/urban areas in the east and north and the higher elevation foothill areas around Mt. Diablo to the west. The documented occurrences of San Joaquin kit foxes in this area correspond well to locations within the modeled core area habitat.

**Literature Cited**


**Personal Communications**

Orloff, Sue. Wildlife biologist, San Joaquin kit fox expert, and an HCP/NCP Science Advisor, Ibis Environmental Consulting, San Rafael, CA.
Tricolored Blackbird (*Agelaius tricolor*)

**Status**
- **State:** Bird Species of Special Concern, Priority 1
- **Federal:** None

**Population Trend**
- **Global:** Declining
- **State:** Declining (Beedy and Hamilton 1997, 1999)
- **Within Inventory Area:** Possibly declining (Beedy and Hamilton 1997).

The first systematic surveys of Tricolored Blackbird population status and distribution were conducted by Neff (1937, 1942). During a 5-year interval, he found 252 breeding colonies in 26 California counties; the largest colonies were in rice-growing areas of the Central Valley. He observed as many as 736,500 adults per year (1934) in just eight Central Valley counties. The largest colony he observed was in Glenn County; it contained more than 200,000 nests (about 300,000 adults) and covered almost 24 hectares (60 acres). Several other colonies in Sacramento and Butte Counties contained more than 100,000 nests (about 150,000 adults).

DeHaven et al. (1975a) estimated that the overall population size in the Sacramento and northern San Joaquin valleys had declined by more than 50% since the mid-1930s. They performed intensive surveys and banding studies in the areas surveyed by Neff (1937) and observed significant declines in Tricolored Blackbird numbers and the extent of suitable habitat in the period since Neff’s surveys. Orians (1961a) and Payne (1969) observed colonies of up to 100,000 nests in Colusa, Yolo, and Yuba Counties, but did not attempt to survey the entire range of the species.

The U.S. Fish and Wildlife Service, the California Department of Fish and Game, and California Audubon cosponsored intensive, volunteer Tricolored Blackbird surveys in suitable habitats throughout California in 1994, 1997, 1999, and 2000 (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000). Local, regional, and statewide Tricolored Blackbird populations have experienced major declines since 1994. Statewide totals of adults in four late-April surveys covering all recently known colony sites were: 369,359 (1994); 237,928 (1997); 104,786 (1999); and 162,508 (2000). These surveys also identified several important distribution and population trends for Tricolored Blackbirds.

- Local, regional, and statewide populations and distributions vary from year to year.
- Sixty percent of all Tricolored Blackbirds located in all years were found in the 10 largest colonies.
- Seventy percent of all Tricolored Blackbird nests and 86% of all foraging by nesting birds were on private agricultural lands.
In some portions of their range, Tricolored Blackbirds have declined or been eliminated; the species has been subject to local extirpation in most of Yolo County and portions of southern Sacramento County.

Data Characterization

Statewide surveys were conducted for tricolored blackbirds (Agelaius tricolor) in California during 1994 and 1997 (Beedy and Hamilton 1999). Additional surveys include data on local distribution and population trends (Neff 1937, DeHaven et al. 1975a, ). Because this species is nomadic with erratic movement behavior, local occurrence data provides only limited information on long-term small area use patterns. This species forages and breeds in specific locations the inventory area with freshwater marshes dominated by cattails of bulrushes, or in areas with suitable willow, blackberry, thistle, or nettle habitat.

A moderate amount of literature is available for the tricolored blackbird because it is a highly visible colonial bird species commonly associated with wetland habitat. Beedy and Hamilton (1999) provide a comprehensive review of information available on general natural history, behavior, distribution and population changes, known demographics and population regulation, and conservation and management. No rangewide management plan has been developed.

Range

Tricolored Blackbirds are largely endemic to California, and more than 99% of the global population occurs in the state. In any given year, more than 75% of the breeding population can be found in the Central Valley (Hamilton 2000). Small breeding populations also exist at scattered sites in Oregon, Washington, Nevada, and western coastal Baja California (Beedy and Hamilton 1999).

The species’ historical breeding range in California included the Sacramento and San Joaquin valleys, lowlands of the Sierra Nevada south to Kern County, the coast region from Sonoma County to the Mexican border, and sporadically on the Modoc Plateau (Dawson 1923; Neff 1937; Grinnell and Miller 1944).

Population surveys and banding studies of Tricolored Blackbirds in the Central Valley from 1969 through 1972 concluded that their geographic range and major breeding areas were unchanged since the mid-1930s (DeHaven et al. 1975a). Since 1980, active breeding colonies have been observed in 46 California counties, including Alameda County. In recent decades, breeding colonies have been observed in all Central Valley counties and east into the foothills of the Sierra Nevada (Beedy and Hamilton 1997, 1999; Hamilton 2000). The species also breeds locally along the California coast from Humboldt to San Diego Counties; on the Modoc Plateau and western edge of the Great Basin (mostly Klamath Basin); in lowlands surrounding the Central Valley; and in western portions of San Bernardino, Riverside, and San Diego Counties. The species also
Tricolored Blackbird (Agelaius tricolor)

breeds in marshes of the Klamath Basin in Siskiyou and Modoc Counties and Honey Lake Basin in Lassen County (Figure 1). During winter, virtually the entire population of the species withdraws from Washington; Oregon (although a few remain); Nevada; and Baja California, and wintering populations shift extensively within their breeding range in California (Beedy and Hamilton 1999).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

The tricolored blackbird is a sporadic resident within the inventory area. California Natural Diversity Database records document 2 breeding colony occurrences along the northern border of the Los Vaqueros watershed. The Contra Costa County Breeding Bird Atlas shows additional breeding locations east and north of these areas (http://www.flyingemu.com/ccosta).

**Biology**

**Habitat**

Tricolored Blackbirds have three basic requirements for selecting their breeding colony sites: open accessible water; a protected nesting substrate, including either flooded or thorny or spiny vegetation; and a suitable foraging space providing adequate insect prey within a few miles of the nesting colony (Hamilton et al. 1995; Beedy and Hamilton 1997, 1999). Almost 93% of the 252 breeding colonies reported by Neff (1937) were in freshwater marshes dominated by cattails and bulrushes (Schoenoplectus spp.). The remaining colonies in Neff's study were in willows (Salix spp.), blackberries (Rubus spp.), thistles (Cirsium and Centaurea spp.), or nettles (Urtica sp.). In contrast, only 53% of the colonies reported during the 1970s were in cattails and bulrushes (DeHaven et al. 1975a).

An increasing percentage of Tricolored Blackbird colonies in the 1980s and 1990s were reported in Himalayan blackberries (Rubus discolor) (Cook 1996), and some of the largest recent colonies have been in silage and grain fields (Hamilton et al. 1995, Beedy and Hamilton 1997, Hamilton 2000). Other substrates where Tricolored Blackbirds have been observed nesting include giant cane (Arundo donax); safflower (Carthamus tinctorius) (DeHaven et al. 1975a); tamarisk trees (Tamarix spp.); elderberry/poison-oak (Sambucus spp. and Toxicodendron diversilobum); and riparian scrublands and forests (e.g., Salix, Populus, Fraxinus) (Beedy and Hamilton 1999).

Foraging habitats in all seasons include annual grasslands; wet and dry vernal pools and other seasonal wetlands; agricultural fields (e.g., large tracts of alfalfa with continuous mowing schedules and recently tilled fields); cattle feedlots; and dairies. Tricolored Blackbirds also forage occasionally in riparian scrub habitats and along marsh borders. Weed-free row crops and intensively managed vineyards and orchards do not serve as regular foraging sites (Beedy and
High-quality foraging areas include irrigated pastures, lightly grazed rangelands, dry seasonal pools, mowed alfalfa fields feedlots, and dairies (Beedy and Hamilton 1999). Lower quality foraging habitats include cultivated row crops, orchards, vineyards, and heavily grazed rangelands.

**Foraging Requirements**

Foods delivered to Tricolored Blackbird nestlings include beetles and weevils; grasshoppers; caddisfly larvae; moth and butterfly larvae (Orians 1961a; Crase and DeHaven 1977; Skorupa et al. 1980); and, especially in current rice-growing areas, dragonfly larvae (Beedy and Hamilton 1999). Breeding-season foraging studies in Merced County showed that animal matter makes up about 91% of the food volume of nestlings and fledglings, 56% of the food volume of adult females, and 28% of the food volume of adult males (Skorupa et al. 1980).

Adults may continue to consume plant foods throughout the nesting cycle but also forage on insects and other animal foods. Immediately before and during nesting, adult Tricolored Blackbirds are often attracted to the vicinity of dairies, where they take high-energy items from livestock feed rations. Adults with access to livestock feed, such as cracked corn, begin providing it to nestlings when they are about 10 days old (Hamilton et al. 1995). More than 88% of all winter food in the Sacramento Valley is plant material, primarily seeds of rice and other grains but also weed seeds (Crase and DeHaven 1978). In winter, Tricolored Blackbirds often associate with other blackbirds, but flocks as large as 15,000 individuals (almost all Tricolored Blackbirds) may congregate at one location and disperse to foraging sites (Beedy and Hamilton 1999).

**Reproduction**

Tricolored Blackbirds are closely related to Red-winged Blackbirds (*Agelaius phoeniceus*), but the two species differ substantially in their breeding ecology. Red-winged Blackbird pairs defend individual territories, while Tricolored Blackbirds are among the most colonial of North American passerine birds (Bent 1958; Orians 1961a, 1961b, 1980; Orians and Collier 1963; Payne 1969; Beedy and Hamilton 1999). As many as 20,000 or 30,000 Tricolored Blackbird nests have been recorded in cattail marshes of 4 hectares (9 acres) or less (Neff 1937; DeHaven et al. 1975a), and individual nests may be built less than 0.5 meter (1.5 feet) apart (Neff 1937). Tricolored Blackbird’s colonial breeding system may have adapted to exploit a rapidly changing environment where the locations of secure nesting habitat and rich insect food supplies were ephemeral and likely to change each year (Orians 1961a; Orians and Collier 1963; Collier 1968; Payne 1969).

Tricolored Blackbird nests are bound to upright plant stems from a few centimeters to about 1.8 meters (6 feet) above water or ground (Baicich and Harrison 1997); however, nests in the canopies of willows and ashes may be more than 3.7 meters (12 feet) high (Hamilton pers. comm.). Their nests are rarely built on the ground (Neff 1937). Deep cup nests are constructed with outer
layers of long leaves (e.g., cattail thatch, annual grasses, or forbs) woven tightly around supporting stems. The inner layers are coiled stems of grasses lined with soft plant down, mud, or algal fibers. Nest building takes about 4 days (Payne 1969).

Egg laying can begin as early as the second day after nest initiation but ordinarily starts about 4 days after the local arrival of Tricolored Blackbirds at breeding sites (Payne 1969). One egg is laid per day, and clutch size is typically three to four eggs (Payne 1969; Hamilton et al. 1995). Emlen (1941) and Orians (1961b) estimated the incubation period at 11 or 12 days, while Payne (1969) estimated it to be 11–14 days. About 9 days generally elapse from hatching until the oldest nestling is willing to jump from the nest when disturbed. Young require about 15 days from this prefledging date until they are independent of their parents. Thus, one successful nesting effort for a reproductive pair takes about 45 days (Hamilton et al. 1995). Synchronized second broods within a colony may be initiated as little as 30 days after the first brood. Individual pairs may nest 2 or more times per year.

Demography

Banding studies, summarized by Neff (1942) and DeHaven and Neff (1973), indicated that Tricolored Blackbirds can live for at least 13 years, but most live for much shorter periods. There are no annual survivorship studies of Tricolored Blackbird, and available banding data are inadequate to provide this information (Beedy and Hamilton 1999).

Behavior

During the breeding season, Tricolored Blackbirds exhibit itinerant breeding, commonly moving to different breeding sites each season (Hamilton 1998). In the north Central Valley and northeastern California, individuals move after first nesting attempts, both successful and unsuccessful (Beedy and Hamilton 1997). Banding studies indicate that significant movement into the Sacramento Valley occurs during the postbreeding period (DeHaven et al. 1975b).

In winter, numbers of Tricolored Blackbirds decrease in the Sacramento Valley and increase in the Sacramento–San Joaquin River Delta and north San Joaquin Valley (Neff 1937; Orians 1961a; Payne 1969; DeHaven et al. 1975b). By late October, large flocks also congregate in pasturelands in southern Solano County and near dairies on Point Reyes Peninsula in Marin County (Beedy and Hamilton 1999). Other birds winter in the central and southern San Joaquin Valley. Concentrations of more than 15,000 wintering Tricolored Blackbirds may gather at one location and disperse up to 32 kilometers (20 miles) to forage (Neff 1937; Beedy and Hamilton 1999). Individual birds may leave winter roost sites after less than 3 weeks and move to other locations (Collier 1968), suggesting winter turnover and mobility. In early March/April, most birds vacate the wintering areas in the Central Valley and along the coast and move to breeding locations in the Sacramento and San Joaquin Valleys (DeHaven et al. 1975b).
Tricolored Blackbirds are highly colonial and sometimes polygynous, with 1 to 4 females pairing with 1 male (Payne 1969). Historic colonies of over 200,000 pairs have been documented occupying a 24 hectares of cattail marsh (Neff 1937). This social cohesion is retained during the nonbreeding season with birds forming large foraging and roosting flocks. These flocks may be all tricolors, or mixed flocks with Red-winged Blackbirds, Brewer’s Blackbirds, Brown-headed Cowbirds, and European Starlings (Beedy and Hamilton 1999).

Males defend only the immediate areas around the nests. Male territory size ranges from 1.8 square meter (m²) (19.38 square feet) (Lack and Emle 1939) to 3.25 m² (35 square feet) (Orians 1961b). Average size of recently established territories of six banded males at two different colonies was 3.25 m² (35 square feet); volumetric territories in willows were calculated to be 8.5–11.3 cubic meters (300–400 cubic feet) (Collier 1968). Some Himalayan blackberry colonies have nesting densities up to six nests/m² (0.56 nest/square foot) (Cook and Hamilton pers. comms.). After 1 week of nest-building and egg-laying, males may cease territorial defense (Orians 1961b).

Most Tricolored Blackbirds forage within 5 kilometers (3.1 miles) of their colony sites (Orians 1961a), but commute distances of up to 15 kilometers (9.3 miles) have been reported (Beedy and Hamilton 1999). Short-distance foraging (i.e., within sight of the colony) for nestling provisioning also is common. Both sexes are known to provision the nestlings (Beedy and Hamilton 1999).

Proximity to suitable foraging habitat appears to be extremely important for the establishment of colony sites, as Tricolored Blackbirds always forage, at least initially, in the field containing the colony site (Cook 1996). However, usually only a minor fraction of the area within the commuting range of a colony provides suitable foraging habitat. For example, within a 5-kilometer (3-mile) radius there may be low-quality foraging habitats such as cultivated row crops, orchards, vineyards, and heavily grazed rangelands in association with high-quality foraging areas such as irrigated pastures, lightly grazed rangelands, vernal pools, and recently mowed alfalfa fields (Beedy and Hamilton 1999; Cook 1999).

Ecological Relationships

Tricolored blackbirds occupy a unique niche in the Central Valley/coastal marshland ecosystems. In areas where numbers are high, they are both aggressively and passively dominant to, and often displace, sympatric marsh nesting species, including red-winged and yellow-headed blackbirds (Orians and Collier 1963, Payne 1969).

Threats

The greatest threats to this species are the direct loss and alteration of habitat, but other human activities and predation also threaten Tricolored Blackbird populations in the Central Valley (Beedy and Hamilton 1999).
Habitat Loss and Alteration

Most native habitats that once supported nesting and foraging Tricolored Blackbirds in the Central Valley have been altered by urbanization and unsuitable agricultural uses, including vineyards, orchards, and row crops (Frayer et al. 1989; Wilen and Frayer 1990). In Sacramento County, a historic breeding center of the species, the conversion of grassland and pastures to vineyards expanded from 3,050 hectares (7,536 acres) in 1996 to 5,330 hectares (13,171 acres) in 1998 (DeHaven 2000). Many former agricultural areas within the historical range of Tricolored Blackbird are now being urbanized; in western Placer County, where Tricolored Blackbirds forage in the ungrazed annual grasslands associated with rural subdivisions, suitable habitat will be largely eliminated as current land conversion patterns continue.

In some places, most historical Tricolored Blackbird breeding and foraging habitats have been eliminated and there is currently little or no breeding effort where there once were large colonies (Orians 1961a; Beedy et al. 1991). Elsewhere, Tricolored Blackbirds have shifted from cattails as a primary nesting substrate (Neff 1937) to Himalayan blackberries (DeHaven et al. 1975a), and more recently to cereal crops and barley silage (Hamilton et al. 1995).

Other Human Activities

Nests and nest contents in cereal crops and silage are often destroyed by agricultural operations (Hamilton et al. 1995; Beedy and Hamilton 1997). Harvesting of silage and plowing of weedy fields are currently the most common reasons Tricolored Blackbird nesting colonies are destroyed on agricultural lands. Other factors that may affect the nesting success of colonies in agricultural areas include herbicide and pesticide applications and spraying for mosquito abatement (Beedy and Hamilton 1999).

Predation

Predation is at present (i.e., 1985–2002) a major cause of complete nesting failure at some Tricolored Blackbird colonies in the Central Valley. Historical accounts documented the destruction of nesting colonies by a diversity of avian, mammalian, and reptilian predators. Recently, especially in permanent freshwater marshes of the Central Valley, entire colonies (>50,000 nests) have been lost to Black-crowned Night-Herons, Common Ravens, coyotes, and other predators (Beedy and Hamilton 1999).

Conservation and Management

The tricolored blackbird is a bird species of special concern in California (California Department of Fish and Game and Point Reyes Bird Observatory 2001). Management goals that have been proposed include maintaining a viable...
self-sustaining population throughout the species’ current geographic range, avoiding losses of colonies and their associated habitats, increasing breeding populations on suitable public and private lands managed for this species, and enhancing public awareness and support for protection of habitat and active colonies. A California Department of Fish and Game and U.S. Fish and Wildlife Service program for purchasing portions of crops to preserve several large colonies of tricolors in Kings, Fresno, and Tulare Counties was implemented in 1993 and 1994 with significant conservation results. These actions and participation by landowners in delaying harvest to protect active nesting colonies resulted in an addition of an estimated 37,000 and 44,000 first-year added to the 1994 and 1995 breeding seasons (Beedy and Hamilton 1999). Similar conservation measures could be used in the inventory area to enhance populations.

Modeled Species Distribution

Model Description

Assumptions
1. Core Breeding Habitat: Wetland, pond, and sloughs/channels in grassland, alkali grassland, cropland, pastures, ruderal, urban, and oak savanna land-cover types.

2. Primary Foraging Habitat: Pastures, grassland, seasonal wetlands, cropland.


Rationale
Tricolored blackbirds historically occurred within the Central Valley associated with emergent freshwater marshes dominated by cattails or bulrushes, with some colonies occurring in willows, blackberries, thistles, and nettles associated with sloughs and natural channels (Neff 1937). More recent colonies have been observed in a diversity of upland and agricultural areas (Collier 1968, Cook 1996), riparian scrublands and woodlands Orians 1961a; DeHaven et al 1975a; Beedy et al. 1991; Hamilton et al. 1995; Beedy and Hamilton 1999).

Small breeding colonies have been documented at public and private lakes, reservoirs, and parks surrounded by shopping centers, subdivisions, and other urban development. Adults from these colonies generally forage in nearby undeveloped upland areas. Beedy and Hamilton (1999) predict that these small, urban wetlands and upland foraging habitats may continue to accommodate tricolored blackbirds in the future unless they are eliminated entirely by development. High-quality foraging areas include irrigated pastures, lightly grazed grasslands, dry seasonal pools, mowed alfalfa fields feedlots, and dairies (Beedy and Hamilton 1999). Lower quality foraging habitats include cultivated row crops, orchards, vineyards, and heavily grazed rangelands.
Model Results

Figure 2 shows the modeled potential habitat of the tricolored blackbird within the inventory area. The modelled habitat is extensive because it includes a wide range of land-cover types. The documented occurrences of tricolored blackbirds in east Contra Costa County are limited, in part due to the nomadic behavior of the species, but are consistent with the modelled habitat. The model may overestimate suitable core habitat in urban areas. It is likely that a small subset of ponds within urban areas actually provide suitable habitat due to requirements of suitable foraging habitat nearby. We conservatively assumed that all urban ponds are potentially suitable because of the lack of data on pond conditions. The model may overestimate suitable core habitat outside urban area because the condition of ponds (e.g., vegetation, ponding duration, etc.) is unknown. The model does not include reservoirs as suitable habitat, although tricolored blackbird may use emergent vegetation around the margins of some reservoirs (e.g., Contra Loma, Antioch, Marsh Creek, but not Los Vaqueros) for breeding. We did not map emergent vegetation around the margins of reservoirs because it fell below our minimum mapping unit.

Literature Cited


California Department of Fish and Game and Point Reyes Bird Observatory. 2001. California bird species of special concern: draft list and solicitation of input. Available at URL: <http://www.prbo.org/BSSC/draftBSSClist.pdf>.


Golden Eagle (*Aquila chrysaetos*)

**Status**

**State:** Fully Protected species

**Federal:** Protected under the Bald Eagle and Golden Eagle Protection Act

**Population Trend**

**Global:** Apparently stable in most areas of western U.S.; unknown elsewhere

**State:** Declining in southern California; common and presumably stable elsewhere in California

**Within Inventory Area:** Unknown

**Data Characterization**

Extensive long-term studies have been conducted on the distribution, demographics, and general biology of Golden Eagles (*Aquila chrysaetos*) in the vicinity of the ECCC HCP/NCCP inventory area as part of investigations on the impact of wind turbine operation on this species (see Hunt et al. 1998). These studies provide detailed information on the distribution and habitat-use patterns of resident and non-resident Golden Eagles, population structure, reproductive rates, survival rates, and population equilibrium dynamics.

A moderate amount of additional literature is available for the Golden Eagle outside the inventory area because it is a highly visible, fully protected bird of prey and top avian predator within its range. Most of the literature pertains to general natural history, behavior, distribution, and population changes in the past 30 to 40 years. Some information is available on demographics and population trends. Limited species-specific management information is available.

**Range**

The Golden Eagle is Holarctic in distribution. In North America, it breeds from northern and western Alaska east to the Northwest Territories, Canada, and south to southern Alaska, Baja California, the highlands of northern Mexico, west-central Texas, western portions of Oklahoma, Nebraska, and the Dakotas, and irregularly in eastern North America. The Golden Eagle winters in North America from south-central Alaska and the southern portions of the Canadian provinces south throughout the western breeding range and more rarely eastward (Johnsgard 1990).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

The Golden Eagle is a resident breeder and migrant within the ECCC HCP/NCCP inventory area. The reproductive status of numerous nesting pairs has been monitored regularly within this general area (Hunt et al. 1998).
Biology

Habitat

Golden eagles use nearly all terrestrial habitats of the western states except densely forested areas. In the interior central Coast Ranges of California, Golden Eagles favor open grasslands and oak savanna, with lesser numbers in oak woodland and open shrublands (Hunt et al. 1998). Secluded cliffs with overhanging ledges and large trees are used for nesting and cover. Nest trees include several species of oak (Quercus spp.), foothill pine (Pinus sabianiana and P. coulteri), California bay laurel (Umbellularia californica), eucalyptus (Eucalyptus spp.), and western sycamore (Plantanus racemosa) (Hunt et al. 1998). Preferred territory sites include those that have a favorable nest site, a dependable food supply (medium to large mammals and birds), and broad expanses of open country for foraging. Hilly or mountainous country where takeoff and soaring are supported by updrafts is generally preferred to flat habitats (Johnsgard 1990). Deeply cut canyons rising to open mountain slopes and crags are ideal habitat (Beebe 1974).

Breeding densities are directly related to territorial spacing and foraging requirements for the species. Territory size has been estimated to average 124 square kilometers (sq km) in northern California (Smith and Murphy 1973), but can vary largely with habitat conditions. Hunt et al. (1998) report an 820-sq-km area near Livermore supported at least 44 pairs of Golden Eagles in 1997, with a density of 1 pair per 19 sq km. This density is among the highest reported for the species.

Foraging

Golden eagles prey mostly on rabbits, hares, and rodents, but also take other mammals, birds, reptiles, and some carrion (Olendorff 1976, Hunt et al. 1998). California ground squirrels (Spermophilus beecheyii) and black-tailed jackrabbits (Lepus californicus) are the 2 most important prey species for the Golden Eagle within the inventory area (Hunt et al. 1998). Eagles typically hunt by using favorite perches located near areas that have regular updrafts to facilitate soaring to heights from which they can scan their hunting areas (Johnsgard 1990).

Reproduction

Nest building can occur almost any time of year (Brown 1976). Golden eagles prefer to locate their nests on cliffs or trees near forest edges or in small stands near open fields (Bruce et al. 1982, Hunt et al. 1995, 1998). Mating occurs from
late January through August, with peak activity in March through July. Eggs are laid from early February to mid-May. Clutch size varies from 1 to 4 eggs, but 2 is the most common size (Brown 1976, Johnsgard 1990, Hunt et al. 1995). Incubation lasts 43–45 days (Beebe 1974), and the fledging period is about 72–84 days (Johnsgard 1990). The young usually remain dependent on their parents for as long as 11 weeks afterward. Breeding success tends to be variable depending upon local prey abundance. In a 15-year study of Golden Eagles in Oregon, Thompson et al. (1982) calculated a mean of 1.08 young fledged per breeding territory, 1.7 young fledged per successful nest, and 51% overall nesting success. Beecham and Kochert (1975) showed a similar average of 1.1 young fledged per nesting attempt, 1.8 young fledged per successful nest, and 65% overall nesting success in Idaho. More recently, Hunt et al. (1998) reported natality estimates of 0.64 and 0.58 young per pair for 57 and 59 pairs, respectively, in 1996 and 1997, within a 190-sq km wind resource area, a portion of which is within the ECCC HCP/NCCP inventory area. Brood sizes for this study varied from 1.44 to 1.62 fledglings per nest.

Demography

There are no published reports of the longevity of Golden Eagles in the wild. Captive Golden Eagles have lived to 48 years, but it is not likely that they live that long in the wild (Brown and Amadon 1968).

Behavior

Movement and Dispersal

Breeding Golden Eagles in the central Coast Ranges of California are mostly resident; juveniles may remain in the vicinity of their natal area until evicted by the parents. Floater non-breeding birds (adults without breeding territories) commonly move about regionally until they find a suitable vacant territory or are able to evict a territorial owner (Brown 1969, Hunt et al. 1995, 1998). Some migrants may temporarily move into areas used by resident birds during the winter.

Social

Healthy Golden Eagle populations include 4 population segments: breeders, juveniles, subadults, and floaters (Hunt et al. 1998). Breeders are individuals 4 years old or older that defend territories containing a potentially successful nest. Breeding pairs partition the landscape into a mosaic of territories that define the population density and size. Territorial boundaries tend to remain fairly stable from year to year (Marzluff et al. 1997). The size and density of territories is a function of either food or nest-site availability. During years of low prey availability, eagles may forgo breeding but still occupy and maintain their territories.

Juveniles are eagles less than 1 year old; subadults are 1, 2, and 3 years of age. The existence of floaters is an indication that all habitat suitable for breeding is
occupied by territorial pairs (Hunt et al. 1995, 1998). Floaters act to maintain the breeding segment of the population by replacing breeders that have died. However, if the number of floaters is large relative to the number of breeders, floater competition for nesting territories may reduce the reproductive rate (Hansen 1987).

**Ecological Relationships**

Golden eagles are the top avian predator in the grassland/savanna ecosystem of the central Coast Range in California. They may directly compete with ferruginous and other smaller hawks for small mammals, and with California condors (*Gymnogyps californianus*) for carrion. Territorial interactions with other Golden Eagles may result in some fatalities.

**Threats**

Existing threats to Golden Eagle survival in the central Coast Ranges of California include both foraging- and nesting-habitat loss; human disturbance of nesting birds; and direct fatalities from wind turbine strikes, electrocution, and poisoning. An analysis of the causes of fatalities of 61 Golden Eagles radio-tagged and recovered in the Diablo Range from January 1994 to December 1997 (Hunt et al. 1998) showed that 37% were killed by turbine strikes, 16% by electrocution, and 5% by lead poisoning (Hunt et al. 1998). The remaining birds were lost due to shootings (2%), car strikes (5%), botulism (2%), territorial fights with other eagles (5%), collision with fences (3%), fledging mishaps (10%), and other unknown factors (15%).

**Conservation and Management**

Golden eagle management and conservation generally includes habitat management, population enhancement, hazard management, controlling human activity in sensitive raptor areas, and education. Cattle ranching throughout the central Coastal Ranges can benefit and be beneficial to the Golden Eagle if grazing is maintained at moderate levels that stimulate growth of herbaceous foods used by primary prey species, including ground squirrels and rabbits (Hunt et al. 1995). In this area, ground squirrel populations are reported to reach their highest densities in areas of low grass height typical of grazed lands. Cattle ranching also provides eagles a source of carrion from dead cows, stillborn calves, and placentas.

Hazard management efforts that are being implemented to reduce wind turbine strikes include replacement of turbine models with fewer larger, but slower, ones that are less likely to strike soaring or hunting eagles.
Modeled Species Distribution

Model Description

Assumptions
1. Foraging habitat: All land cover areas except urban, aqueduct, aquatic, turf, orchards and vineyards.

2. Nesting habitat: Traditional nesting sites identified by researchers. Secluded cliffs with overhanging ledges and large trees adjacent to suitable foraging habitat. (not mapped)

Rationale
In the interior central Coast Ranges of California, Golden eagles use nearly all terrestrial habitats except urban, aquatic, turf, orchards, vineyards, and densely forested areas. Golden Eagles favor open grasslands and oak savanna, with lesser numbers in oak woodland and open shrublands (Hunt et al. 1998). In Contra Costa County, there are numerous traditional and stable nesting sites and territories of Golden eagles (T. Hunt, pers. comm.).

Results

Figure 2 shows the modeled potential habitat of the golden within the inventory area. The habitat is very large, encompassing most of the inventory area. The documented occurrences of golden eagle include both verified nesting sites and estimated territory areas. Foraging ranges greatly exceed these areas. The known occurrences of golden eagles in east Contra Costa County fall within the modeled habitat.

Literature Cited


Western Burrowing Owl
(Athene cunicularia hypugea)

Status

State: Species of Special Concern
Federal: None

Population Trend

Global: Declining
State: Declining
Within Inventory Area: Unknown

Data Characterization

The location database for the Western Burrowing Owl within the inventory area includes 17 data records dated from 1989 to 2000. Of these records, 13 were documented within the past 10 years; of these, 5 are of high precision and may be accurately located within the inventory area. Approximately 1 of these high precision records is located within developed areas. The remainder of the records occur within nonnative annual grassland habitats, or adjacent to roads or irrigation canals in agricultural fields.

The California Department of Fish and Game has recently been petitioned to list the Western Burrowing Owl as endangered or threatened under the State Endangered Species Act. A large amount of peer-reviewed literature is available for the Western Burrowing Owl. This species is declining throughout its range; therefore, most of the research studies emphasize nest site selection, passive relocation, use of artificial burrows, reproductive success, dispersal, and foraging behavior. Common management efforts employed to conserve existing burrowing owl colonies include prevention of all disturbance during the nesting season, installation of permanent artificial burrows, and management of the vegetation around the burrows by mowing or controlled grazing.

Range

The Western Burrowing Owl, the western race of the burrowing owl, is found throughout western North America, west of the Mississippi River and south into Mexico. Other burrowing owl races occur in arid, open habitats from the provinces of southern and southwestern Canada to southern Florida and South America (Haug et al. 1993).

In California the range of Western Burrowing Owl extends through the lowlands south and west from north central California to Mexico, with small, scattered populations occurring in the Great Basin and the desert regions of the
southwestern part of the state (DeSante et al. 1996). Burrowing Owls are absent from the coast north of Sonoma County and from high mountain areas such as the Sierra Nevada and the ranges extending east from Santa Barbara to San Bernardino. Burrowing Owl populations have been greatly reduced or extirpated from the San Francisco Bay Area (Trulio 1997) and along the California coast to Los Angeles. They have also apparently disappeared from the Coachella Valley. The remaining major population densities of Burrowing Owls in California are in the Central and Imperial Valleys (DeSante et al. 1996).

The Western Burrowing Owl is distributed over most of the Central Valley. Suitable foraging and breeding habitat for burrowing owl, such as grasslands, vernal pool grasslands, fallow agricultural fields, and open oak woodlands occur throughout most of the Central Valley and are represented in the inventory area. The potential to extend owl habitat use into suitable areas is limited by land management practices that reduce ground squirrel populations, thereby limiting the number of suitable owl nesting burrows.

**Occurrences within the ECCC HCP/NCCP Inventory Area**

The Western Burrowing Owl occurs in the southeast portion of the inventory area (Glover pers. comm.) and likely occurs in potential habitat throughout other portions of the inventory area. Potential habitat is defined as habitat that could support burrowing owls, based on a general classification of land cover types (e.g., grassland, vernal pool grassland, grassland pasture) developed for the HCP/NCCP. Because a comprehensive survey for the burrowing owl has not been conducted in the inventory area, neither the current population size nor the locations of all occurrences are known.

**Biology**

**Habitat**

Burrowing owls require habitat with 3 basic attributes: open, well-drained terrain; short, sparse vegetation; and underground burrows or burrow facsimiles. During the breeding season, they may also need enough permanent cover and taller vegetation within their foraging range to provide them with sufficient prey, such as small mammals (Wellicome 1997). Burrowing owls occupy grasslands, deserts, sagebrush scrub, agricultural areas (including pastures and untilled margins of cropland), earthen levees and berms, coastal uplands, and urban vacant lots, as well as the margins of airports, golf courses, and roads.

Burrowing owls select sites that support short vegetation, even bare soil, presumably because they can easily see over it. However, they will tolerate tall vegetation if it is sparse. Owls will perch on raised burrow mounds or other topographic relief, such as rocks, tall plants, fence posts, and debris piles, to attain good visibility (Haug et al. 1993).
The most important habitat consideration for the Western Burrowing Owl is the availability of underground burrows throughout their life cycle. Although the owls nest and roost in these burrows, they do not (contrary to their name) create them. Rather, the owls rely on other animals to dig their burrows. Throughout their range, they use burrows excavated by fossorial (i.e., digging) mammals or reptiles, including prairie dogs, ground squirrels, badgers, skunks, armadillos, woodchucks, foxes, coyotes, and gopher tortoises (Karalus and Eckert 1987). Where the number and availability of natural burrows is limited (e.g., where burrows have been destroyed or ground squirrels eradicated), owls will occupy drainage culverts, cavities under piles of rubble, discarded pipe, and other tunnel-like structures (Haug et al. 1993).

For Western Burrowing Owls, what constitutes an isolated habitat patch and the minimum size of a viable patch of habitat (i.e., habitat capable of sustaining a population over a long time period) are not well documented. These parameters are affected by habitat quality, the juxtaposition of the site relative to other suitable habitat, surrounding land uses, and prey availability. Burrowing owls have been observed in small (i.e., 1 acre) lots nearly surrounded by development, and owls will fly through urban areas to forage in nearby areas. However, the type and minimum extent of development that constitutes a movement barrier between occupied patches and nearby foraging areas are not known.

It is assumed that corridors between small habitats and other suitable areas would partly offset the insular effects of small or isolated habitats on owl populations by increasing foraging potential and facilitating dispersal or colonization. The size and dimensions of corridors that would be adequate to facilitate movements of burrowing owls between suitable habitats has not been studied. Also, these requirements probably vary with the distance between suitable habitats, surrounding land uses, and the type and quality of habitat within the corridor.

**Foraging Requirements**

This opportunistic feeder will consume arthropods, small mammals, birds, amphibians, and reptiles. Insects are often taken during the day, while small mammals are taken at night. In California, crickets and meadow voles were found to be the most common food items (Thomsen 1971). In urban areas, burrowing owls are often attracted to street lights, where insect prey congregates.

Owls have been detected foraging out to 1 mile from their burrows (Johnson pers. comm.). Inter-nest distances, which indicate the limit of an owl’s territory, have been found to average between 61 and 214 meters (198 and 695 feet) (Thomsen 1971, Haug and Oliphant 1990). Nocturnal foraging can occur up to several kilometers away from the burrow, and owls concentrate their hunting in uncultivated fields, ungrazed areas, and other habitats with an abundance of small mammals (Haug and Oliphant 1990).

**Reproduction**

Burrowing owls in California typically begin pair formation and courtship in February or early March, when adult males attempt to attract a mate. Like other
owls, Western Burrowing Owls breed once per year in an extended reproductive period, during which most adults mate monogamously. Both sexes reach sexual maturity at 1 year of age. Clutch sizes vary, and the number of eggs laid is proportionate to prey abundance (the more prey that is available, the more eggs owls tend to lay). Clutches in museum collections in the western United States contain 1 to 11 eggs (Murray 1976). The incubation period is 28–30 days. The female performs all the incubation and brooding and is believed to remain continually in the burrow while the male does all the hunting. The young fledge at 44 days but remain near the burrow and join the adults in foraging flights at dusk (Rosenberg et al. 1998). Additional information on reproductive behavior is described below in “Behavior.”

There is little information on lifetime reproductive success (Haug 1993). Females supplemented with food will have higher reproductive success than females without supplemented food, which may explain poor reproductive success in areas with low-quality foraging habitat (Wellicome 1997). Depending on assumptions about migration, the probability that juvenile burrowing owls will survive to 1 year of age (the age of first breeding) has been estimated between 0.23 and 0.93, and annual adult survivorship between 0.42 and 0.93 (Johnson 1997).

**Demography**

The maximum life span recorded for a banded bird in the wild is about 8.5 years (Rosenberg et al. 1998). Collisions with vehicles are the most common cause of mortality in this species (Haug et al. 1993). Other sources of owl mortality include disease, exposure, and human activity around nests (digging or disking) (Johnson 1992). Predators of Burrowing Owls include Prairie Falcon (*Falco mexicanus*), Red-tailed Hawk (*Buteo jamaicensis*), Swainson’s Hawk (*Buteo swainsoni*), Ferruginous Hawk (*Buteo regalis*), Northern Harrier (*Circus cyaneus*), Golden Eagle (*Aquila chrysaetos*), coyote (*Canis latrans*), and domestic dogs and cats. Many owls are killed at night by traffic when flying low over roads. Attempts to exterminate rodents by the use of poisons may also kill Burrowing Owls (Rosenberg et al. 1998).

**Dispersal**

Burrowing Owls tend to be resident where food sources are stable and available year-round. They disperse or migrate south in areas where food becomes seasonally scarce. In northern California, owls migrate south during September and October. Southern California populations are not migratory. In resident populations, nest-site fidelity is common, with many adults renesting each year in their previous year’s burrow; young from the previous year often establish nest sites near (<300 m) their natal sites (Rosenberg et al. 1998). Burrowing Owls in migratory populations also often renest in the same burrow, particularly if the previous year’s breeding was successful (Belthoff and King 1997). Other birds in the same population may move to burrows near their previous year’s burrow.
The spatial requirements of burrowing owls are not well understood. Breeding pairs of Western Burrowing Owls may require a minimum of 6.5 acres of contiguous grassland of high foraging quality to persist (California Department of Fish and Game 1995). However, burrowing owl pairs have been observed in isolated habitat patches as small as 1 acre. An area this size does not support the foraging requirements of most burrowing owls, and individuals occurring at sites this small must forage offsite. Reproductive success and long-term persistence in small and isolated habitats are unknown. Although the relationship between habitat area and population viability of this species is not well documented, small and isolated habitat patches are not likely to sustain high reproductive success or long-term persistence (see “Threats” below).

**Behavior**

During the breeding season, burrowing owls spend most of their time within 50 to 100 meters (162 to 325 feet) of their nest or satellite burrows (Haug and Oliphant 1990). During the day, they forage in the vicinity of the natal burrow, where they find it easy to prey on insects in low, open vegetation. Burrowing owls will nest in loose colonies, although owls display intraspecific territoriality immediately around nest burrow (Haug et al. 1993).

Burrowing owls in California typically begin pair formation and courtship in February or early March, when adult males attempt to attract a mate. Loud “coo-cooing” at dusk indicates that this stage of the breeding cycle has begun. Beginning in April, eggs are laid at least 1 day apart and are incubated by both adults for about 3 to 4 weeks. Young owlets are brooded underground for another 3 to 4 weeks, at the end of which they may sometimes be seen at the burrow entrance in their natal-down plumage. Nestlings emerge asynchronously and tentatively in early June. They gradually become bolder, eventually spending more time outside, near the burrow entrance. During this period, nestlings can range widely on foot, even before they can fly. The adults guard their brood tenaciously, attacking intruders if provoked. Older nestlings or fledglings may move to nearby satellite burrows as the natal burrow becomes crowded.

**Ecological Relationships**

Western burrowing owls most commonly live in burrows created by California ground squirrels (Spermophilus beecheyi). Accordingly, the quality of burrowing owl habitat in the inventory area is closely and positively related to the occurrence and population health of ground squirrels in an area. Burrowing owls and ground squirrels can co-inhabit the same burrow system (Johnson pers. comm.), but the frequency with which this occurs has not been measured, and underground interactions have not been studied. Burrowing owls may compete incidentally with other predators such as coyote, other owls and hawks, skunks, weasels, and badgers for rodents and a variety of insects. (Rosenberg et al. 1998).
Threats

An immediate threat to the burrowing owl is the conversion of grassland habitat to urban and agricultural uses, and the loss of suitable agricultural lands to development. Equally important is the loss of fossorial rodents, such as prairie dogs and ground squirrels, across much of the owl’s historical habitat. Eradication programs have decimated populations of these rodents and have in turn disrupted the ecological relationships on which owls depend—because Western Burrowing Owls need other animals to dig their burrows, the loss of fossorial rodents limits the extent of year-round owl habitat.

Another cause of population declines is thought to be pesticide use (especially organophosphates in southern Canada), but evidence does not clearly indicate that other contaminants are reducing populations (Gervais et al. 1997). Habitat fragmentation (Remsen 1978) probably increases foraging distances, making hunting less efficient and potentially reducing reproductive success. Fragmentation may reduce the chances that a male owl will attract a mate and could decrease reproductive success.

In urban settings, owls occurring in isolated habitats may experience frequent disturbances from adjacent land uses (e.g., habitat degradation, predation) and barriers to foraging areas. Important biotic interactions between owls and rodent populations may be disrupted because some rodent populations are sensitive to habitat area and surrounding land uses as well. For example, the availability of rodent prey may be limited in isolated habitats, and ground squirrels may abandon or be eradicated from small parcels of habitat in urban settings. Also, small and isolated occurrences are more likely to experience random local extirpation as a result of natural disturbances (Goodman 1987), and recolonization of small or isolated habitat patches is less likely than recolonization of large habitat areas.

The population of Western Burrowing Owls in the Central Valley is threatened by conversion of habitat to urban uses and agriculture, particularly the conversion of grasslands to vineyards. Agricultural lands provide much lower quality habitat for burrowing owls than grasslands. Suitable habitat in agricultural areas is usually restricted to peripheral bands along the edges of plowed fields. These areas are often frequently disturbed and subject to loss from agricultural activities. Also, the loss of suitable agricultural land to development has reduced the extent of suitable habitat. Control of ground squirrels has reduced the extent and quality of potentially suitable burrowing owl habitat by reducing the number of suitable nesting burrows. The use of rodenticides and insecticides may have reduced prey populations, resulting in lowered survivorship and reproductive success.
Conservation and Management

The burrowing owl is experiencing precipitous population declines throughout North America. In Canada, its numbers are rapidly declining, and, in 1995, the Committee on the Status of Endangered Wildlife in Canada listed it as endangered. In Mexico, it is officially considered threatened. The burrowing owl is also declining throughout most of the western United States and has disappeared from much of its historical range in California. Nearly 60% of California burrowing owl “colonies” that existed in the 1980s had disappeared by the early 1990s (DeSante and Ruhlen 1995, DeSante et al. 1997). In the San Francisco Bay Area and the central portion of the Central Valley (from Yolo and Sacramento Counties to Merced County), the burrowing owl population has declined by at least 65% since 1986 (DeSante pers. comm.). The primary factors cited in the decline are habitat loss, pesticides, predators, harassment, reduced burrow availability, and vehicle collisions.

Common management efforts employed to conserve existing burrowing owl colonies include prevention of all disturbance during the nesting season, installation of permanent artificial burrows, and management of the vegetation around the burrows by mowing or controlled grazing.

Modeled Species Distribution

Model Description

Assumptions
1. All annual grassland, alkali grassland, wind turbine, seasonal wetland, ruderal and turf land cover types within the inventory area were considered suitable breeding and foraging habitat for western burrowing owl.

2. All pasture and cropland land cover was considered occasional or limited use areas for western burrowing owl.

Rationale
Western burrowing owls typically occur in dry, open, shortgrass, treeless plains often associated with burrowing mammals (Haug et al. 1993). Golf courses, cemeteries, road allowances within cities, levees, and ruderal borders around agricultural fields, airports, and vacant lots in residential areas are also used for both breeding and foraging. Within the ECCC HCP/NCCP inventory area these habitats are represented by the annual grassland, alkali grassland, wind turbine, seasonal wetland, ruderal and turf land cover types.

Burrowing owls are also known to use agricultural areas occasionally when they are fallow or continually in the margins of these fields. Many patches of ruderal land-cover type less than 10 acres in size (i.e., less than the minimum mapping unit) occur within areas mapped as cropland or pasture. These small patches are suitable for burrowing owls. To account for the occasional use by owls of fallow agricultural fields, and the low density use by owls of patches of ruderal areas,
we mapped habitat as “occasional or limited use” in all cropland and pasture land-cover types.

**Model Results**

Figure 2 shows the modeled potential habitat of the western burrowing owl within the ECCC HCP/NCCP inventory area. The habitat includes large areas of grassland and ruderal habitat throughout the inventory area, and extensive areas of occasional or limited use in cropland and pasture. Most of the available occurrence records are included within the model boundaries. Those outside the model are most likely in suitable habitat areas, but in areas smaller than the 10-acre resolution of the model. Suitable habitat smaller than 10 acres outside model boundaries (e.g., patches associated in residential areas and around airports), were not mapped and are therefore potentially under-represented. However, the model may compensate for this potential bias by conservatively estimating the amount of grassland, ruderal, cropland, and pasture habitat available to burrowing owls for breeding and foraging.

Western burrowing owls are almost certainly undersurveyed and underreported in the inventory area. Actual densities of owls may be low because of historic or current rodent control programs that reduce their prey base.

**Literature Cited**


California Department of Fish and Game. 1995. Staff report on burrowing owl mitigation. Sacramento, CA.


Personal Communications


Johnson, Brenda. Ornithologist and Western Burrowing Owl expert, California Department of Fish and Game, Sacramento, CA. Email correspondence with Ed West, March 2002.
Swainson’s Hawk (*Buteo swainsoni*)

**Status**
- State: Threatened
- Federal: None

**Population Trend**
- Global: Declining
- State: Declining
- Within Inventory Area: Unknown

**Data Characterization**

The location database for the Swainson’s hawk (*Buteo swainsoni*) within the inventory area includes 4 data records from the California Natural Diversity Database (CNDDB) (2001), dated 1987 to 2000, and approximately 7 nest site locations within the last 4 years (Steve Glover pers. comm). Of these 11 records, 8 were documented within the last 10 years. All records are considered extant and mapped at high precision (nest may be accurately located within 80 meters).

A considerable amount of literature is available for the Swainson’s hawk. Most of the literature pertains to habitat requirements, niche determination, competition with congeners, population trends, migration, and mortality from insecticide use on the wintering grounds.

**Range**

This diurnal raptor is a complete migrant, highly mobile, and has a large home range. Swainson’s hawks breed in desert, shrubsteppe, grassland, and agricultural habitats in areas throughout most of the western U.S. and Canada, and in northern Mexico (England et al. 1995). They are locally common to rare breeders in California. Historically, breeding populations probably occurred throughout the state of California, except in bioregions characterized by mountainous forested terrain (Bloom 1980). Breeding populations in California currently occur in 2 locations, the Great Basin and the Central Valley. The largest population of breeding Swainson’s hawks in California is located in the middle of the Central Valley between Sacramento and Modesto, and in the northern San Joaquin Valley. Swainson’s hawks arrive on the breeding grounds in late February and early March in the Central Valley and in mid-April in the Great Basin. In September, most Swainson’s hawks migrate to the Pampas of southern South America. However, the Central Valley population winters in Central Mexico and to a lesser extent throughout Central and South America (Bradbury et al. in prep.).
Occurrences within the ECCC HCP Inventory Area

Swainson’s hawks have been documented nesting in the inventory area; however, they are not regular breeders there. The core breeding population occurs along the Central Valley floor, outside of the inventory area. In the inventory area, most pairs have been observed nesting in small clumps of eucalyptus trees (Glover, pers. comm. 2002). There are 4 CNDDB (2001) records of Swainson’s hawk nesting in the northeast section of the ECCC HCP/NCCP inventory area.

Biology

Habitat

In general, Swainson’s hawks inhabit a wide variety of open habitats. In California’s Central Valley, suitable habitat consists of 2 primary elements: suitable nest trees and proximity to high-quality foraging habitat. This species nests within riparian forest or in remnant riparian trees and forages in agricultural lands (such as fallow fields and alfalfa fields) (Estep 1989, Babcock 1995). Swainson’s hawks also use clumps of eucalyptus trees, and a variety of large trees near old farm houses. Agricultural patterns and cover types influence suitability of foraging and home-range habitat. Overall, Swainson’s hawk home range sizes are variable and apparently influenced by cropping patterns, including crop changes during the breeding season (Estep 1989). Habitat with the highest foraging value includes ruderal fields, fallow fields, grain crops, and safflower fields. In the Central Valley, extensive areas of unsuitable agricultural cover types may be the reason Swainson’s hawks have large home-range sizes (mean 40.4 sq km) in this region (Babcock 1995).

Breeding

In the Central Valley, nest trees commonly used by Swainson’s hawk include Fremont cottonwood (Populus fremontia), willow (Salix spp.), sycamore (Plantanus racemosa), Valley Oak (Quercus lobata), and walnut (Juglans spp.). Occasionally planted trees, such as eucalyptus (Eucalyptus spp.), pine (Pinus spp.) and (Sequoia sempervirens), are also used for nesting. Most of the known nests occur in stringers of remnant riparian forest along drainages (England et al. 1997).

Density of Swainson’s hawks within their breeding territories is influenced by land use and availability of nest trees (Estep 1989). Nest trees may be isolated or in a riparian forest (England et al. 1997). Breeding habitat suitability is also dependent on surrounding landscape and abundance of prey. Nest placement tends to be in the upper canopy and semi-exposed, which may provide birds with a panoramic view of the territory. Tree and nest heights are higher in the Central Valley compared to nest trees in the western United States (Estep 1989).
Foraging
Historically, the Swainson’s hawk probably foraged in upland and seasonally flooded perennial grasslands (Woodbridge 1998). Currently, Swainson’s hawks forage in low-growing crops and are more abundant in areas of moderate cultivation than in either grassland areas or areas of extensive cultivation (Schmutz 1987). When ranking various habitats used by Swainson’s hawks in the Central Valley, Estep (1989) found that perennial grassland and alfalfa fields ranked highest for foraging habitat suitability.

Central Valley Swainson’s hawks prey on small mammals, birds, toads, crayfish, and insects. California voles (*Microtus* spp.), pocket gophers (*Thomomys bottae*), and deer mice (*Peromyscus maniculatus*) account for the majority of the mammalian prey species during the breeding season. Immediately after the breeding season and prior to migration, the majority of the diet consists of grasshoppers and crickets (Estep 1989). There is no data on diet for wintering Swainson’s hawks (for the Central Valley population), but diet composition is probably made up of insects and to a lesser degree small mammals (Bradbury et al. in prep.).

Reproductive Capacity
During the breeding season, Swainson’s hawks form monogamous pairs and will defend territories against conspecifics (Estep 1989). A clutch size is typically 1 to 4 eggs (Fitzner 1980, England et al. 1997). In general, Central Valley Swainson’s hawks will have a single clutch, which will be completed by mid-April (Estep 1989). Rarely does this species attempt to renest if first nest attempt fails. The female does the majority of incubating, and the incubation period lasts 34 to 35 days (Fitzner 1980). In addition, the female does most of the brooding and shading of nestlings, while the male feeds the young for their first 2 to 3 weeks (England et al. 1997). Young fledge at approximately 38 to 46 days (England et al. 1997). The Central Valley population exhibits low reproductive success compared to populations in other areas. This is probably due to the complete alteration of native foraging habitat into cultivated fields and urban development (Estep 1989).

Breeding density is influenced by availability of nest trees and land use. High densities of breeding birds are associated with alfalfa fields, while low densities are associated with irrigated pasture and weedy fields (Woodbridge 1991). A mean breeding density of 30.23 pair/100 sq km was recorded in the Central Valley (Estep 1989).

Demography
There is little information on survival rates or longevity in this species (England et al. 1997). In Washington State, Swainson’s hawks are thought to be long-lived (15–20 years) (Fitzner 1980). Mortality in
nestlings is primarily due to starvation and predation from nest predators (England et al. 1997). Adult mortality results from human-caused sources, such as collisions with vehicles, gunshot, and pesticide application used to control grasshopper outbreaks (especially in South America) (England et al. 1997).

Dispersal

Juveniles remain with adults for 2 to 4 weeks after fledging, at which point they depart parental territories and form groups in areas where food is abundant. Adults also congregate at this time (in August) and forage on insects in fields (Fitzner 1980, Estep 1989). Juveniles and adults leave the breeding ground in September (Bradbury et al. in prep.).

Behavior

Swainson’s hawks build nests out of sticks, plant parts, and other weeds. Woodbridge (1998) found that some nests appeared flimsy and might not last the winter. Courtship displays occur near the nest site. They involve circling and steep dives (England et al. 1997).

During the breeding season, Swainson’s hawks travel up to 29 km in search of prey (Estep 1989, Woodbridge 1991). This species spends large amounts of time foraging while soaring over open habitats. Foraging behavior in the Central Valley is associated with cultivation activities that expose prey (e.g. flood irrigation, burning, and disking). Large flocks of non-breeding individuals will forage and roost communally during the breeding season, eating a variety of prey that ranges from bats to flying insects (England et al. 1997, Woodbridge 1998).

Home-range size is dependent on proximity to foraging sites and the distribution of high-quality foraging habitat. The home-range size for pairs nesting in the Central Valley ranged from 336 to 8,718 hectares (Estep 1989) in one study, and from 724 to 7,659 hectares (Babcock 1995) in another study. The smallest home ranges were observed in areas where nest sites in riparian forest habitat were close to alfalfa or similar, recently harvested row crops (Estep 1989).

Ecological Relationships

There is no information on predation of adults (England et al. 1997). Researchers have observed egg and nestling predation by American crows (Corvus brachynchos), great horned owls (Bubo virginianus), and golden eagles (Aquila chrysaetos).
Threats

Loss of high-quality foraging habitat is probably the most significant threat to the species’ population within the inventory area. Loss of nesting habitat (remnant riparian) may be a threat to this species statewide. In addition, nest sites on private lands are vulnerable to changes in development and agricultural practices.

Swainson’s hawks show a strong association with riparian forests. Protection and restoration of these habitats may therefore be important to the recovery of the species. As mentioned above, presence of suitable nest trees combined with proximity to high-quality foraging habitat is necessary for the reproduction of this species.

Current DFG guidelines for mitigation of loss of foraging habitat are not sufficient because the guidelines allow for losses of foraging habitat throughout the remainder of the region (Estep pers. comm.). The guidelines do not consider cumulative effects of agricultural intensification and conversion of crops that provide high-quality foraging habitat to crops that provide low-quality foraging habitat (e.g. alfalfa to vineyards).

Conservation and Management

The majority of the state’s breeding sites are located in 2 disjunct populations: 1 in the Great Basin in the northeast corner of the state, and the other in the Central Valley. The largest population of this species is located within the inventory area between Sacramento and Modesto. Estep (pers comm.) estimates that this population includes approximately 900 breeding pairs.
Modeled Species Distribution

Model Description

Assumptions

1. Potential breeding habitat included all riparian woodland scrub and non-native woodland land cover types within the inventory area in or east of Marsh Creek and below 200 feet in elevation.

2. All cropland and pasture, within 10 miles of existing breeding sites or potential breeding habitat were considered potential Swainson’s hawk foraging habitat.

3. Annual grassland, alkali grassland, and seasonal wetland land-cover types below 200 feet in elevation are also considered potential foraging habitat.

Rationale

Breeding Habitat: In California, Swainson’s hawks typically nest at the edge of narrow bands of riparian vegetation, in isolated oak woodland and in lone trees, roadside trees, or farmyard trees, as well as in adjacent urban residential areas (Estep 1989; England et al. 1995, 1997). There are no breeding records of Swainson’s Hawk west of Marsh Creek despite the occurrence of high-quality riparian habitat (e.g., Kirker Creek). The western extent of the breeding range of this species was considered to be Marsh Creek (Estep, pers. comm.; Sterling, pers. comm.).

Foraging Habitat: Historically, Swainson’s hawks are believed to have foraged in upland and seasonally flooded perennial grasslands (Woodbridge 1998). In the Central Valley, Swainson’s hawks now forage primarily in low-growing crop areas and perennial grasslands (Estep 1989, pers. comm. 2002). Preferred foraging habitats include alfalfa, fallow fields, beet, tomato, and other low-growing row or field crops, dry-land and irrigated pasture, rice land during the non-flooded period, and cereal grain crops (Estep 1989). Individual birds or nesting pairs may use over 15,000 acres of habitat or range up to 18 miles from the nest in search of prey (Estep 1989, Babcock 1993). The California Department of Fish and Game considers a 10-mile flight distance between active nest sites and suitable foraging habitats as a standard for direct impact analysis. This distance was used to identify all potential foraging Swainson’s hawk foraging habitat within the ECCC HCP/NCCP inventory area. Swainson’s hawks in the inventory do not forage above approximately 200 feet in elevation or west of Marsh Creek (Glover, pers. comm.; Sterling, pers. comm.; Estep, pers. comm.), so a filter was used in this model to exclude these areas.
Results

Figure 2 shows the modeled potential habitat of the Swainson’s hawk within the ECCC HCP/NCCP inventory area. Potential breeding habitat is restricted to riparian areas along lower Marsh Creek (above and below the Marsh Creek Reservoir) and isolated stands of non-native woodland. Potential foraging habitat includes extensive areas of row-crop and pasture land cover within the inventory area. All of these areas are within the 10-mile foraging range of the species from potential nesting habitat. Only one occurrence record was available for this species within the inventory area digitally. This record was located within potential breeding habitat identified by the model. Ten records identified in the Contra Costa Breeding Bird Atlas (Glover 2001) all fall within the modeled foraging habitat in the northeast corner of the inventory area.

Numerous other sites within agricultural and urban areas may also provide suitable breeding habitat for this species in the form of small woodlands and isolated trees. However, these areas could not be identified in this model because these small-scale features were not mapped.

Literature Cited


**Personal Communication**


Silvery Legless Lizard (*Anniella pulchra pulchra*)

**Status**

- **State:** Species of Concern
- **Federal:** None

**Population Trend**

- **Global:** Declining
- **State:** Declining
- **Within Inventory Area:** Unknown

**Data Characterization**

The location database for the silvery legless lizard (*Anniella pulchra pulchra*) within its known range in California includes 14 data records dated from 1988 to 2000. Of these records, 12 were documented within the past 10 years; of these, 9 are of high precision and may be accurately located. One of these records is located within the inventory area, at the East Bay Regional Park District Legless Lizard Preserve.

A small amount of literature is available for the silvery legless lizard because of its cryptic behavior and general difficulty to find. Most of the available literature pertains to natural history and reproductive patterns.

**Range**

The silvery legless lizard is nearly endemic to California. It ranges from Antioch in Contra Costa County south through the Coast, Transverse, and Peninsular Ranges, along the western edge of the Sierra Nevada Mountains and parts of the San Joaquin Valley and Mojave Desert to El Consuelo in Baja California (Hunt 1983, Jennings and Hayes 1994). Its elevation range extends from near sea level on the Monterey Peninsula to approximately 1,800 meters above sea level in the Sierra Nevada foothills.

**Occurrences within the ECC HCP Inventory Area**

The East Bay Regional Park District Legless Lizard Preserve is located east of the intersection of Highway 4 and Big Break Road north of Oakley. This is the only California Natural Diversity Database record for this species in the inventory area, but other occurrences are likely to exist within the inventory area due to the presence of suitable habitat.
Biology

Habitat

Silvery legless lizards occur primarily in areas with sandy or loose loamy soils such as under sparse vegetation of beaches, chaparral, or pine-oak woodland; or near sycamores, cottonwoods, or oaks that grow on stream terraces (Gorman 1957, Cunningham 1959, Banta and Morafka 1968, Stebbins 1985, Jennings and Hayes 1994). The sandy loam soils of stabilized dunes seem to be especially favorable habitat (Grinnel and Camp 1917, Miller 1944, Smith 1946, Bury 1985). The species is often found under or in the close vicinity of logs, rocks, old boards, and the compacted debris of woodrat nests (Jennings and Hayes 1994). Rocky soils or areas disturbed by agriculture, sand mining, or other human uses is not suitable for legless lizards (Miller 1944, Bury 1972, Hunt 1983, Stebbins 1985). Soil moisture is essential for legless lizards to conserve energy at high temperatures; it also allows shedding to occur (Jennings and Hayes 1994).

Foraging Requirements

Adult and juvenile lizards are insectivorous and subsist largely on larval insects (especially moths and beetles), adult beetles, termites, and spiders (Jennings and Hayes 1994).

Reproduction

Silvery legless lizards are live-bearing and are believed to breed between early spring and July (Goldberg and Miller 1985). Oviductal eggs are observed in females from July through October (Goldberg and Miller 1985), and litters of 1 to 4 (normally 2) young are born from September to November (Miller 1944). Gestation lasts about 4 months (Goldberg and Miller 1985). Young lizards typically reach sexual maturity in 2 to 3 years (for males and females, respectively).

Demography

The longevity of the silvery legless lizard populations in the wild is unknown. However, sexually mature adults have lived for almost 6 years under laboratory conditions (Jennings and Hayes 1994).

Behavior

Legless lizards are fossorial animals that construct burrows in loose sandy soil (Miller 1944, Stebbins 1954). They appear to be active mostly during the
morning and evening, when they rest just beneath the surface of sunlight-warmed substrate. They may also be active on the surface at night when substrate temperatures remain warm for extended intervals.

**Ecological Relationships**

Known predators of legless lizards include ring neck snakes (*Diadophis punctatus*), common king snakes (*Lampropeltis getulus*), deer mice (*Peromyscus maniculatus*), long-tailed weasels (*Mustela frenata*), domestic cats (*Felis sylvestris*), California thrashers (*Toxostoma redivivum*), American robins (*Turdus migratorius*), and loggerhead shrikes (*Lanius ludovicianus*) (Jennings and Hayes 1994).

**Threats**

The legless lizard’s specialization for a fossorial existence in substrates with a high sand fraction makes it vulnerable to many types of habitat loss and disturbance. Legless lizards cannot survive in urbanized, agricultural, or other areas where a loose substrate in which to burrow has been removed or altered (e.g., disturbed by blowing or bulldozing) (Jennings and Hayes 1994). Other factors can alter the substrate such that the species cannot survive in the area any longer. These factors include livestock grazing, off-road vehicles activities, sand mining, beach erosion, excessive recreational use of coastal dunes, and the introduction of exotic plant species, such as ice plants (*Carpobrotus edulis* and *Mesembryanthemum crystallinum*), Marram grass (*Ammophila arenaria*), veldt grass (*Ehrharata calycina*) and eucalyptus trees (*Eucalyptus* spp.). These factors decrease soil moisture or alter the conformation of the substrate, which may act to limit the food base or make the substrate physically unsuitable for legless lizards (Jennings and Hayes 1994). Pesticides may also threaten legless lizards because of the species’ insectivorous diet (Honegger 1975). Increasing numbers of feral cats associated with residential areas also threaten extant populations of this species (Miller 1944, Jennings and Hayes 1994).

**Conservation and Management**

Detailed studies of legless lizard habitat requirements need to be conducted to determine the distribution and ecological needs of this species more precisely.
Modeled Species Distribution

Model Description

Model Assumptions:

1. Core Habitat: Sandy to sandy loam soil areas\(^1\) (Soil Conservation Service 1977) in chaparral/scrub, oak woodland, ruderal, and riparian woodland/scrub land-cover types.

Rationale
Silvery legless lizards occur primarily in areas with sandy or loose loamy soils such as under sparse vegetation of beaches, chaparral, or oak woodland; or near sycamores, cottonwoods, or oaks that grow on stream terraces (Gorman 1957, Cunnigham 1959, Banta and Morafka 1968, Stebbins 1985, Jennings and Hayes 1994). The sandy loam soils of stabilized dunes seem to be especially favorable habitat (Grinnell and Camp 1917, Miller 1944, Smith 1946, Bury 1985). See the profile on this species in the preliminary draft of the HCP/NCCP for more details on its ecology.

Results

Figure 2 shows the modeled potential habitat of the silvery legless lizard within the inventory area. The habitat is largely defined by the presence of suitable soils within chaparral/scrub, oak woodland, riparian woodland land cover areas. The only documented occurrence of this species in the inventory area is at the East Bay Regional Park District Legless Lizard Preserve east of the intersection of Highway 4 and Big Break Road in Oakley. This record is included in modeled habitat.

Literature Cited


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\(^1\) Any soil type that mentioned “sand” or “sand and loam” was considered a sandy loam soil potentially suitable for silvery legless lizard.


Alameda Whipsnake
(*Masticophis lateralis euryxanthus*)

**Status**
- **State:** None
- **Federal:** Threatened

**Population Trend**
- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Unknown

**Data Characterization**

There are 19 California Natural Diversity Database (CNDDB) records within the inventory area. The precision of these records ranges from an 80-meter circle to a 1-mile-radius circle (Darlene McGriff pers comm.). Of these 19 records, only 5 were recorded within the last 10 years, and the remaining 14 were documented as early as 1980. All of these CNDDB records are considered extant.

The USFWS published a draft recovery plan for the Alameda whipsnake in November 2002. The USFWS designated critical habitat for this species in March 2000 (65 FR 12155). The critical habitat designation was challenged in court and withdrawn as a result in May 2003.

**Range**

The Alameda whipsnake is a subspecies of the California whipsnake (*Masticophis lateralis*). The North American distribution for the California whipsnake includes Northern California west of the Sierran Crest and desert to central Baja California. This species is absent from the floor of the Central Valley, and its California distribution parallels that of chaparral habitat (Stebbins 1985). The Alameda whipsnake’s range is restricted to the inner Coast Range in western and central Contra Costa and Alameda Counties (U.S. Fish and Wildlife Service 2000). The historical range of the Alameda whipsnake has been fragmented into 5 disjunct populations (U.S. Fish and Wildlife Service 1997): Tilden–Briones, Oakland–Las Trampas, Hayward–Pleasanton Ridge, Sunol–Cedar Mountain, and the Mount Diablo–Black Hills (U.S. Fish and Wildlife Service 1997).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Of the 48 CNDDB (2001) records for the Alameda whipsnake in the state, 19 records occur within the ECCC HCP/NCCP inventory area. A large portion of the Mount Diablo–Black Hills population of the Alameda whipsnake occurs within the ECCC HCP/NCCP inventory area.
Biology

Habitat

The Alameda whipsnake occurs primarily in coastal scrub and chaparral communities, but also forages in a variety of other communities in the inner Coast Range, including grasslands and open woodlands (Swaim 1994). Rock outcrops with deep crevices or abundant rodent burrows are important habitat components for overnight dens, refuges from predators and excessive heat, and foraging (Swaim 1994). According to USFWS (2000), suitable habitat for this species includes communities that support mixed chaparral, coastal scrub, and annual grassland and oak woodlands that are adjacent to scrub habitats. Grassland areas that are linked to scrub by rock outcrops or river corridors are also considered primary constituent elements (U.S. Fish and Wildlife Service 2000).

The Alameda whipsnake requires open and partially open, low-growing shrub communities for many of its biological needs. This habitat provides cover for snakes during dispersal, cover from predators, and a variety of microhabitats where whipsnakes can move to regulate their body temperature (Swaim 1994). Whipsnakes exhibit a high degree of stability and a high mean activity in body temperature (33.4 degrees centigrade). Whipsnake habitat must consist of a mix of sunny and shady sites in order to provide a range of temperatures for the snake’s activities (Swaim 1994, U.S. Fish and Wildlife Service 2000). A sparse shrub canopy is ideal because it also provides a visual barrier from avian predators (Swaim 1994).

Other important habitat features include small mammal burrows, rock outcrops, talus, and other forms of shelter that provide snakes with alternative habitats for temperature regulation, protection from predators, egg-laying sites, and winter hibernaculum (winter residence where the snakes hibernate). Alameda whipsnakes spend November through March in a winter hibernaculum (U.S. Fish and Wildlife Service 2000).

Home-range size for male snakes in Alameda and Contra Costa counties (Tilden Park and Moller Ranch) varies in size from 1.9 to 8.7 hectares (ha) (mean = 5.5 ha). Home-range size for female snakes was 3.9 and 2.9 hectares (Swaim 1994). When movements of individual snakes were monitored (2 males and 1 female) in these areas, results indicated that most of the home range was not used. Both male and female snakes repeatedly returned to core retreat areas within their home range after intervals of non-use. These snakes did exhibit overlap in use of these relatively large home ranges, and there was no evidence of territorial behavior in this species (Swaim 1994).

Breeding Habitat Requirements

Mating occurs from late March through mid-June (U.S. Fish and Wildlife Service 2000). Whipsnakes lay a clutch of 6 to 11 eggs (Stebbins 1985), probably in loose soil or under logs or rocks (Zeiner et al. 1988). According to Swaim (1994), female Alameda whipsnakes will use grassland habitat for egg laying.
Little else is known about habitat requirements for breeding and egg laying (Zeiner et al. 1988). Swaim (1994) documented that courtship and mating occur near the female’s hibernaculum. During the breeding season, male snakes exhibit more movement throughout their home range, while female snakes remain sedentary from March until egg laying (Swaim 1994).

**Foraging Requirements**

In general, whipsnakes prey on a variety of vertebrate species, including frogs, lizards, nestling birds, and rodents (Zeiner et al. 1988). Studies indicate that the Alameda whipsnake prefers lizard prey and may be an example of a feeding specialist. Occupied areas usually support a prey base of at least 2 lizard species, especially the western fence lizard (*Sceloporus occidentalis*) (Stebbins 1985), and whipsnake populations thrive when lizards are abundant (McGinnis 1992 in USFWS 2002).

Rock outcrops are particularly important foraging habitat for the Alameda whipsnake because they support many of the species’ prey (U.S. Fish and Wildlife Service 2000). Additionally, the Alameda whipsnake has been observed foraging in grassland habitats adjacent to native Diablan sage scrub habitats (Swaim 1994).

**Demography**

There have been no studies of the demography or longevity of Alameda whipsnakes.

**Dispersal**

The Alameda whipsnake is non-migratory. There is little information on site fidelity and patterns of dispersal in this species; however, Swaim (1994) observed evidence of individual snakes using the same home range in successive years.

**Behavior**

The Alameda whipsnake is a fast moving, diurnal predator that forages actively on the surface (Zeiner et al. 1988). Alameda whipsnakes have 2 seasonal peaks in activity, 1 during the spring mating season and the other during late summer/early fall. During the first peak in activity males will move throughout their home range, while females remain close to their hibernaculum. Male movement appears to be associated with foraging and searching for mates. Females exhibit a peak in activity only for a few days during the spring when they move to an area outside their normal range, presumably to find egg-laying sites (Swaim 1994). After reproductive activities are completed, male and female movements resume similar patterns. In mid-June, both males and females exhibit decreased activity levels, though evidently this species does not estivate during the summer months (Swaim 1994). The second peak in seasonal activity
occurs in late summer/fall. During this time, Swaim (1994) recorded activity in both hatchling and adult snakes, possibly in response to an increase in the availability of prey (hatchling lizards).

**Ecological Relationships**

Diurnal predators, especially raptors, prey on adult Alameda whipsnakes. Nocturnal mammals likely prey on Alameda whipsnake eggs (Zeiner et al. 1988). Basking in open terrain may expose snakes to predators such as red-tailed hawks (Fitch 1949 in Swaim 1994).

**Threats**

Alameda whipsnake populations have declined from loss of habitat resulting from urban expansion (U.S. Fish and Wildlife Service 2000). Urban development, particularly road and highway construction, has also fragmented Alameda whipsnake populations and made them more vulnerable to extinction (U.S. Fish and Wildlife Service 1997). Urban development adjacent to whipsnake habitat increases the likelihood of predation from feral cats and injury or death from public recreational use. Other significant threats to this species’ recovery include inappropriate grazing practices and alteration of habitat through fire suppression (U.S. Fish and Wildlife Service 1997).

Fire suppression alters suitable Alameda whipsnake habitat in 2 important ways. First, fire suppression increases the chances of large catastrophic fires occurring in areas where vegetation has become overgrown. A buildup of flammable fuel loads in Alameda whipsnake habitat can lead to high intensity fire events that may be detrimental to this species. Second, fire suppression leads to a closed scrub canopy which tends to reduce the diversity of microhabitats that whipsnakes require (Swaim 1994).

**Conservation and Management**

The USFWS lists the Mount Diablo–Black Hills population of the Alameda whipsnake as having a high potential for recovery if threats from urban development, catastrophic wildfire, and grazing practices can be managed well (U.S. Fish and Wildlife Service 2000). As of August 2003, there had been no approved HCPs that cover the Alameda whipsnake or its habitat. At least three HCPs that cover the species are in development:

- Alameda Watershed HCP (San Francisco Public Utilities Commission);
- Mount Diablo State Park HCP (California Department of Parks and Recreation); and
- East Bay Watershed Lands HCP (East Bay Municipal Utilities District).
According to the recovery plan, recovery of Alameda whipsnake populations will require a combination of long-term research/management and immediate management actions. Incompatible land uses include fire suppression, off-road vehicle use, grazing practices, unauthorized collecting and mining.

Modeled Species Distribution in HCP Study Area

Model Description

Model Assumptions
All chaparral and scrub land cover within the inventory area was considered core habitat for Alameda whipsnake. In addition, a perimeter zone of all adjacent grassland, oak savanna and oak woodland within 500 feet of the scrub areas was also considered core habitat for this species. Core habitat for Alameda whipsnake is defined as home range areas in which individuals find shelter, breed, hibernate, and spend the majority of their time foraging.

All areas of annual grassland, oak woodland, oak savannah, riparian woodland/scrub and stream channels within a 1-mile radius of core Alameda whipsnake habitat were considered suitable movement habitat for this species.

Rationale
Core Habitat: Direct observations of Alameda whipsnakes and radio telemetry data on their movement patterns have shown that individuals tend to establish home ranges primarily within coastal scrub habitat, but also frequently move into adjacent grassland, oak savanna and occasionally oak woodland (Jennings 1983, Stebbins 1985, Swaim 1994). Most telemetry locations are within 170 feet of scrub habitat, but individuals have been tracked out to 500 feet (Swaim 1994). Whipsnakes can remain in grasslands for periods ranging from a few hours to several weeks. Male whipsnakes use grasslands primarily during the mating season in spring; females use these areas mostly after mating, possibly in their search for suitable egg-laying sites (Swaim 1994). Rock outcrops are also important habitat to whipsnakes in providing sites for efficient thermoregulation, shelter retreats, and foraging. Within the core areas, Alameda whipsnakes most commonly occur on east, south, southeast and southwest facing slopes (Swaim 1994), but may also use north facing slopes in more open stands of scrub habitat (McGinnis 1990, Swaim, pers. comm. in USFWS 2000a).

Movement habitat and corridors: Adult male whipsnakes commonly move long distances away from their core areas during the breeding season (Swaim 2000). Also juveniles and hatchlings disperse annually away from their natal core areas in search of new habitats. A recent review of Alameda whipsnake locality data revealed that numerous Alameda whipsnakes have been observed at distances significantly greater than 500 feet from scrub habitat (Swaim 2000). These distances range from 0.1 mile to 4 miles. The 4 mile records appears to be anomalous; the next longest distance being 1.5 miles and all other records (9) were less than 1 mile (mean for the 10 values = 0.46 miles).
Because the data on these whipsnake movements is limited (Swaim 2000), for the purposes of this model we used a conservative estimate of 1.0 mile to define the potential dispersal/movement distance of whipsnakes away from core coastal scrub habitat. Within this radius, however, it is unknown what pathways the snakes may take. Rock outcrops probably facilitate these long distance movements in these areas, but are apparently not essential (Swaim 1994, 2000). Individual whipsnakes have been located over 3,000 feet from scrub in areas where no significant rock outcrops were present between the closest patch of scrub and the location where the snake was found. Stream channels also are probably used as movement corridors between core areas (Swaim 2000). For these reasons we included all grassland and oak savanna areas within a 1-mile radius of all coastal scrub area in the inventory area as suitable Alameda whipsnake movement habitat. Furthermore, we considered all stream channels in and networked with channels within this 1-mile radius as potential dispersal/movement corridors for this species.

Model Results

Figure 2 shows the modeled potential habitat of the Alameda whipsnake within the HCP/NCCP inventory area. The habitat includes the eastern slopes of Mt. Diablo and much of the surrounding foothills in the western and southwestern portions of the inventory area. The documented occurrences of Alameda whipsnakes in this area correspond well to locations within core areas or in adjacent movement habitat and corridors. Two recently documented occurrences are located in grassland habitat north and northeast of Los Vaqueros Reservoir approximately 4 miles from the nearest potential chaparral/scrub habitat. We closely examined the aerial photos at these locations and found no visible features (e.g., small patch of scrub, small rock outcrop, etc.) that might explain the occurrences. The California Department of Fish and Game (CDFG) has funded a trapping study of whipsnakes at those locations to verify them and to develop a better understanding of whipsnake habitat away from chaparral and coastal sage scrub stands. CDFG staff agreed that the model could not be refined any more based on our current understanding of suitable habitat for this species and the data available (C. Wilcox, pers. comm.).

A small area southeast of Mt. Diablo is not shown as suitable habitat for the Alameda whipsnake. This area is likely suitable movement habitat because of the proximity (less than 1 mile) of chaparral and scrub habitat outside the inventory that was not mapped.

The minimum home range size of adult male Alameda whipsnakes in coastal scrub habitat is approximately 5 acres. Habitat patches of this size within the inventory area could not be mapped due to the 10-acre minimum resolution of the model. Rock outcrop areas, which are important to the Alameda whipsnake within core areas and movement corridors, were not mapped if they were less than one acre in size. If small patches of these habitat occurred to the east of mapped suitable habitat, the dispersal range of this species would extend farther into the urban limit line. A close examination of the aerial photos found no such small patches within the grassland in or near the urban limit line that would
extend the model to the north or east. The model provides reasonable and conservative estimates for both core habitat and movement corridors/dispersal habitat.

**Literature Cited**

California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2 (March 5, 2001 update). California Department of Fish and Game, Sacramento, CA.


**Personal Communications**

Darlene McGriff, California Department of Fish and Game. November 27, 2001. Email correspondence.


Wilcox, Carl. Conservation Planning Manager, California Department of Fish and Game, Yountville, CA. Meeting with David Zippin, October 2002.
Giant Garter Snake (Thamnopsis gigas)

Status

State: Threatened
Federal: Threatened

Population Trend

Global: Declining
State: Declining
Within Inventory Area: Unknown

Data Characterization

The location database for the giant garter snake (Thamnopsis gigas) within its known range in California includes 142 data records from 1908 to 2000. Of these, 30 were documented within the past 10 years, 12 or which are of high precision and may be accurately located. Two of these records are located outside but near the ECCC HCP/NCCP inventory area. This database includes records of individual sightings and locations of occupied, vacant, and natal dens.

A moderate amount of literature is available for the giant garter snake because of its threatened status. Most of the literature pertains to habitat requirements, distribution, population demographics, threats, and management activities. A recovery plan for the giant garter snake has been published (U.S. Fish and Wildlife Service 1999).

Range

The giant garter snake is endemic to the valley floor of the Sacramento and San Joaquin Valleys of California. Records coincide with the historical distribution of large flood basins, freshwater marshes, and tributary streams of the Central Valley of California (Hansen and Brode 1980). The historic distribution of the giant garter snake extended from Sacramento and Contra Costa Counties southward to Buena Vista Lake near Bakersfield in Kern County. Some experts consider Contra Costa County outside the current range of giant garter snake; however the lack of records from the County may be due to a lack of survey effort (Hansen pers. comm.) (see below).

Occurrences within the ECCC HCP/NCCP Inventory Area

One historic record of giant garter snake was documented within the ECCC HCP/NCCP inventory area near Antioch (Hansen pers. comm.). Although this species may have occurred in the inventory area historically, it may have been extirpated there due to predation by sport fish (e.g., striped bass, black bass). Areas in the inventory area west of Marsh Creek are not considered within the range of giant garter snake (Hansen pers. comm.).
Suitable habitat occurs in the slough areas and drainage network associated with agricultural fields in the northeast section of the County (U.S. Fish and Wildlife Service 1999). The lack of records from this area may be due to a lack of survey effort. For example, recent studies of giant garter snake distribution and genetics have not focused on Contra Costa County (Hansen pers. comm.).

**Biology**

**Habitat**

The giant garter snake inhabits agricultural wetlands and associated waterways, including irrigation and drainage canals, rice fields, marshes, sloughs, ponds, small lakes, low-gradient streams, and adjacent uplands (U.S. Fish and Wildlife Service 1999). Important features of these habitats include: 1) sufficient water during the snake’s active season (early spring through mid–fall) to maintain an adequate prey base; 2) emergent vegetation, such as cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.), for escape cover and foraging habitat; 3) upland habitat with grassy banks and openings to waterside vegetation for basking; and 4) higher elevation upland areas for cover and refuge from flood waters during the snake’s inactive season (Hansen 1980, 1988, Brode and Hansen 1992, Hansen and Brode 1993). Giant garter snakes are absent from the larger rivers; wetlands with sand, gravel, or rock substrates; and riparian areas lacking suitable basking sites or suitable prey populations (Hansen 1980, Rossman and Stewart 1987, Brode 1988, Hansen 1988, U.S. Fish and Wildlife Service 1999).

**Foraging Requirements**


**Reproduction**

The breeding season for the giant garter snake extends from March through May and resumes briefly during September (G. Hansen pers. comm. in U.S. Fish and Wildlife Service 1999). Males begin searching for females immediately after emergence from overwintering sites. Females brood young internally and typically give birth to 10 to 46 young (mean = 23) from late July through early September (Hansen and Hansen 1990). The young immediately disperse to dense cover where they absorb their yolk sac, then start feeding independently. The young will typically have doubled in size by 1 year of age (G. Hansen pers. comm.).
comm. in U.S. Fish and Wildlife Service 1999), and sexual maturity usually takes 3 years in males and 5 years in females.

**Demography**

No studies of the longevity of giant garter snakes have been conducted.

**Behavior**

Giant garter snakes are most active from early spring through mid-fall; activity being dependent on local weather conditions (Brode 1990, Hansen and Brode 1993). During the winter, giant garter snakes are generally inactive, although some individuals may bask or move short distances on warmer days (U.S. Fish and Wildlife Service 1999). During the active season, giant garter snakes generally remain in close proximity to wetland habitats but can move over 800 feet from the water (G. Hansen 1988, Wylie et al. 1997) during the day. Some individuals may move up to 5 miles over a period of several days, if the conditions of their habitat become unsuitable (Wylie et al. 1997).

**Ecological Relationships**

Giant garter snakes prey on a variety of fish and amphibians available within their habitat and are in turn prey for raccoons (*Procyon lotor*), striped skinks (*Mephitis mephitis*), opossum (*Didelphis virginiana*), red foxes (*Vulpes vulpes*), gray foxes (*Urocyon cinereoargenteus*), hawks (*Buteo* spp.), northern harriers (*Circus cyaneus*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), American bittern (*Botaurus lentiginosus*), and great blue herons (*Ardea herodias*). Giant garter snakes may coexist with 2 other species of garter snake: the valley garter snake (*T. sirtalis fitichi*) and the western terrestrial garter snake (*T. elegans*) (R. Hansen 1980, G. Hansen 1986). This coexistence may be possible because of differences in foraging behavior (U.S. Fish and Wildlife Service 1999).

**Threats**

Habitat loss, degradation, and fragmentation are the primary threats to giant garter snake population viability (U.S. Fish and Wildlife Service 1999). Conversion of wetlands for agricultural, urban, and industrial development has resulted in the loss of over 90% of suitable habitat for this species in the Central Valley. Degradation of habitat—including maintenance of flood control and agricultural waterways, weed abatement, rodent control, discharge of contaminants into wetlands and waterways, and overgrazing in wetland or streamside habitats—may also cumulatively threaten the survival of some giant garter snake populations (Brode and Hansen 1992, California Department of Fish and Game 1992, G. Hansen 1988, Hansen and Brode 1993).
Introduction of non-native predators, including the bullfrog, largemouth bass (*Micropterus salmoides*) and catfish (*Ictalurus* spp.), has been responsible for eliminating many species of native fishes and aquatic vertebrates in the western United States (Minkley 1973, Moyle 1976, Holland 1992). Exotic species probably had detrimental effects on the giant garter snake through direct predation (sensu Bury and Whelan 1984, Treanor 1993) and competition for smaller forage fish (California Department of Fish and Game 1992, G. Hansen 1986, Schwalbe and Rosen 1989).

Toxic contamination, particularly from selenium, and impaired water quality have also been identified as threats to some populations of the giant garter snake (Ohlendorf et al. 1988, Saiki and Lowe 1987, U.S. Fish and Wildlife Service 1993). Preliminary studies have documented potential bioaccumulative effects of agriculturally derived contaminants on giant garter snakes or their prey species (see Saiki et al. 1992, 1993). Disease and parasitism, (potentially related to reduced immune response ability from contaminants), may also pose a threat to this species (U.S. Fish and Wildlife Service 1999).

**Conservation and Management**

The giant garter snake was listed as threatened in California in 1971 and federally in 1993. Subsequent conservation actions have included the establishment of guidelines and mechanisms to minimize and mitigate take (U.S. Fish and Wildlife Service 1999), habitat and population surveys (G. Hansen 1982, 1986, 1996, Hansen and Brode 1980), and development of management plans for public lands and land acquisitions (U.S. Fish and Wildlife Service 1999). A draft recovery plan for the giant garter snake was completed in 1999 (U.S. Fish and Wildlife Service 1999).

**Modeled Species Distribution**

**Model Description**

**Assumptions**

1. The slough/channel, pond, and stream land-cover type east of Marsh Creek and within or adjacent to pasture and cropland were considered core habitat for the giant garter snake.

2. Pasture, cropland, and ruderal land-cover types within 900 feet of core habitat were considered potential movement and foraging habitat for the giant garter snake.

3. Core or movement habitat that was not linked to the San Joaquin River through other core or movement habitat was omitted from the model.
Rationale

Core Habitat: The giant garter snake inhabits agricultural wetlands and associated waterways, including sloughs, irrigation and drainage canals, ponds, low-gradient streams, and adjacent uplands (U.S. Fish and Wildlife Service 1999). Areas in the inventory area west of Marsh Creek are not considered within the range of giant garter snake (Hansen pers. comm.). Suitable habitat (both core and movement) was defined only as areas accessible from the San Joaquin River, which provides the only link with known populations outside the inventory area.

Movement Habitat: During the active season, giant garter snakes generally remain in close proximity to wetland habitats but can move over 800 feet from the water during the day (G. Hansen 1988, Wylie et al. 1997). Because the actual movement patterns of garter snakes are not known, we used a conservative estimate of 900 feet to define the potential movement habitat requirements for this species.

Model Results

Figure 2 shows the modeled potential habitat of the giant garter snake within the inventory area. No occurrence records for this species were found within the inventory area. The only known records in the vicinity of the inventory area are to the north in the Sacramento/San Joaquin Delta. However, few surveys have been conducted for this species within the inventory area, but suitable habitat is known to occur there. Suitable core and movement habitat is largely restricted to the sloughs and surrounding agricultural areas in the eastern edge of the inventory area.

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______. 1990. Guidelines for procedures and timing of activities related to modification or relocation of giant garter snake habitat. California Department of Fish and Game Inland Fisheries Division, October 1990.


California Department of Fish and Game. 1992. Draft five-year status report. Californian Department of Fish and Game, Inland Fisheries Division.


**Personal Communications**

California Tiger Salamander  
(*Ambystoma californiense*)

**Status**

<table>
<thead>
<tr>
<th>State</th>
<th>Species of Special Concern</th>
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**Population Trend**

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<tr>
<td>State</td>
<td>Declining (Jennings and Hayes 1994)</td>
</tr>
<tr>
<td>Within Inventory Area</td>
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</table>

**Data Characterization**

The location database for the California tiger salamander (*Ambystoma californiense*) within the inventory area includes 96 data records dated from 1920 to 1999. Of these records, 45 were documented within the past 10 years. Of the 45 records, all are considered extant, and 37 are mapped at a “specific” precision level (within 80 meters).

There is a moderate amount of general information on the ecology of the California tiger salamander and several peer-reviewed research studies. Available literature includes research on reproductive ecology, burrowing ability, dispersal from breeding area, habitat use and migratory behavior. There are many gaps in data for the California tiger salamander, including habitat and population distribution, and differentiating between introduced tiger salamanders and California tiger salamanders. The lack of certain types of data may be due to the fact that this species spends most of its life underground in small mammal burrows (U.S. Fish and Wildlife Service 2000). The California tiger salamander was not recognized as distinct species until 1991 (U.S. Fish and Wildlife Service 2000).

**Range**

The California tiger salamander is endemic to California. Historically, the California tiger salamander probably occurred in grassland habitats throughout much of the state. Although this species still occurs within much of its range, it has been extirpated from many historic localities (Fisher and Shaffer 1996, Stebbins 1985). The loss of California tiger salamander populations has been due primarily to habitat loss within its historic range (Fisher and Shaffer 1996).

Currently, the California tiger salamander occurs in six populations from the Central Valley and Sierra Nevada foothills, from Yolo County south to Tulare County, and in the coastal valleys and foothills, from Sonoma County south to Santa Barbara County (Zeiner et al. 1988).
The six populations of California tiger salamander are found in Sonoma County, Santa Barbara County, the Bay Area (central and southern Alameda County, Santa Clara County, western Stanislaus and Merced Counties, and San Benito County), the Central Valley (Yolo County, Sacramento County, East Contra Costa County, northeast Alameda County, San Joaquin County, Stanislaus County, Merced County and northwest Madera County), southern San Joaquin Valley (Madera County, central Fresno County, northern Tulare County, and Kings County), and the Central Coast Range (south Santa Cruz County, Monterey County, northern San Luis Obispo County, western San Benito, Fresno and Kern Counties) (U.S. Fish and Wildlife Service 2003a). Isolated populations are found at the Gray’s Lodge Wildlife Area in Butte County and at Grass Lake in Siskiyou County (Zeiner et al. 1988). Most populations occur at elevations below 1,500 feet, but tiger salamanders have been recorded at elevations up to 4,500 feet. Although populations have declined, the species continues to breed at a large number of locations within its current range (59 FR 18353–18354, April 18, 1994). At most historic breeding sites below 200 feet elevation, ponds remain present but no longer support California tiger salamanders. These sites are typically occupied by non-native species (Fisher and Shaffer 1996).

**Occurrences within the ECCC HCP Inventory Area**

Because a comprehensive survey for the California tiger salamander has not been conducted in the HCP inventory area, neither the current population size nor the locations of all occurrences are known.

**Biology**

**Habitat**

California tiger salamanders require 2 major habitat components: aquatic breeding sites and terrestrial estivation or refuge sites. California tiger salamanders inhabit valley and foothill grasslands and the grassy understory of open woodlands, usually within 1 mile of water (Jennings and Hayes 1994). The California tiger salamander is terrestrial as an adult and spends most of its time underground in subterranean refugia. Underground retreats usually consist of ground-squirrel burrows and occasionally human-made structures. Adults emerge from underground to breed, but only for brief periods during the year. Tiger salamanders breed and lay their eggs primarily in vernal pools and other ephemeral ponds that fill in winter and often dry out by summer (Loredo et al. 1996); they sometimes use permanent human-made ponds (e.g., stock ponds), reservoirs, and small lakes that do not support predatory fish or bullfrogs (see “Ecological Relationships” discussion below) (Stebbins 1972, Zeiner et al. 1988). Streams are rarely used for reproduction.

Adult salamanders migrate from upland habitats to aquatic breeding sites during the first major rainfall events of fall and early winter and return to upland habitats after breeding. This species requires small-mammal (e.g., California ground...
squirrel) burrows for cover during the non-breeding season and during migration to and from aquatic breeding sites (Zeiner et al. 1988). Petranka (1998) estimated that 83% of California tiger salamanders utilize rodent burrows for upland refugia (in U.S. Fish and Wildlife Service 2003). California tiger salamanders also use logs, piles of lumber, and shrink-swell cracks in the ground for cover (Holland et al. 1990). California tiger salamanders can overwinter in burrows up to 1 mile from their breeding sites (Jennings and Hayes 1994).

The California tiger salamander is particularly sensitive to the duration of ponding in aquatic breeding sites. Because tiger salamanders have a long developmental period, the longest lasting seasonal ponds or vernal pools are the most suitable type of breeding habitat for this species; these pools are also typically the largest in size (Jennings and Hayes 1994). Because at least 10 weeks are required to complete metamorphosis (see “Demography” below) (Feaver 1971), aquatic sites that are considered suitable for breeding should at least 10 weeks. Moreover, large vernal pool complexes, rather than isolated pools, probably offer the best quality habitat; these areas can support a mixture of core breeding sites and nearby refuge habitat (Shaffer et al. 1994, Jennings and Hayes 1994).

The suitability of California tiger salamander habitat is proportional to the abundance of upland refuge sites that are near aquatic breeding sites. California tiger salamanders primarily use California ground squirrel burrows as refuge sites (Loredo et al. 1996; Trenham 2001); Botta’s pocket gopher burrows are also frequently used (Barry and Shaffer 1994, Jennings and Hayes 1994). The presence and abundance of tiger salamanders in many areas are limited by the number of small-mammal burrows available; salamanders are typically absent from areas that appear suitable other than their lack of burrows. Loredo et al. (1996) emphasized the importance of California ground squirrel burrows as refugia for California tiger salamanders, and suggested that a commensal relationship existed between the California tiger salamander and California ground squirrel in which tiger salamanders benefit from the burrowing activities of squirrels. In a study conducted near Concord, California, Loredo et al. (1996) found that California ground squirrel burrows were used almost exclusively as refuge sites by California tiger salamanders. Also, tiger salamanders apparently do not avoid burrows occupied by ground squirrels (Loredo et al. 1996).

The proximity of refuge sites to aquatic breeding sites also affects the suitability of salamander habitat. Although the variation in distances between breeding and refuge sites is poorly studied (Jennings and Hayes 1994), juvenile salamanders are known to migrate distances up to 1 mile (1.6 km) from breeding sites (Austin and Shaffer 1992, Mullen in U.S. Fish and Wildlife Service 2000). Loredo et al. (1996) found that tiger salamanders may use burrows that are first encountered during movements from breeding to upland sites. In their study area, where the density of California ground squirrel burrows was high, the average migration distances between breeding and refuge sites for adults and juveniles was 118 feet (35.9 m) and 85 feet (26.0 m), respectively. Therefore, although salamanders may migrate up to 1 mile, migration distances are likely to be less in areas supporting refugia closer to breeding sites. Also, habitat complexes that include upland refugia relatively close to breeding sites are considered more suitable...
because predation risk and physiological stress in California tiger salamanders probably increases with migration distance.

**Reproduction**

Adult California tiger salamanders migrate to and congregate at aquatic breeding sites during warm rains, primarily between November and February (Shaffer and Fisher 1991, Barry and Shaffer 1994). Tiger salamanders are rarely observed except during this period (Loredo et al. 1996). During this period, tiger salamanders breed and lay eggs primarily in vernal pools and other shallow ephemeral ponds that fill in winter and often dry by summer (Loredo et al. 1996). Spawning usually occurs within a few days after migration, and adults probably leave the breeding sites at night soon after spawning (Barry and Shaffer 1994 citing Storer 1925).

Eggs are laid singly or in clumps on both submerged and emergent vegetation and on submerged debris in shallow water (Stebbins 1972, Shaffer and Fisher 1991, Barry and Shaffer 1994, Jennings and Hayes 1994). Larvae develop rapidly, and metamorphosis begins in late spring or early summer (Loredo-Prendeville 1995). At least 10 weeks are required to complete metamorphosis (Feaver 1971). Juveniles disperse from aquatic breeding sites to upland habitats after metamorphosis (Storer 1925, Holland et al. 1990).

California tiger salamanders breed in vernal pools and other temporary rainwater ponds. This species will also use permanent human-made ponds, without predatory fish, for reproduction. Females lay eggs on submerged vegetation in shallow water. In ponds without vegetation, females will lay eggs on objects on the pond bottom (Jennings and Hayes 1994). After breeding, adults leave the breeding ponds and return to small mammal burrows.

After approximately 2 weeks, the salamander eggs begin to hatch into larvae. Once larvae reach a minimum body size they metamorphose to the terrestrial juvenile salamander. Larvae in small ponds develop faster, while larvae inhabiting ponds that retain water for longer will be larger at time of metamorphosis. In general, salamanders require 10 weeks living in ponded water for complete metamorphosis. If a pond dries prior to metamorphosis, the larvae will desiccate and die (U.S. Fish and Wildlife Service 2000).

The California tiger salamander breeds primarily in vernal pools and swales—unique ecosystems that fill with winter rains and dry completely by summer—and then spends most of its lifecycle estivating underground in adjacent valley oak woodland or grassland habitat, primarily in abandoned rodent burrows. Research has shown that dispersing juveniles can roam up to 1 mile from their breeding ponds and that a minimum of 480 acres of uplands habitat is needed surrounding a breeding pond in order for the species to survive over the long term. Reserves of multiple breeding ponds surrounded by 1000 acres or more of habitat are recommended to ensure the persistence of the species.

**Foraging Requirements**

Aquatic larvae feed on algae, small crustaceans, and small mosquito larvae for about 6 weeks after hatching (U.S. Fish and Wildlife Service 2000). Larger larvae feed on zooplankton, amphipods, mollusks, and smaller tadpoles of pacific...
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California Tiger Salamander (*Ambystoma californiense*)

treefrogs, red-legged frogs, western toads and spadefoot toads (Zeiner et al. 1988, U.S. Fish and Wildlife Service 2000). During estivation, California tiger salamanders eat very little (Shaffer et al. 1994 in U.S. Fish and Wildlife Service 2000). During the fall and winter, adult salamanders emerge from underground retreats during rain events and on nights of high relative humidity to feed and migrate to breeding ponds (U.S. Fish and Wildlife Service 2000). Adults eat earthworms, snails, insects, fish, and small mammals (Stebbins 1972).

**Demography**

Local populations of California tiger salamanders may not reproduce during years of low rainfall when ephemeral pools do not fill (Barry and Shaffer 1994, Jennings and Hayes 1994). However, it is presumed that the longevity of this species allows local populations to persist through all but the longest drought periods (Barry and Shaffer 1994). Individuals have been known to live for more than 10 years (Trenham et al. 2000 in U.S. Fish and Wildlife Service 2000).

Trenham et al. (2001) showed that pool complexes occupied by California tiger salamander fit a metapopulation model. Also, long-term demographic data suggest that there are source-sink relationships between pools in a complex (Trenham et al. 2000, 2001) (see “Dispersal” below).

**Dispersal**

Adult California tiger salamanders migrate to and congregate at aquatic breeding sites during warm rains, primarily between November and February (Shaffer and Fisher 1991, Barry and Shaffer 1994). Tiger salamanders are rarely observed except during this period (Loredo et al. 1996). Dispersal of juveniles from natal ponds to underground refugia occurs during summer months, when breeding ponds dry out. Juveniles disperse from breeding sites after spending a few hours or days near the pond margin (Jennings and Hayes 1994). Dispersal distance varies and may increase with an increase in precipitation (Trenham in revision in U.S. Fish and Wildlife Service 2000). Juveniles have been found more than 1,200 feet away from breeding ponds (Mullen in U.S. Fish and Wildlife Service 2000), yet most juveniles tend to remain closer to breeding ponds (U.S. Fish and Wildlife Service 2000).

Some genetic data suggest low rates of California tiger salamander migration between vernal pool complexes (Shaffer et al. 1994, Irschick and Shaffer 1997) or metapopulations; this suggests that natural colonization after a local extirpation event may be unlikely (Fisher and Shaffer 1994). Trenham et al. (2001) showed that pool complexes occupied by California tiger salamander fit a metapopulation model, and dispersal rates between ponds may be high for both first-time and experienced breeders; and dispersal rates are probably high enough to prevent local extirpations within a pool complex.
Ecological Relationships

California tiger salamander larvae and embryos are susceptible to predation by fish (Stebbins 1972, Zeiner et al. 1988, Shaffer et al. 1994), and tiger salamander larvae are rarely found in aquatic sites that support predatory fish (Shaffer and Fisher 1991, Shaffer and Stanley 1992, Shaffer et al. 1994). Aquatic larvae are taken by herons and egrets and possibly garter snakes (Zeiner et al. 1988). Shaffer et al. (1993) also found a negative correlation between the occurrence of California tiger salamanders and the presence of bullfrogs; however, this relationship was detected only in unvegetated ponds. This suggests that vegetation structure in aquatic breeding sites may be important for survival. Because of their secretive behavior and limited periods above ground, adult California tiger salamanders have few predators (U.S. Fish and Wildlife Service 2000).

Threats

California tiger salamander populations have experienced dramatic declines throughout the historical range of the species, particularly in the Central Valley. California tiger salamander populations have declined as a result of 2 primary factors: widespread habitat loss and habitat fragmentation. These factors have both been caused by conversion of valley and foothill grassland and oak woodland habitats to agricultural and urban development (Stebbins 1985). For example, residential development and land use changes in the California tiger salamander’s range have removed or fragmented vernal pool complexes, eliminated refuge sites adjacent to breeding areas, and reduced habitat suitability for the species over much of the Central Valley (Barry and Shaffer 1994, Jennings and Hayes 1994). Grading activities have probably also eliminated large numbers of salamanders directly (Barry and Shaffer 1994). Overall, approximately 75% of habitat for California tiger salamander within its historic range has been lost (Fisher and Shaffer 1996).

The introduction of bullfrogs, Louisiana red swamp crayfish, and non-native fishes (mosquitofish, bass, and sunfish) into aquatic habitats has also contributed to declines in tiger salamander populations (Jennings and Hayes 1994; 59 FR 18353–18354, April 18, 1994, U.S. Fish and Wildlife Service 2000). These non-native species prey on tiger salamander larvae and may eliminate larval populations from breeding sites (Jennings and Hayes 1994). At sites where aquatic vegetation is present, exotic fish appear more likely to result in California tiger salamander extirpation than bullfrogs (Fisher and Shaffer 1996). At most historic breeding sites below 200 feet elevation, ponds remain present but no longer support California tiger salamanders. Instead, these sites are typically occupied by non-native species (Fisher and Shaffer 1996).

Burrowing-mammal control programs are considered a threat to California tiger salamander populations. Rodent control through destruction of burrows and release of toxic chemicals into burrows can cause direct mortality to individual salamanders and may result in a decrease of available suitable habitat (U.S. Fish and Wildlife Service 2000).
Vehicular related mortality is an important threat to California tiger salamander populations (Barry and Shaffer 1994, Jennings and Hayes 1994). California tiger salamanders will readily attempt to cross roads during migration, and roads that sustain heavy vehicle traffic or barriers that impede seasonal migrations may have impacted tiger salamander populations in some areas (Shaffer and Fisher 1991, Shaffer and Stanley 1992, Barry and Shaffer 1994). Therefore, establishing artificial structures that could impede movements or maintaining roads that support a considerable amount of vehicle traffic in areas that support California tiger salamander populations can severely degrade salamander habitat (see Jennings and Hayes 1994).

Hybridization between California tiger salamander and an introduced congener, *A. tigrinum*, has been documented and may be extensive (Riley et al. 2003). *A. tigrinum* was introduced to California for use as fishing bait; and both taxa co-occur in ponds and vernal pools. Hybridization between native and exotic taxa, due to lack of reproductive isolation, can threaten native taxa by causing genetic swamping, reduced genetic diversity, and reduced genetic purity of native populations. In rare species such as California tiger salamander, hybridization can also lead to population extirpation. In a study of tiger salamander hybridization conducted in the Salinas Valley, Riley et al. (2003) found that the degree of genetic mixing between California tiger salamander and *A. tigrinum* depended on breeding habitat type. In artificial ponds, there appeared to be no barriers to gene exchange between California tiger salamander and *A. tigrinum*. However, in vernal pools, significantly fewer hybrid genotypes and more pure parental genotypes were found. These results suggest that the potential for reproductive isolation between the two taxa may be higher in native habitats.

**Conservation and Management**

The California tiger salamander is a Federal Candidate Species and California Species of Special Concern within the ECCC HCP/NCCP inventory area (U.S. Fish and Wildlife Service 1994). On January 19, 2000, the Santa Barbara County population of the California tiger salamander was listed as endangered species on an emergency listing (U.S. Fish and Wildlife Service 2000). On July 22, 2002, the Sonoma County population was listed as endangered on an emergency listing. On March 19, 2003, the U.S. Fish and Wildlife Service issued a final rule that listed this population as endangered (U.S. Fish and Wildlife Service 2003). These actions strongly indicate the imperiled nature of this species and the potential that important habitat loss within the ECCC HCP/NCCP inventory area could lead to listing of the Contra Costa population of tiger salamanders during the projected 50-year HCP permit period. Currently, neither the Candidate listing nor the Species of Concern designation provides formal protection to this species.

The East Bay and Livermore Valley populations comprise a genetically distinct region within the California tiger salamander’s distribution (Shaffer et al. 1994). Also, the East Bay and Sacramento Valley populations may be the most genetically diverse populations, suggesting that those regions may comprise the
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core of the species’ distribution, and are of particularly high conservation value (Shaffer et al. 1994).

Existing conservation measures for this species include preservation of occupied habitat, mitigative replacement of lost habitat, and prevention of contamination of aquatic habitat used by the species. Research has shown that dispersing juveniles can roam up to 1 mile from their breeding ponds and that a minimum of 480 acres of uplands habitat is needed surrounding a breeding pond in order for the species to survive over the long term. Reserves of multiple breeding ponds surrounded by 1000 acres or more of habitat are recommended to ensure the persistence of the species (Center for Biological Diversity 2002).

Modeled Species Distribution

Model Description

Assumptions

1. All ponds, wetlands, seasonal wetlands, and alkali wetlands within annual grassland, oak savanna, and oak woodland were considered potential breeding habitat for California tiger salamander.

2. All non-urban, non-aquatic land cover types within 1 mile of potential breeding sites were considered potential migration and aestivation habitat for this species.

Rationale

California tiger salamanders require 2 major habitat components: aquatic breeding sites and terrestrial aestivation or refuge sites. California tiger salamanders inhabit valley and foothill grasslands and the grassy understory of open woodlands, usually within 1 mile of water (Jennings and Hayes 1994). The California tiger salamander is terrestrial as an adult and spends most of its time underground in subterranean refugia. Underground retreats usually consist of ground-squirrel burrows and occasionally human-made structures. Adults emerge from underground to breed, but only for brief periods during the year. Tiger salamanders breed and lay their eggs primarily in vernal pools and other ephemeral ponds that fill in winter and often dry out by summer (Loredo et al. 1996); they sometimes use permanent human-made ponds (e.g., stock ponds), reservoirs, and small lakes that do not support predatory fish or bullfrogs (see “Ecological Relationships” discussion below) (Stebbins 1972, Zeiner et al. 1988). Streams are rarely used for reproduction.

Adult salamanders migrate from upland habitats to aquatic breeding sites during the first major rainfall events of fall and early winter and return to upland habitats after breeding. This species requires small-mammal (e.g., California ground squirrel) burrows for cover during the non-breeding season and during migration to and from aquatic breeding sites (Zeiner et al. 1988). California tiger salamanders also use logs, piles of lumber, and shrink-swell cracks in the ground
California Tiger Salamander (*Ambystoma californiense*)

for cover (Holland et al. 1990) California tiger salamanders can overwinter in burrows up to 1 mile from their breeding sites (Jennings and Hayes 1994).

The proximity of refuge sites to aquatic breeding sites also affects the suitability of salamander habitat. Although the variation in distances between breeding and refuge sites is poorly studied (Jennings and Hayes 1994) juvenile salamanders are known to migrate distances up to 1 mile (1.6 km) from breeding sites (Austin and Shaffer 1992, Mullen *in* U.S. Fish and Wildlife Service 2000. Research has shown that dispersing juveniles can roam up to 1 mile from their breeding ponds.

**Model Results**

Figure 2 shows the modeled potential habitat of the California tiger salamander. The habitat includes approximately two-thirds of the inventory area and is largely located in the hilly portions of the western side of this area. All documented occurrences of this species fit well within the boundaries of the model.

The large proportion of the modeled habitat within non-urban areas is due to the large number of ponds that provide potential breeding habitat and the potential dispersal distance of this species. Loredo et al. (1996) found that tiger salamanders may use burrows that are first encountered during movements from breeding to upland sites. In their study area, where the density of California ground squirrel burrows was high, the average migration distances between breeding and refuge sites for adults and juveniles was 118 feet (35.9 m) and 85 feet (26.0 m), respectively. Therefore, although salamanders may migrate up to 1 mile, migration distances are likely to be less in areas supporting refugia closer to breeding sites. However, because the actual movement patterns of the salamanders away from breeding sites is not known within the inventory area, we used a conservative estimate of 1 mile to define the potential movement/dispersal habitat requirements for this species. Also, due to the 10 acre minimum resolution function of the model, vernal pools and seasonal wetlands could not be delineated within the modeled distribution area and their abundance is likely to have been underestimated.

**Literature Cited**


Shaffer, H. B., and R. Fisher. 1991. Final report to the California Department of Fish and Game; California tiger salamander surveys, 1990–Contract (FG 9422). California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California.


California Red-Legged Frog (*Rana aurora draytonii*)

**Status**

**State:** Meets requirements as a “rare, threatened or endangered species” under CEQA

**Federal:** Threatened

**Population Trend**

**Global:** State endemic; declining

**State:** Declining

**Within Inventory Area:** Apparently stable in some areas

**Data Characterization**

The location database for the California red-legged frog (*Rana aurora draytonii*) within its known range in California includes 419 data records dated from 1919 to 2001. Of these records, 344 were documented within the past 10 years; of these, 203 are of high precision and may be accurately located within the inventory area. Approximately 81 of these high-precision records are located within or near the inventory area. These records occur within non-native grassland, riparian forest, riparian woodland, riparian scrub, freshwater marsh, and wetland.

A moderate amount of literature is available regarding the California red-legged frog because of its threatened status and the recent trend in global decline in amphibians. Most of the literature pertains to habitat requirements, population trends, ecological relationships, threats, and conservation efforts. A final recovery plan for the California red-legged frog has been published by the U.S. Fish and Wildlife Service (2002).

**Range**

The historical range of the California red-legged frog extended along the coast from the vicinity of Point Reyes National Seashore, Marin County, California and inland from Redding, Shasta County southward to northwestern Baja California, Mexico (Jennings and Hayes 1985, Hayes and Krempels 1986). The current distribution of this species includes only isolated localities in the Sierra Nevada, northern Coast and Northern Traverse Ranges. It is still common in the San Francisco Bay area and along the central coast. It is now believed to be extirpated from the southern Traverse and Peninsular ranges (U.S. Fish and Wildlife Service 2002).

**Occurrences within the ECC HCP/NCCP Inventory Area**

Contra Costa and Alameda Counties contain the majority of known California red-legged frog occurrences in the San Francisco Bay Area (U.S. Fish and
However, this species seems to have been nearly eliminated from the western lowland portions of these counties, particularly near urbanization. Eighty-one occurrences of California red-legged frogs have been documented within the inventory area (California Natural Diversity Database 2001). Numerous ponds and creeks in Simas Valley support California red-legged frogs (Dunne 1995). Sizeable breeding populations are also found at Sand Creek (Black Diamond Mines Regional Park) and Round Valley (Round Valley Regional Preserve) (S. Bobzien in litt. 1900 cited in U.S. Fish and Wildlife Service 2002). Some of the highest densities of California red-legged frog occur in many of the stock ponds within the Los Vaqueros watershed.

**Biology**

**Habitat**

Within their range, California red-legged frogs occur from sea level to about 5,000 feet above sea level (U.S. Fish and Wildlife Service 2002). Almost all of the documented occurrences of this species, however, are located below 3,500 feet. Breeding sites include a variety of aquatic habitats—larvae, tadpoles and metamorphs use streams, deep pools, backwaters within streams and creeks, ponds, marshes, sag ponds, dune ponds, and lagoons. Breeding adults are commonly found in deep (more than 2 feet), still or slow-moving water with dense, shrubby riparian or emergent vegetation (Hayes and Jennings 1988). Adult frogs have also been observed in shallow sections of streams that are not shrouded by riparian vegetation. Generally, streams with high flows and cold temperatures in spring are unsuitable for eggs and tadpoles. Stock ponds are frequently used by this species if they are managed to provide suitable hydroperiod, pond structure, vegetative cover, and control of nonnative predators.

During dry periods, California red-legged frogs are seldom found far from water. However, during wet weather, individuals may make overland excursions through upland habitats over distances up to 2 miles. These dispersal movements are generally straight-line, point-to-point migrations rather than following specific habitat corridors. Dispersal distances are believed to depend on the availability of suitable habitat and prevailing environmental conditions. Very little is known about how California red-legged frogs use upland habitats during these periods.

During summer, California red-legged frogs often disperse from their breeding habitat to forage and seek summer habitat if water is not available (U.S. Fish and Wildlife Service 2002). This habitat may include shelter under boulders, rocks, logs, industrial debris, agricultural drains, watering troughs, abandoned sheds, or hay-ricks. They will also use small mammal burrows, incised streambed channels, or areas with moist leaf litter (Jennings and Hayes 1994; U.S. Fish and Wildlife
This summer movement behavior, however, has not been observed in all California red-legged frog populations studied.

**Foraging Requirements**

California red-legged frogs consume a wide variety of prey. Adult frogs typically feed on aquatic and terrestrial insects, crustaceans and snails (Stebbins 1985, Hayes and Tennant 1985), as well as worms, fish, tadpoles, smaller frogs (e.g. *Hyla regilla*), and occasionally mice (*Peromyscus californicus*) (U.S. Fish and Wildlife Service 2002). Aquatic larvae are mostly herbivorous algae grazers (Jennings et al. in litt. 1992). Feeding generally occurs along the shoreline of ponds or other watercourses and on the water surface. Juveniles appear to forage during both daytime and nighttime, whereas subadults and adults tend to feed more exclusively at night (Hayes and Tennant 1985).

**Reproduction**

California red-legged frogs breed from November through April (Storer 1925, U.S. Fish and Wildlife Service 2002). Males usually appear at the breeding sites 2 to 4 weeks before females. Females are attracted to calling males. Females lay egg masses containing about 2,000 to 5,000 eggs, which hatch in 6 to 14 days, depending on water temperatures (U.S. Fish and Wildlife Service 2002). Larvae metamorphose in 3.5 to 7 months, typically between July and September (Storer 1925, Wright and Wright 1949, U.S. Fish and Wildlife Service 2002). Sexual maturity is usually attained by males at 2 years of age and females at 3 years of age.

**Demography**

Adult California red-legged frogs can live 8 to 10 years (Jennings et al. 1992), but the average life span is probably much lower (Scott pers. comm. in U.S. Fish and Wildlife Service 2002). Most mortality occurs during the tadpole stage (Licht 1974). No long-term studies have been conducted on the population dynamics of red-legged frogs.

**Ecological Relationships**

California red-legged frogs are primary, secondary, and tertiary consumers in the aquatic/terrestrial food web of their habitat. As described above, they prey on a wide variety of invertebrates and vertebrates, as well as algae as larvae. Numerous predators prey on these frogs, including raccoons (*Procyon lotor*), great blue herons (*Ardea herodias*), American bitterns (*Botaurus lentiginosus*), black-crowned night herons (*Nycticorax nycticorax*), red-shouldered hawks (*Buteo*...
lineatus), opossums (Didephis virginiana), striped skunks (Mephitis mephitis), spotted skunks (Spilogale putorius), and garter snakes (Thamnophis spp.) (Fitch 1940, Fox 1952, Jennings and Hayes 1990, Rathbun and Murphy 1996). In some areas, introduced aquatic vertebrates and invertebrates also prey on one or more of the life stages of California red-legged frogs. These predators include bullfrogs (Rana catesbeiana), African clawed frogs (Xenopus laevis), red swamp crayfish (Procambarus clarkii), signal crayfish (Pacifastacus leniusculus), bass (Micropterus spp.), catfish (Ictalurus spp.), sunfish (Lepomis spp.), and mosquitofish (Gambusia affinis) (Hayes and Jennings 1986).

**Threats and Reasons for Decline**

The viability of existing California red-legged frog populations is threatened by numerous human activities that often act synergistically and cumulatively with natural disturbances (i.e. droughts or floods) (U.S. Fish and Wildlife Service 2002). These activities include those that result in the degradation, fragmentation, and loss of habitat through agriculture, urbanization, mining, overgrazing, recreation, timber harvesting, nonnative plants, impoundments, water diversions, degraded water quality, and introduced predators.

Over 90% of the historic wetlands in the Central Valley have been lost due to conversion for agriculture or urban development (U.S. Fish and Wildlife Service 1978, Dahl 1990). This has resulted in a significant loss of frog habitat throughout the species’ range (U.S. Fish and Wildlife Service 2002). Habitat along many stream courses has also been isolated and fragmented, resulting in reduced connectivity between populations and lowered dispersal opportunities. These isolated populations are now more vulnerable to extinction through stochastic environmental events (i.e. drought, floods) and human-caused impacts (i.e., grazing disturbance, contaminant spills) (Soulé 1998). In a comprehensive evaluation of prevailing hypotheses on the causes of declines in the California red-legged frog populations, Davidson et al. (2001) determined that there is a strong statistical correlation between locations where frog numbers had declined and upwind agricultural land use. They concluded that wind-borne agrochemicals may be an important factor in these declines.

Increasing urbanization in the Central Valley is also resulting in the continuing loss and fragmentation of California red-legged frog habitat and creates barriers to dispersal by frogs to neighboring populations. Isolated populations are subject to increased predation from nonnative predators, changes in hydroperiod due to variable wastewater outflows, and increased potential for toxic runoff from developments. All of these conditions can reduce the viability of affected frog populations. Similarly, agricultural expansion in the Central Valley has resulted in habitat loss and fragmentation, the introduction of fertilizers, fungicides, pesticides, and herbicides into riparian ecosystems and water diversions and impoundments that can reduce historic flows necessary to support adequate aquatic habitat for frogs and other species (U.S. Fish and Wildlife Service 2002). Poorly managed recreation, mining, timber harvest, and infrastructure
maintenance activities, such as road construction and repair, trail development and facilities development, can also have significant detrimental effects on remaining California red-legged habitat through disturbance, contamination, and introduction of nonnative species that prey on or compete with the frogs.

Conservation and Management

The California red-legged frog was federally listed as threatened in 1996. Since then, numerous conservation efforts have been undertaken by various federal, state, and local and private organizations to minimize impacts and establish preserves and protective policies to ensure the viability of this species (U.S. Fish and Wildlife Service 2002). A final recovery plan for the California red-legged frog was completed in May 2002 that calls for the preservation of all known populations and their habitat, the establishment of a viable metapopulation, development of effective land use policies and guidelines, continued research on the ecological requirements of California red-legged frogs necessary for conservation, continued monitoring, and the establishment of an outreach program.

Modeled Species Distribution

Model Description

Assumptions
1. Ponds and streams in riparian woodland/scrub, wetland or seasonal wetland, annual grassland, alkali grassland, oak savanna, oak woodland, chaparral, non-urban ruderal (ruderal land cover areas outside existing urban land cover areas) and turf land-cover types were considered potential breeding habitat for California red-legged frog.

2. Streams in urban areas were also considered potential breeding habitat for this species.

3. All non-urban non-aquatic land cover types within 1 mile of potential breeding sites were considered potential migration and aestivation habitat for this species. Ponds in urban areas with substantial areas of suitable aestivation habitat intact (>50% of 1-mile buffer) were considered to be suitable breeding habitat unless absence is verified by recent surveys.

Rationale
Breeding habitat: Breeding sites used by California red-legged frogs include a variety of aquatic habitats (Stebbins 1985, Hayes and Jennings 1988, USFWS 2000b). Larvae, tadpoles and metamorphs use streams, deep pools, backwaters within streams and creeks, ponds, and marshes. Breeding adults are commonly
found in deep (more than 2 feet), still or slow-moving water with dense, shrubby riparian or emergent vegetation (Hayes and Jennings 1988). Adult frogs have also been observed in shallow sections of streams that are not shrouded by riparian vegetation. Generally, streams with high flows and cold temperatures in spring are unsuitable for eggs and tadpoles. Within the ECCC HCP/NCCP inventory area stock ponds are frequently used as breeding sites by this species if the ponds are managed to provide suitable hydroperiod, pond structure, vegetative cover, and control of nonnative predators. All existing ponds and streams within the inventory area were, therefore, considered potential suitable breeding habitats for California red-legged frogs.

Migration and aestivation habitat: During dry weather, California red-legged frogs are seldom found far from water. However, as ponds dry out these frogs disperse from their breeding sites to other areas with water or to temporary shelter or aestivation sites. This latter habitat may include small mammal burrows, incised stream channels, shelter under boulders, rocks, logs, leaf litter, agricultural drains, watering troughs, abandoned sheds or unused farm equipment (Jennings and Hayes 1994, USFWS 2000b). Movements of up to 1 mile from breeding sites to aestivation sites are apparently typical (Stebbins 2002), although some individual frogs have been found up to 2 miles away (USFWS 2000b). These dispersal and migration movements are generally straight-line, point-to-point migrations rather than following specific habitat corridors (USFWS 2000b, Stebbins 2002). They may be along long-established historic migratory pathways that provide specific sensory cues that guide the seasonal movement of the frogs (Stebbins 2002). Dispersal distances are believed to depend on the availability of suitable habitat and prevailing environmental conditions. However, because the actual movement patterns of California red-legged frogs in these habitats is generally not known, for this model we conservatively estimated that all non-urban land cover areas within a radius of 1 mile from all potential breeding sites were potential migration and/or aestivation habitats for California red-legged frogs.

Model Results

Figure 1 shows the modeled potential habitat of the California red-legged frog within the ECCC HCP/NCCP inventory area. The habitat includes approximately two-thirds of the inventory area, and is primarily located along the hilly portions of the western side of this area. All documented occurrence locations fit well within the boundaries of the model.

The large size of the habitat is due to the high number of ponds that provide potential breeding habitat and the potential dispersal distance of this species. Because the actual movement patterns of the frogs away from breeding sites is not known (but is believed to often be line-of-sight), we used conservative estimates of the movement/dispersal habitat requirements based on known distances of movement of individuals provided in available reports. We then included all potentially suitable habitats within a radius based on the mode of dispersion.
long-range distances moved by the frogs and classified these areas as suitable movement habitat for the species. Although the model underestimates the extent of ponds and other aquatic features, it is unknown whether the model underestimates or overestimates the extent of suitable breeding habitat for the California red-legged frog because, with the exception of the Los Vaqueros watershed and East Bay Regional Park lands, the suitability of these ponds (both mapped and unmapped) for this species is unknown.

Two aquatic sites in Brentwood are surrounded by urban development but may still support this species. The DFG and the U.S. Fish and Wildlife Service (FWS) have agreed to field verify these sites to determine if California red-legged frog are present. Until these surveys are complete, we will assume presence at these sites.

**Literature Cited**


Hayes, M. P. and M. R. Jennings. 1985. *Pre-1900 overharvest of California red-legged frogs (Rana aurora draytonii) in the Pescadero Marsh Natural Preserve*. Prepared for the
California Department of Parks and Recreation under contract No. 4-823-9018 with the California Academy of Sciences.


U. S. Fish and Wildlife Service. 1978. Concept plan for waterfowl wintering habitat preservation, Central Valley, California. Region 1, Portland, OR.


Foothill Yellow-Legged Frog (*Rana boylii*)

**Status**

State:  Species of Concern  
Federal:  None

**Population Trend**

Global:  Declining  
State:  Declining  
Within Inventory Area:  Unknown

**Data Characterization**

The location database for the foothill yellow-legged frog (*Rana boylii*) within its known range in California includes 288 occurrence records dated from 1958 to 2001. None was documented for the inventory area, but Jennings and Hayes (1994) show 11 occurrence records of foothill yellow-legged frog in Contra Costa County. Eight of these populations are believed to be extinct. The 3 remaining records are concentrated in the Mount Diablo region.

A moderate amount of literature is available for the foothill yellow-legged frog because of its local availability for study and the recent trend in global decline in amphibians. Most of the literature pertains to habitat requirements, population trends, ecological relationships, threats, and conservation efforts.

**Range**

Historically, foothill yellow-legged frogs occurred from west of the crest of the Cascade Mountains in Oregon south to the Transverse Ranges in Los Angeles County, and in the Sierra Nevada foothills south to Kern County (Zweifel 1955; Stebbins 1985). An isolated population was reported in Sierra San Pedro Martir, Baja Mexico (Loomis 1965). The current range excludes coastal areas south of northern San Luis Obispo County and foothill areas south of Fresno County where the species is apparently extirpated (Jennings and Hayes 1994). Its known elevation range extends from near sea level to approximately 2,040 meters above sea level (Stebbins 1985).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Foothill yellow-legged frogs occur in numerous perennial streams throughout the inventory area. As described above, there 11 documented occurrence records of foothill yellow-legged frog in Contra Costa County—8 believed to be extinct and 3 concentrated in the Mount Diablo region.
Biology

Habitat

Foothill yellow-legged frogs require shallow, flowing water in small to moderate-sized streams with at least some cobble-sized substrate (Hayes and Jennings 1988, Jennings 1988). This habitat is believed to favor oviposition (Storer 1925, Fitch 1936, Zweifel 1955) and refuge habitat for larvae and postmetamorphs (Hayes and Jennings 1988, Jennings 1988). This species has been found in streams without cobble (Fitch 1938, Zweifel 1955), but it is not clear whether these habitats are regularly used (Hayes and Jennings 1988, Jennings and Hayes 1994). Foothill yellow-legged frogs are usually absent from habitats where introduced aquatic predators, such as various fishes and bullfrogs, are present (Hayes and Jennings 1986, 1988; Kupferberg 1994). The species deposits its egg masses on the downstream side of cobbles and boulders over which a relatively thin, gentle flow of water exists (Storer 1925, Fitch 1936, Zweifel 1955). The timing of oviposition typically follows the period of high flow discharge from winter rainfall and snowmelt (Jennings and Hayes 1994). The embryos have a critical thermal maximum temperature of 26°C (Zweifel 1955).

Foraging Requirements

Adult foothill yellow-legged frogs feed primarily on both aquatic and terrestrial insects (Fitch 1936); tadpoles preferentially graze on algae (Jennings and Hayes 1994). Postmetamorphs eat aquatic and terrestrial insects (Storer 1925, Fitch 1936).

Reproduction

Foothill yellow-legged frogs in California generally breed between March and early June (Storer 1925, Grinnell et al. 1930, Wright and Wright 1949, Jennings and Hayes 1994). Masses of eggs are deposited on the downstream side of cobbles and boulders. After oviposition, a minimum of approximately 15 weeks is required to reach metamorphosis, which typically occurs between July and September (Storer 1925, Jennings 1988). Larvae attain adult size in 2 years (Storer 1925).

Demography

Masses of 300 to 1,200 eggs are deposited during oviposition by each breeding female. Juvenile and adult survivorship is unknown. Adult longevity is unknown.
Amphibians

Species Accounts

♦ Foothill Yellow-Legged Frog (*Rana boylii*)

Ecological Relationships

Garter snakes are considered one of the most prominent predators of foothill yellow-legged frog tadpoles (Fitch 1941, Zweifel 1955, Lind 1990, Jennings and Hayes 1994). Salamanders, including the rough-skinned newt (*Taricha tarosa*), are believed to prey on the species’ eggs.

Threats

Habitat loss and degradation, introduction of exotic predators, and toxic chemicals (including pesticides) pose continued and increasing threats to the long-term viability amphibians throughout California (Jennings and Hayes 1994). In addition, poorly timed water releases from upstream reservoirs can scour egg masses of this species from their oviposition substrates (Jennings and Hayes 1994), and decreased flows can force adult frogs to move into permanent pools, where they may be more susceptible to predation (Hayes and Jennings 1988).

Conservation and Management

The principal conservation measures necessary for maintaining viable populations of this species include habitat preservation, restoration, and management to retain ecological conditions necessary for survival and population growth. However, information on the range of ecological conditions that can be tolerated by this species is limited. Studies on the habitat requirements of the foothill yellow-legged frog larvae and early postmetamorphic states are urgently needed (Jennings and Hayes 1994). An understanding of the variation in flow and shear conditions that egg masses and larvae will tolerate is needed, as well as a more precise understanding of the critical thermal maxima of the embryonic stages (Jennings and Hayes 1994). In managed streams, Jennings and Hayes (1994) recommend avoiding water releases that create excess flow and shear conditions when egg masses and the more-fragile younger larval stages are present.
Amphibians

Foothill Yellow-Legged Frog (*Rana boylii*)

Modeled Species Distribution

Model Description

Model Assumptions
Core Habitat: Perennial streams in riparian woodland/scrub, grassland, oak savanna, and oak woodland land cover types.

Low-use habitat: Other streams in riparian woodland/scrub, grassland, oak savanna, and oak woodland land cover types.

Rationale
Foothill yellow-legged frogs are stream-dwelling amphibians that require shallow, flowing water in small to moderate-sized perennial streams with at least some cobble-sized substrate (Hayes and Jennings 1988, Jennings 1988). This species has also been found in perennial streams without cobble (Fitch 1938, Zweifel 1955), but it is not clear whether these habitats are regularly used (Hayes and Jennings 1988, Jennings and Hayes 1994).

Model Results

Figure 2 shows the modeled potential habitat of the foothill yellow-legged frog within the inventory area. Suitable breeding habitat appears to be present in six distinct areas in the inventory area that maintain perennial stream flows and pass through suitable land-cover types:

- Upper Marsh Creek upstream of Round Valley Regional Park and the Los Vaqueros Watershed;
- A small section of lower Marsh Creek below Marsh Creek Reservoir;
- Kellogg Creek downstream of the Los Vaqueros Dam;
- Lower Sand Creek just before it becomes a constructed early channel;
- Tributaries to Mount Diablo Creek in Clayton: Mitchell Creek, Donner Creek, and an unnamed tributary; and
- Lower Kirker Creek in Pittsburg.

The small section of lower Marsh Creek is likely perennial due to agricultural runoff and may not provide suitable habitat for foothill yellow-legged frog. Kellogg Creek has become perennial below the Los Vaqueros Dam since the construction of Los Vaqueros Reservoir; future releases below the dam are uncertain. It is unlikely that lower Kirker Creek provides suitable breeding habitat for foothill yellow-legged frog because the reach is surrounded by dense urban development. Thus, the only stable and naturally-occurring potential habitat for the species occurs in upper Marsh Creek, lower Sand Creek, tributaries to Mount Diablo Creek in Clayton. Most other stream reaches above
the urban and agricultural lowlands are shown as potential low use habitat. There are no documented occurrences of foothill yellow-legged frogs in the inventory area but the species is expected to occur in suitable habitat.

**Literature Cited**


Lind, A. J. 1990. Ontogenetic changes in the foraging behavior, habitat use and food habits of the western aquatic garter snakes, *thamnophis couchii*, at Hurdygurdy Creek, Del Norte County, California. MA thesis, Humboldt State University, Arcata, CA.


Longhorn Fairy Shrimp (*Branchinecta longiantenna*)

**Status**

- **State:** Meets the requirements as a “rare, threatened, or endangered species” under CEQA
- **Federal:** Endangered

**Population Trend**

- **Global:** Declining due to habitat loss and fragmentation (Eriksen and Belk 1999)
- **State:** As above
- **Within Inventory Area:** Unknown

**Data Characterization**

The location database for the longhorn fairy shrimp (*Branchinecta longiantenna*) within the inventory area includes 2 records from 1982 and 1990 near the Los Vaqueros Reservoir (Eng et. al. 1990, California Natural Diversity Database 2001). These 2 locations are shallow sandstone rock outcrop vernal pools within non-native grassland. Other natural and artificial habitats have a high probability of being occupied by additional populations of the longhorn fairy shrimp throughout the grassland habitats within the ECCC HCP/NCCP inventory area.

In addition to the original description (Eng et. al. 1990), Eriksen and Belk (1999) presented a brief discussion of the longhorn fairy shrimp and provided a distribution map. Hill and Shepard (1997) produced a scanning electron micrograph of the cyst (resting egg), and Helm (1997) provided some generalized natural history data. No other peer-reviewed technical literature has been published concerning the longhorn fairy shrimp.

**Range**

Only 8 populations of the longhorn fairy shrimp are known (U.S. Fish and Wildlife Service 1996). The distribution of the longhorn fairy shrimp is limited to rock outcrop pools in the central Coast Ranges of Contra Costa and Alameda Counties, alkaline pools in San Luis Obispo County, and grassy-bottomed pools in Madera County (Eng et al.1990, Eriksen and Belk 1999, Jones & Stokes file information).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Two records for this species exist in the ECCC HCP/NCCP inventory area: the Souza Ranch (type locality), and a rock outcrop in Vasco Caves Regional Preserve. The paucity of data points within the inventory area may be due to a lack of survey effort. Critical habitat has been designated for the species in Vasco Caves Regional Preserve (U.S. Fish and Wildlife Service 2003).
Biology

Habitat

Typical habitat for special-status fairy shrimp in California include vernal pools, seasonally ponded areas within vernal swales, ephemeral pools in rock outcrops, playas, and alkali flats (Eng et al. 1990). Other kinds of depressions that hold water of a similar volume, depth, and area, and for a similar duration and seasonality as vernal pools and ponded areas within swales also may be potential habitat. These other depressions—typically artificial habitats and partially or completely unvegetated—may be suitable for this species. Examples of artificial habitats that may be suitable for this species are railroad toe-drains, roadside ditches, abandoned agricultural drains, ruts left by heavy construction vehicles, and depressions in firebreaks (Eng et al. 1990).

Longhorn fairy shrimp in Contra Costa and Alameda Counties are primarily reported from water pooled in sandstone depressions. Vernal pools in other parts of California that support these fairy shrimp are either alkaline pools or grass bottomed, with clear to tea-colored water (U.S. Fish and Wildlife Service 1994). The seasonal pool habitat is subject to seasonal variations, and longhorn fairy shrimp are dependent on the ecological characteristics of such variations. These characteristics include duration of inundation and presence or absence of water at specific times of the year (U.S. Fish and Wildlife Service 1994). The longhorn fairy shrimp is capable of living in vernal pools of relatively short duration (pond 6 to 7 weeks in winter and 3 weeks in spring) (Eriksen and Belk 1999).

Feeding

Longhorn fairy shrimp are omnivorous filter-feeders. Fairy shrimp indiscriminately filter particles from the surrounding water, including bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do some other crustacean groups (Eriksen and Belk 1999).

Ecology

Longhorn fairy shrimp are a component of the planktonic crustacea within seasonal temporary pools and can occur in densities as high as 200 per liter of water. Planktonic crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard, Green-winged Teal, Greater Yellowlegs, and Killdeer all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months.

Predator consumption of fairy shrimp cysts (resting eggs) aids in distributing populations of fairy shrimp. Predators expel viable cysts in their excrement,
Invertebrates

Longhorn Fairy Shrimp (*Branchinecta longiantenna*)

Often at locations other than where they were consumed (e.g., Wissinger et al. 1999). If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts can also be transported in mud carried on the feet of animals, including livestock, that may wade through their habitat (Rogers, unpublished data).

Beyond inundation of the habitat, the specific cues for hatching are unknown (Eriksen and Belk 1999), although temperature is believed to play a large role. Typically, midvalley fairy shrimp mature in about 16 days when water temperatures reach at least 20 degrees Celsius (Eriksen and Belk 1999). Longhorn fairy shrimp have been reported to co-occur with the vernal pool fairy shrimp (*Branchinecta lynchi*).

**Threats**

Longhorn fairy shrimp are threatened by the same activities as other vernal pool invertebrates. These threats include the conversion of vernal pool habitat to agricultural lands and urban development, and extinction because of the small and isolated nature of remaining populations (U.S. Fish and Wildlife Service 1994). The limited and disjunct distribution of vernal pools, coupled with the even more limited distribution of the longhorn fairy shrimp, means that any reduction in vernal pool habitat could adversely affect this species.

Habitat fragmentation can isolate and reduce population size, resulting in a process of progressive population extinction. Small or isolated populations are more susceptible to extinction from random environmental disturbance. Recolonization opportunities are also diminished when physical barriers, such as development or lack of vernal pool habitat, isolate populations from one another or inhibit transport of cysts. Isolated populations are potentially more susceptible to inbreeding depression, which can result in local extinction or reduced fitness (Gilpin and Soule 1986, Goodman 1987a, 1987b). However, this has never been demonstrated for branchiopod crustaceans.

Activities that alter the suitability of habitat may impact the special-status crustaceans dependent on these habitats. These activities include damaging the impermeable clay and/or hardpan layers of the habitat bottom, filling in the habitat, altering (e.g., through contaminants) or destroying the watershed that conveys overland flow into the habitat. Additionally, introduction of non-native plants, destruction or degradation of the surrounding upland habitat, introduction of fish (such as *Gambusia* spp.) into special-status shrimp habitats, and activities that would discourage or prevent waterfowl and waders from feeding at occupied habitats and thereby restrict gene-flow between populations would also significantly affect longhorn fairy shrimp populations.

**Conservation and Management**

Because comprehensive surveys for the longhorn fairy shrimp in the ECCC HCP/NCCP inventory area have not been conducted and known occurrences
Invertebrates

Longhorn Fairy Shrimp (*Branchinecta longiantenna*)

throughout the species range are based mostly on incidental observations (e.g., CNDDB), the population size and locations of this species in the ECCC HCP/NCCP inventory area are not known. Also, suitable habitat for the longhorn fairy shrimp in the ECCC HCP/NCCP inventory area was identified based on a general classification of land-cover types. Field evaluation of the habitat classification has not been conducted, and the extent to which vernal pools in the inventory area meet the habitat requirements of longhorn fairy shrimp is unknown. Also, the importance of artificial habitats that may support longhorn fairy shrimp in the ECCC HCP/NCCP inventory area has not been evaluated.

However, the dependency of this species on vernal pool habitats provides some useful information on the types of impacts that can occur to longhorn fairy shrimp from covered activities. Based on its restricted distribution, the current USFWS conservation requirement for this species is that no take (individuals or habitat) will be allowed.

Species Distribution Model

No species distribution model could be developed for the longhorn fairy shrimp because suitable microhabitats (sandstone vernal pools) occur at too small a scale to be mapped in the inventory area.

Literature Cited


Rogers, D.C. In prep. Observations on Western North American Large Branchiopods.


U.S. Fish and Wildlife Service. April 19, 1996. Interim survey guidelines to permittees for recovery permits under Section 10(a) (1)(A) of the Endangered Species Act for the listed vernal pool brachiopods.


Invertebrates

Vernal Pool Fairy Shrimp (Branchinecta lynchi)

Status
State: Meets the requirements as a “rare, threatened, or endangered species” under CEQA
Federal: Threatened

Population Trend
Global: Declining due to habitat loss and fragmentation (Eriksen and Belk 1999)
State: As above
Within Inventory Area: Unknown

Data Characterization

The location database for the vernal pool fairy shrimp (Branchinecta lynchi) within the inventory area includes 6 records from 1993, 1997, and 1999 from within the ECCC HCP/NCCP inventory area. The majority of locations are vernal pools within non-native grassland. Other natural and artificial habitats have a high probability of being occupied by additional populations of the vernal pool fairy shrimp throughout the grassland habitats within the ECCC HCP/NCCP inventory area.

Beyond the original description (Eng et al. 1990), a scanning electron micrograph of the cyst (resting egg) (Hill and Shepard 1997), and some generalized natural history data (Helm 1997), no peer-reviewed technical literature has been published concerning the vernal pool fairy shrimp. Eriksen and Belk (1999) presented a brief discussion of the vernal pool fairy shrimp and provided a distribution map.

Range

The vernal pool fairy shrimp is found from Jackson County near Medford, Oregon, throughout the Central Valley, and west to the central Coast Ranges. Isolated southern populations occur on the Santa Rosa Plateau and near Rancho California in Riverside County (Eng et al.1990, Eriksen and Belk 1999, Jones & Stokes file information). In 1996, the U.S. Fish and Wildlife Service reported that there were 32 known populations of the vernal pool fairy shrimp, ranging from the Stillwater Plain in Shasta County through most of the length of the Central Valley to Paisley in Tulare County, and along the central Coast Range from northern Solano County to Pinnacles National Monument in San Benito County. Disjunct populations were also reported to occur in San Luis Obispo County, Santa Barbara County, and Riverside County.

Vernal pool fairy shrimp have been observed in the western portions (Central Valley region) of Tehama, Butte, Yuba, Placer, Stanislaus, Madera, Fresno, and Tulare Counties (Eriksen and Belk 1999). This species has also been observed in
Invertebrates

Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)

The eastern portions of Alameda, Yolo, and Glenn Counties (Eriksen and Belk 1999). It has been observed in Sacramento, Colusa, and Merced Counties as well.

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Six records for this species exist in the ECCC HCP/NCCP inventory area. Vernal pool fairy shrimp may also be found elsewhere throughout the inventory area in appropriate habitats. The paucity of data points within the open space areas is due to a lack of survey effort.

Existing vernal pool fairy shrimp records include numerous occupied pools on the Cowell Ranch on the northeast side of Mount Diablo, artificial pools in a railroad access road near Pittsburgh, and pools in the Byron Hot Springs area (e.g., Stromberg and Ford 2003). Critical habitat has been designated for the species in two areas in the inventory area (U.S. Fish and Wildlife Service 2003): West of the Byron Airport and within the Los Vaqueros Watershed.

**Biology**

**Habitat**

Typical habitat for special-status fairy shrimp in California include vernal pools, seasonally ponded areas within vernal swales, rock outcrop ephemeral pools, playas, and alkali flats (Eng et al. 1990). Other kinds of depressions that hold water of a similar volume, depth, and area, and for a similar duration and seasonality as vernal pools and ponded areas within swales also may be potential habitat. These other depressions, however, are typically artificial habitats and partially or completely unvegetated. Examples are railroad toe-drains, roadside ditches, abandoned agricultural drains, ruts left by heavy construction vehicles, and depressions in firebreaks (Eng et al. 1990).

Vernal pool fairy shrimp have also been found in water pooled in sandstone outcrops and in alkaline vernal pools. Vernal pools that support these fairy shrimp are often grass or mud bottomed, with clear to tea-colored water, and are often found in basalt-flow depression pools on unplowed grasslands (U.S. Fish and Wildlife Service 1994). Vernal pools are subject to seasonal variations, and vernal pool fairy shrimp are dependent on the ecological characteristics of such variations. These characteristics include duration of inundation and presence or absence of water at specific times of the year (U.S. Fish and Wildlife Service 1994). The vernal pool fairy shrimp is capable of living in Central Valley vernal pools of relatively short duration (pond 6 to 7 weeks in winter and 3 weeks in spring) (Eriksen and Belk 1999). Other factors contributing to the suitability of pools for vernal pool fairy shrimp include alkalinity, total dissolved solids (TDS), and pH (U.S. Fish and Wildlife Service 1994; Eriksen and Belk 1999). This fairy shrimp occurs in pools with alkalinity ranging from 22 to 274 ppm (parts per million), 48 to 481 ppm TDS, and a pH range from 6.3 to 8.5 (Eriksen and Belk
Invertebrates

Vernal Pool Fairy Shrimp (Branchinecta lynchi)

1999). U.S. Fish and Wildlife Service (1994) described the water in pools occupied by vernal pool fairy shrimp as having low conductivity and chloride, though specific numbers were not given. Vernal pool fairy shrimp have been found in pools ranging from 0.1 acre to 0.05 acre (Eriksen and Belk 1999). However, Platenkamp (1998) found that at Beale Air Force Base in Yuba County vernal pool fairy shrimp occurred more frequently in small, deep pools. Specific descriptions of the size and depth of occupied vernal pools were not reported in this paper.

Feeding

Vernal pool fairy shrimp are omnivorous filter-feeders. Fairy shrimp indiscriminately filter particles from the surrounding water, including bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). The precise size of items these fairy shrimp are capable of filtering is currently unknown. However, fairy shrimp will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based upon taste, as do some other crustacean groups (Eriksen and Belk 1999). Vernal pool fairy shrimp will also rasp periphyton from sticks, stems, and slender leaves (Rogers in prep.).

Ecology

Vernal pool fairy shrimp are a component of the planktonic crustacea within seasonal temporary pools and can occur in densities as high as 200 per liter of water. Planktonic crustacea are important in the food web, as they represent a high-fat, high-protein resource for migratory waterfowl. Mallard, Green-winged Teal, Bufflehead, Greater Yellowlegs, and Killdeer all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during the winter months.

Predator consumption of fairy shrimp cysts (resting eggs) aids in distributing populations of fairy shrimp. Predators expel viable cysts in their excrement, often at locations other than where they were consumed (e.g. Wissinger et al. 1999). If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts can also be transported in mud carried on the feet of animals, including livestock, that may wade through the habitat (Rogers in prep.).

Beyond inundation of the habitat, the specific cues for hatching are unknown (Eriksen and Belk 1999), although temperature is believed to play a large role. Typically, midvalley fairy shrimp mature in about 16 days when water temperatures reach at least 20 degrees Celsius (Eriksen and Belk 1999).

Vernal pool fairy shrimp commonly co-occur with the California linderiella (Linderiella occidentalis) (Eriksen and Belk 1999). This species has also been reported co-occurring with the midvalley pool fairy shrimp (Branchinecta mesovallensis) on 3 occasions, in which the midvalley fairy shrimp was probably
washed into the vernal pool fairy shrimp habitat by abnormally high rainfall (Eriksen and Belk 1999).

**Threats**

Vernal pool fairy shrimp are threatened by the same activities as other vernal pool invertebrates. These threats include the conversion of vernal pool habitat to agricultural lands and urban development, and stochastic extinction because of the small and isolated nature of remaining populations (U.S. Fish and Wildlife Service 1994). The limited and disjunct distribution of vernal pools, coupled with the even more limited distribution of the vernal pool fairy shrimp, means that any reduction in vernal pool habitat quantity could adversely affect this species.

Habitat fragmentation can isolate and reduce population size, resulting in a process of progressive population extinction. Small or isolated populations are more susceptible to extinction from random environmental disturbance. Recolonization opportunities are also diminished when physical barriers, such as development or lack of vernal pool habitat, isolate populations from one another or inhibit transport of cysts. Isolated populations are potentially more susceptible to inbreeding depression, which can result in local extinction or reduced fitness (Gilpin and Soule 1986, Goodman 1987a, 1987b). However, this has never been demonstrated for branchiopod crustaceans.

Activities that alter the suitability of habitat may impact the special-status crustaceans dependent on these habitats. These activities include damaging the impermeable clay and/or hardpan layers of the habitat bottom, filling in the habitat, and altering (e.g. through contaminants) or destroying the watershed that conveys overland flow into the habitat. Additionally, introduction of non-native plants, destruction or degradation of the surrounding upland habitat, introduction of fish (such as *Gambusia* spp.) into special-status shrimp habitats, and activities that would discourage or prevent waterfowl and waders from feeding at occupied habitats and thereby restrict gene flow between populations would also significantly affect midvalley fairy shrimp populations.

**Conservation and Management**

The conservation of vernal pool fairy shrimp is directly tied to the conservation of suitable vernal pool habitat. However, because comprehensive surveys for the vernal pool fairy shrimp in the ECCC HCP/NCCP inventory area have not been conducted and because known occurrences throughout the species range are based mostly on incidental observations (e.g., CNDDDB), the population size and locations of this species in the ECCC HCP/NCCP inventory area are not known. Also, suitable habitat for the vernal pool fairy shrimp in the ECCC HCP/NCCP inventory area was identified based on a general classification of land cover types. Field evaluation of the habitat classification has not been conducted, and the extent to which vernal pools in the inventory area meet the habitat requirements of vernal pool fairy shrimp is unknown. Also, the importance of
artificial habitats that may support vernal pool fairy shrimp in the ECCC HCP/NCCP inventory area has not been evaluated.

**Species Distribution Model**

No species distribution model could be developed for the vernal pool fairy shrimp because vernal pools and other suitable microhabitats occur at too small a scale to be mapped in the inventory area (e.g., vernal pools are subsumed within “seasonal wetlands”).

**Literature Cited**


Rogers, D.C. In prep. Observations on Western North American Large Branchiopods.


longhorn fairy shrimp, and the vernal pool tadpole shrimp; and threatened status for the vernal pool fairy shrimp.

United States Fish and Wildlife Service. April 19, 1996. Interim survey guidelines to permittees for recovery permits under Section 10(a) (1)(A) of the Endangered Species Act for the listed vernal pool brachiopods.


Midvalley Fairy Shrimp  
(*Branchinecta mesovallensis*)

**Status**

**State:** Meets the requirements as a “rare, threatened or endangered species” under CEQA  
**Federal:** None; petitioned for endangered status (U.S. Fish and Wildlife Service 2003)

**Population Trend**

**Global:** Declining due to habitat loss and fragmentation (Center for Biological Diversity 2001, Eriksen and Belk 1999, Belk & Fugate 2000)  
**State:** As above  
**Within Inventory Area:** Unknown

**Data Characterization**

The location database for the midvalley fairy shrimp (*Branchinecta mesovallensis*) within the study area includes a single data record from 1997 near the Byron Airport and can be accurately located within the inventory area. The single location is a shallow vernal pool within nonnative grassland. Additional natural and artificial habitats have a high probability of being occupied by the midvalley fairy shrimp throughout the grassland habitats within the inventory area.

Except for the original description (Belk and Fugate 2000), a scanning electron micrograph of the cyst (resting egg) (Hill and Shepard 1997), and over-generalized natural history data (Helm 1997), no peer-reviewed technical literature has been published concerning the midvalley fairy shrimp. However, a U.S. Fish and Wildlife Service study is currently in progress, and the data from that study is available. In addition, Eriksen and Belk (1999) have presented a brief discussion of the midvalley fairy shrimp and provided a distribution map.

**Range**

Midvalley fairy shrimp is endemic to California Central Valley grassland vernal pools (Belk and Fugate 2000). Known occurrences include scattered populations from the Mather Field area of Sacramento south through Galt from Sacramento County; the Jepson Prairie, Travis Air Force Base, and Vacaville areas in Solano County; from Lodi north to the county border in San Joaquin County; the Byron Airport in Contra Costa County; the Virginia Smith Trust (Haystack Mountain) and Arena Plains National Wildlife Reserve in Merced County; 1 location in central Madera County; and 1 in northern Fresno County (Erickson and Belk 1999, Belk and Fugate 2000, Rogers in prep.).
Invertebrates

Midvalley Fairy Shrimp (*Branchinecta mesovallensis*)

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Midvalley fairy shrimp could be found throughout the inventory area in appropriate habitats. A single record for this species exists near the Byron Airport. The paucity of data points within open space areas is due to a lack of survey effort. Because this species has a brief life cycle and inhabits shallow temporary pools and artificial habitats that may only pond between 4 and 14 days, it is very likely that this species would be missed during typical U.S. Fish and Wildlife Service protocol-level surveys (U.S. Fish and Wildlife Service 1996).

**Biology**

**Habitat**

Typical habitat for special-status fairy shrimp in California includes vernal pools, seasonally ponded areas within vernal swales, rock outcrop ephemeral pools, playas, and alkali flats (Eng et al. 1990). Other kinds of depressions that hold water of a similar volume, depth, and area, and for a similar duration and seasonality to vernal pools and ponded areas within swales may also be potential habitat. These other depressions, however, are typically artificial habitats and are partially or completely unvegetated. Examples include railroad toe-drains, roadside ditches, abandoned agricultural drains, and depressions in fire breaks (Eng et al. 1990).

Midvalley fairy shrimp require seasonally ephemeral aquatic habitats that pool in winter and spring. This species most commonly occurs in small to medium grassy or clay-bottomed vernal pools, roadside ditches, and railroad toe-drains (Rogers in prep.). The midvalley fairy shrimp is adapted to habitats that are inundated for short periods and can complete its life cycle (cyst to adult with fertilized eggs) in as little as 4 days, especially under extreme circumstances, such as years with below-average rainfall (Rogers in prep.). The ability to rapidly complete its life cycle allows the midvalley fairy shrimp to use habitats that are extremely hydrologically unstable (i.e., fill and dry quickly).

Little is known about midvalley fairy shrimp habitat requirements. Typically, the midvalley fairy shrimp is found in small, shallow, “flashy” vernal pools that only pond for 4 days, but it also can also be found in artificial habitats, such as railroad toe-drains, that may be up to 20 centimeters deep and pond for 3 months (Rogers in prep.). Further study may reveal that the species occurs in a wider range of conditions and pool types.

**Feeding**

Midvalley fairy shrimp are omnivorous filter-feeders. Fairy shrimp indiscriminately filter particles from the surrounding water, including bacteria, unicellular algae, and micrometazoa (Eriksen and Belk 1999). The precise size
of items the fairy shrimp are capable of filtering is currently unknown (Eriksen and Belk 1999), but fairy shrimp will attempt to consume whatever material they can fit into their feeding groove and do not discriminate based on taste like other crustacean groups (Eriksen and Belk 1999). Midvalley fairy shrimp will also rasp periphyton from sticks, stems and slender leaves (Rogers in prep.).

Ecology

Midvalley fairy shrimp are a component of the planktonic crustacea within seasonal temporary pools and can occur in densities as high as 200 per liter of water. Planktonic crustacea are important in the food web because they represent a high-fat, high-protein resource for migratory waterfowl. Mallard, green-winged teal, bufflehead, greater yellowlegs, and killdeer all forage actively in Central Valley vernal pools on the invertebrate and amphibian fauna during winter.

Predator consumption of fairy shrimp cysts (resting eggs) aids in distributing populations of fairy shrimp. Predators expel viable cysts in their excrement, often at locations other than where they were consumed (Wissinger et al. 1999). If conditions are suitable, these transported cysts may hatch at the new location and potentially establish a new population. Cysts are also be transported in mud carried on the feet of animals, including livestock, that may wade through the habitat (Rogers in prep.).

Other than inundation of the habitat, the specific cues for hatching are unknown (Eriksen and Belk 1999), although temperature is believed to play a large role. Typically, midvalley fairy shrimp mature in about 16 days once water temperatures reach at least 20ºC (Eriksen and Belk 1999). However, midvalley fairy shrimp can hatch, mature, and produce viable cysts in 4 days under extreme circumstances (Rogers in prep.).

Midvalley fairy shrimp have been found co-occurring with the fairy shrimp Linderiella occidentalis in the Lodi and Galt areas (Rogers in prep.). This species has also been reported co-occurring with the vernal pool fairy shrimp (Branchinecta lynchi) on 3 occasions, where it was likely washed into the vernal pool fairy shrimp habitat by abnormally high rainfall (Eriksen and Belk 1999).

Threats

Midvalley fairy shrimp are threatened by the same activities as other vernal pool invertebrates. These threats include the conversion of vernal pool habitat to agricultural lands and urban development, and stochastic extinction because of the small and isolated nature of remaining populations (U.S. Fish and Wildlife Service 1994). Although only recently described, midvalley fairy shrimp has probably declined over its range as a result of agricultural, suburban, and industrial conversion of its habitat (Eriksen and Belk 1999, Belk and Fugate 2000). Because of the limited and disjunct distribution of vernal pools, coupled
with the even more limited distribution of the midvalley fairy shrimp, any reduction in vernal pool habitat quantity could adversely affect this species.

Habitat fragmentation can isolate and reduce population size, resulting in a process of progressive population extinctions. Small or isolated populations are more susceptible to extinction from random environmental disturbance. Recolonization opportunities are also diminished when physical barriers, such as development or lack of vernal pool habitat, isolate populations from one another or inhibit transport of cysts. Isolated populations are potentially more susceptible to inbreeding depression, which can result in local extinction or reduced fitness (Gilpin and Soule 1986, Goodman 1987a, 1987b), although this has never been demonstrated for branchiopod crustaceans.

Activities that alter the suitability of habitat may impact the special-status crustaceans dependent on these habitats. These activities include damaging the impermeable clay and/or hardpan layers of the habitat bottom, filling in the habitat, and altering (e.g., through contaminants) or destroying the watershed that conveys overland flow into the habitat. In addition, introducing nonnative plants, destroying or degrading the surrounding upland habitat, introducing fish (e.g., Gambusia sp.) into special-status shrimp habitats, and activities that would discourage or prevent waterfowl and waders from feeding at occupied habitats (thereby restricting gene-flow between populations), would also significantly affect midvalley fairy shrimp populations.

Conservation and Management

Conservation of the midvalley fairy shrimp is directly tied to conservation of suitable vernal pool habitat. However, because comprehensive surveys for the midvalley fairy shrimp in the inventory area have not been conducted and because known occurrences throughout the species range are based mostly on incidental observations (e.g., the California Natural Diversity Database), the population size and locations of this species in the inventory area are not known. Also, suitable habitat for the midvalley fairy shrimp in the inventory area was identified based on a general classification of land cover types. Field evaluation of the habitat classification has not been conducted, and the extent to which vernal pools in the study area meet the habitat requirements of midvalley fairy shrimp is unknown. Further, the importance of artificial habitats that may support midvalley fairy shrimp in the inventory area has not been evaluated. However, the primary data gap concerning suitable habitat for the midvalley fairy shrimp is the lack of understanding of what defines suitable habitat.

The rapid life cycle of this species (as little as 4 days) can also result in a lack of detections even while conducting protocol surveys. The U.S. Fish and Wildlife Service (1996) protocol special-status shrimp survey guidelines require that surveys are conducted in 2-week intervals, from initial inundation of the habitat in winter to its subsequent drying in spring. Therefore, standard special-status shrimp surveys according to the required protocols may not detect populations of the midvalley fairy shrimp during years with reduced rainfall.
Species Distribution Model

No species distribution model could be developed for the midvalley fairy shrimp because vernal pools and other suitable microhabitats occur at too small a scale to be mapped in the inventory area (e.g., vernal pools are subsumed within “seasonal wetlands”).

Literature Cited


Center for Biological Diversity. 2001. Petition to list the midvalley fairy shrimp as an endangered species under the Endangered Species Act with concurrent designation of critical habitat. Center for Biological Diversity, Berkeley, CA.


Midvalley Fairy Shrimp (Branchinecta mesovallensis)


———. 1996. Interim survey guidelines to permittees for recovery permits under Section 10(a) (1)(A) of the Endangered Species Act for the listed vernal pool brachiopods. April 19, 1996.


Mount Diablo Manzanita (*Arctostaphylos auriculata*)

**Status**

- **Federal:** None
- **State:** None
- **CNPS:** List 1B

**Population Trend**

- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Unknown

**Data Characterization**

The location database for Mount Diablo manzanita (*Arctostaphylos auriculata*) includes 19 data records dated from 1889 to 1995 (California Natural Diversity Database 2001). Only 1 occurrence was documented in the last 10 years, but all occurrences except 1 are believed to be extant (California Natural Diversity Database 2001). Fifteen of the occurrences are of high precision and may be accurately located within the inventory area.

Very little ecological information on Mount Diablo manzanita is available. The literature on the species pertains primarily to its taxonomy. The main sources of general information are the *Jepson Manual* (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001).

**Range**

Mount Diablo manzanita is endemic to Contra Costa County, where it occurs only on Mount Diablo and in the adjacent foothills. It is found between 700 and 1,860 feet above sea level.

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Fourteen occurrences of Mount Diablo manzanita are known within the inventory area (12 of these have locational data). Ten of these occurrences are in Mount Diablo State Park, on East Bay Regional Park District lands, or on other public lands.
Mount Diablo Manzanita (Arctostaphylos auriculata)

**Biology**

**Physical Description**

Mount Diablo manzanita is an evergreen, perennial shrub, generally between 1 and 4.5 meters tall (Hickman 1993). Its blooming period is from January to March (California Native Plant Society 2001).

**Habitat**

Mount Diablo manzanita occurs primarily in chamise or manzanita chaparral. It can also be found as an understory shrub in coast live oak woodland (California Natural Diversity Database 2001).

<table>
<thead>
<tr>
<th>Species Associated with Mount Diablo Manzanita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenostoma fasciculata</td>
</tr>
<tr>
<td>Arctostaphylos glandulosa</td>
</tr>
<tr>
<td>Arctostaphylos manzanita</td>
</tr>
<tr>
<td>Artemisia californica</td>
</tr>
<tr>
<td>Baccharis pilularis</td>
</tr>
<tr>
<td>Ceanothus cuneatus</td>
</tr>
<tr>
<td>Ceanothus linearifolia</td>
</tr>
<tr>
<td>Ceanothus californica</td>
</tr>
<tr>
<td>Eriogonum nudum</td>
</tr>
<tr>
<td>Galium porrigens</td>
</tr>
<tr>
<td>Helianthella castanea</td>
</tr>
<tr>
<td>Heteromeles arbutifolia</td>
</tr>
<tr>
<td>Mimulus aurantiacus</td>
</tr>
<tr>
<td>Pickeringia montana</td>
</tr>
<tr>
<td>Pinus attenuata</td>
</tr>
<tr>
<td>Pinus coulteri</td>
</tr>
<tr>
<td>Pinus sabiniana</td>
</tr>
<tr>
<td>Quercus agrifolia</td>
</tr>
<tr>
<td>Quercus chrysolepis</td>
</tr>
<tr>
<td>Quercus durata</td>
</tr>
<tr>
<td>Rhus trilobata</td>
</tr>
<tr>
<td>Salvia mellifera</td>
</tr>
<tr>
<td>Zigadenus fremontii</td>
</tr>
</tbody>
</table>
Threats

Mount Diablo manzanita is restricted to a few occurrences in a limited area, but it does not appear to be endangered (California Native Plant Society 2001). Potential threats to Mount Diablo manzanita include direct loss of plants and disturbance that could alter the stand composition. Direct loss of plants could occur from clearing for firebreaks, trail maintenance, road maintenance, and facilities development (California Natural Diversity Database 2001). Activities such as grazing, off-road vehicle use, and dumping cause disturbances that could alter the interaction between chaparral and the adjacent plant communities or allow invasion by exotic species.

Conservation and Management

The long-term maintenance of Mount Diablo manzanita stands will likely depend on fire management practices in the area in which the stands occur. Periodic fires have had a major role in shaping the structure and composition of chaparral stands. Stands are affected by fire intensity and frequency, and by the response to fire by individual plant species. Mount Diablo manzanita does not resprout after fire (Jepson 1922); instead, stands regenerate by recruiting new individuals from seed. In older stands, much of the aboveground biomass consists of dead stems and litter from fallen leaves and twigs. Fire is necessary to allow the establishment of new plants from seeds by removing the overtopping vegetation; it may also stimulate seed germination. Prescription fire plans may need to be created that include conservation measures for Mount Diablo manzanita, such as let-burn areas, controlled burns, and fire intervals.

Species Distribution Model

Model Assumptions

Suitable Habitat: Chaparral/scrub between 700 and 1,860 feet in elevation.

Rationale

Mount Diablo manzanita is endemic to Contra Costa County, where it occurs only on Mount Diablo and in the adjacent foothills. It is found in chaparral/scrub land cover areas between 700 and 1,860 feet above sea level.

Model Results

Figure 2 shows the modeled Mount Diablo manzanita habitat within the ECCC HCP/NCCP inventory area. The habitat is restricted to the eastern and northern flanks of Mt. Diablo. Most of the 12 documented occurrences of this species are consistent with the predicted suitable habitat in the model. One occurrence in
northern Antioch is historical and may have been a misidentification. Four occurrences occur outside of the modeled suitable habitat. Two occurrences fall within patches of chaparral or scrub smaller than the minimum mapping unit of 10 acres (one was mapped as oak woodland, the other as grassland). The other two occurrences are within grassland with no shrubs or trees visible on the aerial photos. These records may be imprecisely located; the actual site may be within up to a mile of the record location.

**Literature Cited**


California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2 (September 5, 2001 update). California Department of Fish and Game, Sacramento, CA.


Brittlescale (Atriplex depressa)

Status

Federal: None
State: None
CNPS: List 1B

Population Trend

Global: Unknown
State: Unknown
Within Inventory Area: Unknown

Data Characterization

The California Natural Diversity Database (2001) reports 57 occurrences of brittlescale (Atriplex depressa), but only 40 of the occurrences are brittlescale populations; 17 of the reported occurrences in central and southern San Joaquin Valley are based on misidentifications of lesser salt scale (Atriplex minuscula) populations (Preston pers. comm.). The records are dated from 1920 to 1996. Twenty-four of the occurrences were documented within the last 10 years. All of the occurrences are believed to be extant (California Natural Diversity Database 2001). Eight of the occurrences are within the inventory area. The occurrences were mapped with high precision and may be accurately located, including those within the inventory area.

Very little information is available on the ecology of brittlescale. The literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the Jepson Manual (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001) and in Jones & Stokes file records.

Range

Brittlescale occurs along the western side of the Great Valley from Glenn County to Merced County and in the small valleys of the inner Coast Ranges, including the Livermore Valley. It occurs in the broad flood basins of the valley floor and on alluvial fans associated with the major streams draining from the inner Coast Range foothills. It is generally found at low elevations but has been collected up to 1,055 feet above sea level.

Occurrences within the ECCC HCP/NCCP Inventory Area

Nine occurrences of brittlescale are present in the inventory area (California Natural Diversity Database 2001; Mundie & Associates and City of Antioch 2002). Four occurrences are on Contra Costa Water District lands at Los
Plants

Brittlescale (Atriplex depressa)

Vaqueros Reservoir or other public lands. One occurrence is on private lands near Antioch; all others are on private lands south and west of Byron.

Biology

Physical Description

Brittlescale is a diminutive annual herb that generally grows prostrate and rarely exceeds 20 centimeters in height (Hickman 1993).

Habitat

Brittlescale occurs on alkali soils of the Pescadero and Solano series. Brittlescale typically occurs in barren areas within alkali grassland, alkali meadow, and alkali scrub. It is occasionally found on the margins of alkali vernal pools.

Species Associated with Brittlescale

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atriplex cordulata</td>
<td>heartscale</td>
</tr>
<tr>
<td>Atriplex coronata</td>
<td>crownscale</td>
</tr>
<tr>
<td>Atriplex fruticulosa</td>
<td>ball saltscale</td>
</tr>
<tr>
<td>Atriplex joaquiniana</td>
<td>San Joaquin spearscale</td>
</tr>
<tr>
<td>Centromadia pungens</td>
<td>common spikeweed</td>
</tr>
<tr>
<td>Distichlis spicata</td>
<td>saltgrass</td>
</tr>
<tr>
<td>Frankenia salina</td>
<td>alkali heath</td>
</tr>
<tr>
<td>Hordeum depressum</td>
<td>low barley</td>
</tr>
<tr>
<td>Hordeum marum ssp. gussaneanum</td>
<td>Mediterranean barley</td>
</tr>
<tr>
<td>Nitrophila occidentalis</td>
<td>western niterwort</td>
</tr>
<tr>
<td>Salicornia subterminalis</td>
<td>Parish's pickleweed</td>
</tr>
<tr>
<td>Spergularia macrotheca</td>
<td>large-flowered sand-spurry</td>
</tr>
<tr>
<td>Suaeda moquinii</td>
<td>bush seepweed</td>
</tr>
</tbody>
</table>

Threats

Brittlescale is known from only a limited number of occurrences and is endangered in a portion of its range (California Native Plant Society 2001). Population trends are unknown (California Natural Diversity Database 2001), but are likely stable or declining. The principal threat to brittlescale has been the historic conversion of much of the alkali grassland to agriculture. Present threats include flooding of alkali grassland to create waterfowl habitat, grazing, and

**Conservation and Management**

Areas with alkali soils are prepared for agriculture by treating the soils with gypsum or other substances that allow sodium salts to be leached from the soil by irrigation. This practice alters the soil chemistry, making restoration of former brittlescale habitat impractical.

**Species Distribution Model**

**Model Assumptions**

Suitable Habitat: All alkali grasslands and alkali wetlands on soils of the Pescadero or Solano soil series (Soil Conservation Service 1977).

**Rationale**

Brittlescale occurs on alkali soils of the Pescadero and Solano series. Brittlescale typically occurs in barren areas within alkali grassland, alkali meadow, and alkali scrub. It is occasionally found on the margins of alkali vernal pools. It occurs in the broad flood basins of the Central Valley floor and on alluvial fans associated with the major streams draining from the inner Coast Range foothills. It is generally found at low elevations but has been collected up to 1,055 feet above sea level.

**Model Results**

Figure 2 shows the modeled brittlescale habitat within the ECCC HCP/NCCP inventory area. The habitat is restricted to alkali soils in the southeastern region of the inventory area. Some suitable habitat is found in the Los Vaqueros Watershed and on the Byron Airport conservation easements. The majority of suitable habitat is found on private lands. The documented occurrences of this species are mostly consistent with the predicted suitable habitat in the model. Two occurrences fall outside modeled habitat and may occur on patches of alkaline soil not mapped by the Soil Conservation Service.

**Literature Cited**

Plants

Brittlescale (*Atriplex depressa*)

California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2
(September 5, 2001 update). California Department of Fish and Game,
Sacramento, CA.

Berkeley, CA.

report*. Sand Creek specific plan and four associated development plans,
Antioch, California. August. State Clearinghouse No. 2001122004.

Soil Conservation Service. 1977. Soil survey of Contra Costa County,
California. Concord, CA.

**Personal Communications**

Preston, R. E. Botanist, Jones & Stokes. May 2001—visit to the University of
California and Jepson Herbaria to examine *Atriplex* specimens.
San Joaquin Spearscale (*Atriplex joaquiniana*)

### Status

**Federal:** None  
**State:** None  
**CNPS:** List 1B

### Population Trend

**Global:** Unknown  
**State:** Unknown  
**Within Inventory Area:** Unknown

### Data Characterization

The location database for San Joaquin spearscale (*Atriplex joaquiniana*) includes 50 data records dated from 1891 to 1996 (California Natural Diversity Database 2001). All of the occurrences are presumed to be extant, but 5 occurrences are historic and have not been surveyed to determine whether the populations are still present. Most of the occurrences are of high precision and may be accurately located, including those in the inventory area.

Very little information is available on the ecology of San Joaquin spearscale. The literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the *Jepson Manual* (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001).

### Range

San Joaquin spearscale occurs along the western side of the Great Valley from Glenn County to Merced County and in the small valleys of the inner Coast Ranges, including the Livermore Valley. It occurs in the broad flood basins of the valley floor and on alluvial fans associated with the major streams draining from the inner Coast Ranges foothills. It is generally found at low elevations, but has been collected up to 1,055 feet above sea level.

### Occurrences within the ECCC HCP/NCCP Inventory Area

Thirty-two occurrences of San Joaquin spearscale are found within the inventory area (California Natural Diversity Database 2001; Jones & Stokes Associates 1989; Mundie & Associates and City of Antioch 2002). Most of the occurrences are within the Los Vaqueros Watershed. Some occurrences are on private lands in the central portion of the inventory area, including within Lone Tree Valley, Briones Valley, and the Brushy Creek watershed south of Byron.
Biology

Physical Description

San Joaquin spearscale is an annual herb between 1 and 3 feet tall (Hickman 1993). It blooms from April to October (California Native Plant Society 2001).

Habitat

San Joaquin spearscale typically occurs in alkali grassland and alkali meadow, or on the margins of alkali scrub. It occurs on clay soils, often in areas of high alkalinity.

Species Associated with San Joaquin Spearscale

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Allenrolfea occidentalis</em></td>
<td>iodine bush</td>
</tr>
<tr>
<td><em>Atriplex coronata</em></td>
<td>crownscale</td>
</tr>
<tr>
<td><em>Atriplex depressa</em></td>
<td>brittlescale</td>
</tr>
<tr>
<td><em>Centromadia pungens</em></td>
<td>common spikeweed</td>
</tr>
<tr>
<td><em>Cordylanthus palmatus</em></td>
<td>palmate bird’s-beak</td>
</tr>
<tr>
<td><em>Distichlis spicata</em></td>
<td>saltgrass</td>
</tr>
<tr>
<td><em>Frankenia salina</em></td>
<td>alkali heath</td>
</tr>
<tr>
<td><em>Hordeum depressum</em></td>
<td>low barley</td>
</tr>
<tr>
<td><em>Hordeum marinum ssp. gussoneanum</em></td>
<td>Mediterranean barley</td>
</tr>
<tr>
<td><em>Lolium multiflorum</em></td>
<td>Italian ryegrass</td>
</tr>
<tr>
<td><em>Nitrophila occidentalis</em></td>
<td>western niterwort</td>
</tr>
<tr>
<td><em>Salicornia subterminalis</em></td>
<td>Parish’s pickleweed</td>
</tr>
<tr>
<td><em>Spergularia macrotheca</em></td>
<td>large-flowered sand-spurry</td>
</tr>
<tr>
<td><em>Suaeda moquinii</em></td>
<td>bush seepweed</td>
</tr>
</tbody>
</table>

Threats

San Joaquin spearscale is known from only a limited number of occurrences and is endangered in a portion of its range (California Native Plant Society 2001). Population trends are unknown (California Natural Diversity Database 2001), but are likely stable or declining. The principal threat to San Joaquin spearscale has been the historic conversion of much of the alkali grassland to agriculture. Present threats include habitat conversion to urban use, overgrazing, and impacts associated with road and utility line construction and maintenance (California Natural Diversity Database 2001).
Conservation and Management

Areas with alkali soils are prepared for agriculture by treating the soils with gypsum or other substances that allow sodium salts to be leached from the soil by irrigation. This practice alters the soil chemistry, making restoration of former San Joaquin saltscale habitat impractical.

This species is being closely monitored at five locations in the Los Vaqueros Watershed every other year (Bainbridge 1999, 2000). Plant density, cover, fruit production, and seed production are assessed each survey period in order to determine the potential effects of livestock grazing and other factors on this species.

Species Distribution Model

A species distribution model was developed that had the same assumptions as the model developed for brittlescale (all alkali grasslands and alkali wetlands on soils of the Pescadero or Solano soil series [Soil Conservation Service 1977]). Many occurrences, however, fell outside of the modeled habitat. Comparison with detailed mapping of San Joaquin spearscale populations in the Los Vaqueros Watershed (Jones & Stokes Associates 1989) showed that this species is not restricted to soils of the Solano and Pescadero soil series. Other soil series on which the species was found were too widespread to provide a useful prediction of the species’ distribution in the inventory area. Therefore, the original species model was discarded.

Literature Cited


California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2 (September 5, 2001 update). California Department of Fish and Game, Sacramento, CA.
San Joaquin Spearscale (*Atriplex joaquiniana*)


Big Tarplant (*Blepharizonia plumosa*)

**Status**

- **Federal:** None
- **State:** None
- **CNPS:** List 1B

**Population Trend**

- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Unknown

**Data Characterization**

The location database for big tarplant includes 36 data records dated from 1916 to 1998 (California Natural Diversity Database 2001). Twenty-nine of the occurrences were documented within the last 10 years. Seven of the occurrences have not been observed for over 60 years, but all the other occurrences are believed to be extant (California Natural Diversity Database 2001). Most of the occurrences are of high precision and may be accurately located, including those within the inventory area.

Very little ecological information is available for big tarplant. The published literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the Jepson Manual (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001).

**Range**

Big tarplant is endemic to the Mount Diablo foothills and is found primarily in eastern Contra Costa, eastern Alameda, and western San Joaquin Counties (Hoover 1937).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

In the inventory area, big tarplant is known from 4 occurrences on Cowell Ranch, west of Brentwood, and 7 occurrences on Roddy Ranch, south of Antioch (California Natural Diversity Database 2001). The historic occurrences in Antioch are likely to have been extirpated, although at least 1 population is present at Black Diamond Mines Regional Park (Preston pers. comm.). Big tarplant may also be present in the hills south of Pittsburg, where it was collected in 1937 and last seen in 1992 (Preston pers. comm.).
Biology

Physical Description

Big tarplant is an herbaceous annual that grows to between 1 and 3 feet tall. Seedlings appear in early spring, but the plants do not begin to bloom until mid-summer. The blooming period, during which the plants produce many heads with white flowers, generally occurs between August and October.

Two species of big tarplant are present in the inventory area: big tarplant and viscid big tarplant (*Blepharizonia laxa*). Viscid big tarplant is the more widely distributed species, ranging throughout most of the south Coast Ranges and reaching its northern limit in Contra Costa County. The two species, which often occur in adjacent populations, can be differentiated by their branching patterns, the amount and color of the simple and glandular hairs on the stems and leaves, the chemical compounds produced by the glands, and by genetic markers (Hickman 1993, Baldwin et al. 2001, Preston pers. comm.). The two species can hybridize, but the hybrids are infertile (Baldwin et al. 2001).

Habitat

Big tarplant occurs in annual grassland on clay to clay-loam soils, usually on slopes and often in burned areas, below 1,500 feet (California Natural Diversity Database 2001). In Contra Costa County, the occurrences are primarily on soils of the Altamont series.

<table>
<thead>
<tr>
<th>Species Associated with Big Tarplant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Avena species</em></td>
<td>wild oats</td>
</tr>
<tr>
<td><em>Bromus species</em></td>
<td>brome grasses</td>
</tr>
<tr>
<td><em>Epilobium brachycarpum</em></td>
<td>panicled willow-herb</td>
</tr>
<tr>
<td><em>Eriogonum angulosum</em></td>
<td>angle-stemmed wild buckwheat</td>
</tr>
<tr>
<td><em>Eriogonum gracile</em></td>
<td>slender woolly wild buckwheat</td>
</tr>
<tr>
<td><em>Grindelia camporum</em></td>
<td>Great Valley gumplant</td>
</tr>
<tr>
<td><em>Holocarpha obconica</em></td>
<td>San Joaquin tarplant</td>
</tr>
<tr>
<td><em>Holocarpha virgata</em></td>
<td>virgate tarplant</td>
</tr>
<tr>
<td><em>Lagophylla ramosissima</em></td>
<td>common hareleaf</td>
</tr>
<tr>
<td><em>Lolium multiflorum</em></td>
<td>Italian ryegrass</td>
</tr>
<tr>
<td><em>Nassella pulchra</em></td>
<td>purple needlegrass</td>
</tr>
</tbody>
</table>

Threats

Big tarplant occurs in only a few highly restricted populations and is endangered throughout its range (California Native Plant Society 2001). The primary threat
to big tarplant has been habitat loss from conversion to urban development. Ground disturbance and erosion caused by cattle grazing and competition from invasive exotics such as yellow star-thistle (*Centaurea solstitialis*) may also pose a threat to populations (California Natural Diversity Database 2001).

**Conservation and Management**

Big tarplant may require management of nonnative annual grasses for long-term population viability. Prescribed burns may be an effective method for managing grasslands in which big tarplant occurs. Such burns should be conducted under conditions that favor low-intensity fire because high plant mortality appears to result from high-intensity fires. Gregory and his colleagues (2001) found that disc seeds of big tarplant germinate at much higher frequencies than ray seeds, and advise that only disc seeds should be used in the creation of new populations.

**Species Distribution Model**

**Model Assumptions**

Primary habitat: Annual grassland below 1,500 feet on the Altamont soil series (Soil Conservation Service 1977).

Secondary habitat: all other annual grassland below 1,500 feet.

**Rationale**

Big tarplant occurs in annual grassland on clay to clay-loam soils, usually on slopes and often in burned areas, below 1,500 feet (California Natural Diversity Database 2001). In Contra Costa County, the occurrences are primarily on soils of the Altamont series (Soil Conservation Service 1977).

**Results**

Figure 2 shows the modeled big tarplant habitat within the ECCC HCP/NCCP inventory area. The distribution of known occurrences is consistent with the predicted suitable habitat of the model.

**Literature Cited**


Mount Diablo Fairy-Lantern (*Calochortus pulchellus*)

**Status**

- **Federal:** None
- **State:** None
- **CNPS:** List 1B

**Population Trend**

- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Unknown

**Data Characterization**

The location database for Mount Diablo fairy-lantern (*Calochortus pulchellus*) includes 29 data records dated from 1940 to 1996 (California Natural Diversity Database 2001). Over half of the occurrences were documented in the previous 10 years, and all of the occurrences are believed to be extant. Most of the occurrences are of high precision and may be accurately located, including those within the inventory area.

Very little information is available on the ecology of Mount Diablo fairy-lantern. The literature on the species pertains primarily to its taxonomy. The main sources of general information on the species are the *Jepson Manual* (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001).

**Range**

Mount Diablo fairy-lantern is endemic to the Diablo Range in Contra Costa County, ranging in elevation between 650 and 2,600 feet (Hickman 1993). These occurrences are mostly located on lands managed by the California Department of Parks and Recreation, East Bay Recreation and Park District, and City of Walnut Creek, with several populations occurring on privately owned land or land of unknown ownership (California Natural Diversity Database 2001).

**Occurrences within the ECC HCP/NCCP Inventory Area**

Twelve occurrences of Mount Diablo fairy-lantern are within the inventory area, 11 of which are on public lands. At least five of the occurrences are either in Mount Diablo State Park or East Bay Regional Park District lands.
Plants

Mount Diablo Fairy-Lantern (*Calochortus pulchellus*)

**Biology**

**Physical Description**

Mount Diablo fairy-lantern, a member of the lily family (Liliaceae), is a bulbiferous perennial herb that grows 10 to 30 centimeters tall (Hickman 1993). It blooms from April through June, producing bright yellow, pendant flowers.

**Population Biology**

Fiedler (1987) reported that the Mount Diablo fairy lantern has low seed survival and seedling establishment, low adult mortality and slow growth. Fiedler (1987) found two size-classes of reproductive individuals in this species.

**Habitat**

Mount Diablo fairy-lantern grows on grassy slopes and in openings in chaparral and oak woodland communities (California Natural Diversity Database 2001).

<table>
<thead>
<tr>
<th>Species Associated with Mount Diablo Fairy-Lantern</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arctostaphylos species</strong></td>
</tr>
<tr>
<td><strong>Quercus species</strong></td>
</tr>
<tr>
<td><strong>Pinus sabiniana</strong></td>
</tr>
<tr>
<td><strong>Aesculus californica</strong></td>
</tr>
<tr>
<td><strong>Toxicodendron diversiloba</strong></td>
</tr>
<tr>
<td><strong>Melica torreyana</strong></td>
</tr>
<tr>
<td><strong>Festuca californica</strong></td>
</tr>
<tr>
<td><strong>Dodecatheon species</strong></td>
</tr>
<tr>
<td><strong>Phacelia species</strong></td>
</tr>
</tbody>
</table>

**Threats**

Mount Diablo fairy-lantern is known from only a limited number of occurrences and is endangered in a portion of its range (California Native Plant Society 2001). Population trends are unknown (California Natural Diversity Database 2001), but are likely stable. Threats to Mount Diablo fairy-lantern include grazing, road and trail maintenance, excessive erosion, and collecting (California Natural Diversity Database 2001).
Conservation and Management

There are no measures being taken in the inventory area to conserve or manage populations of Mount Diablo fairy-lantern.

Species Distribution Model

Model Assumptions

Suitable Habitat: Annual grassland, chaparral/scrub, oak woodland, and oak savannah between 650 feet and 2,600 feet in elevation

Rationale

Mount Diablo fairy-lantern is endemic to the Diablo Range in Contra Costa County, ranging in elevation between 650 and 2,600 feet (Hickman 1993). Mount Diablo fairy-lantern grows on grassy slopes and in openings in chaparral and oak woodland communities (California Natural Diversity Database 2001).

Model Results

Figure 2 shows the modeled Mount Diablo fairy-lantern habitat within the ECCC HCP/NCCP inventory area. All modeled suitable occurs within the western third of the inventory area. All known occurrences with location data are within modeled suitable habitat.

Literature Cited


California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2 (September 5, 2001 update). California Department of Fish and Game, Sacramento, CA.


Recurved Larkspur (Delphinium recurvatum)

Status

- **Federal:** None
- **State:** None
- **CNPS:** List 1B

Population Trend

- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Unknown

Data Characterization

The location database for recurved larkspur (Delphinium recurvatum) includes 63 data records dated from 1902 to 1998 (California Natural Diversity Database 2001). Thirteen of the occurrences are more than 50 years old, and only 20 of the occurrences were documented in the previous 10 years, but most of the occurrences are assumed to be extant. Twenty-seven of the occurrences are of high precision and may be accurately located, including 2 of 4 located within the inventory area.

Very little ecological information is available for recurved larkspur. The literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the *Jepson Manual* (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001).

Range

Historically, recurved larkspur was widely distributed in California’s Great Valley, ranging from Butte County to Kern County. Most of the known occurrences are in Kern, Tulare, and San Luis Obispo Counties. The species now appears to be very rare outside the southern San Joaquin Valley (California Natural Diversity Database 2001).

Occurrences within the ECCC HCP/NCCP Inventory Area

Four occurrences are reported from the inventory area, 3 of which are on private land southeast of Byron.
Biology

Physical Description

Recurved larkspur is a perennial herb and a member of the buttercup family (Ranunculaceae). Recurved larkspur is distinguished from other larkspur species by its pale blue, recurved sepals (Hickman 1993). The flowering period for recurved larkspur is generally from March through May (California Native Plant Society 2001).

Habitat

Recurved larkspur occurs on sandy or clay alkaline soils, generally in annual grasslands or in association with saltbush scrub or valley sink scrub habitats, ranging in elevation from 100 to 2,000 feet above sea level (California Natural Diversity Database 2001).

Species Associated with Recurved Larkspur

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atriplex polycarpa</td>
<td>allscale</td>
</tr>
<tr>
<td>Atriplex spinifera</td>
<td>spinescale</td>
</tr>
<tr>
<td>Bromus madritensis ssp. rubens</td>
<td>red brome</td>
</tr>
<tr>
<td>Centromadia pungens</td>
<td>common spikeweed</td>
</tr>
<tr>
<td>Distichlis spicata</td>
<td>saltgrass</td>
</tr>
<tr>
<td>Erodium cicutarium</td>
<td>red filaree</td>
</tr>
<tr>
<td>Frankenia salina</td>
<td>alkali heath</td>
</tr>
<tr>
<td>Isocoma acradenia var. bracteosa</td>
<td>alkali goldenbush</td>
</tr>
<tr>
<td>Lasthenia californica</td>
<td>California goldfields</td>
</tr>
<tr>
<td>Sporobolus airoides</td>
<td>alkali sacaton</td>
</tr>
<tr>
<td>Suaeda moquinii</td>
<td>bush seepweed</td>
</tr>
</tbody>
</table>

Threats

Recurved larkspur is known from only a limited number of occurrences and is endangered in a portion of its range (California Native Plant Society 2001). Population trends are unknown (California Natural Diversity Database 2001), but are likely stable or declining. The principal threat to recurved larkspur has been the historic conversion of much of the alkali habitat of the Great Valley to agriculture. At present, the primary threat to recurved larkspur is overgrazing. Other threats include road and utility line construction and competition from invasive exotics (California Natural Diversity Database 2001).
Conservation and Management

Areas with alkali soils are prepared for agriculture by treating the soils with gypsum or other substances that allow the sodium salts to be leached from the soil by irrigation. This practice alters the soil chemistry, making restoration of former recurved larkspur habitat impractical.

Species Distribution Model

Model Assumptions

All alkali grassland within the inventory area was considered suitable habitat for recurved larkspur.

Rationale

Recurved larkspur occurs on sandy or clay alkaline soils, generally in annual grasslands or in association with saltbush scrub or valley sink scrub habitats, ranging in elevation from 100 to 2,000 feet above sea level (California Natural Diversity Data Base 2001).

Results

Figure 2 shows the modeled potential habitat of the recurved larkspur within the inventory area. Modeled suitable habitat is restricted to the alkali grassland in the southeast and central portion of the inventory area. Three of the four known occurrences fit well within the boundaries of the model. The record outside the model occurs in a patch of alkali grassland that was below the 10-acre minimum resolution of the land cover mapping.

Literature Cited


California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2 (September 5, 2001 update). California Department of Fish and Game, Sacramento, CA.

Diablo Helianthella (*Helianthella castanea*)

**Status**

- **Federal:** None
- **State:** None
- **CNPS:** List 1B

**Population Trend**

- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Unknown

**Data Characterization**

The location database for Diablo helianthella (*Helianthella castanea*) includes 71 data records dated from 1920 to 1998 (California Natural Diversity Database 2001). Forty-two of the occurrences were documented in the last 10 years, and most of the occurrences were documented in the last 20 years. All of the occurrences are believed to be extant. Most of the occurrences are of high precision and may be accurately located, including those within the inventory area.

Very little ecological information is available for Diablo helianthella. The literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the Jepson Manual (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001).

**Range**

Diablo helianthella is endemic to the San Francisco Bay Area, occurring in the Diablo Range, Berkeley Hills, and San Bruno Mountain (California Natural Diversity Database 2001).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Thirty occurrences are reported from the inventory area: 28 in Mount Diablo State Park, Los Vaqueros Watershed, East Bay Regional Park District lands; and 2 on private land.
Diablo Helianthella (Helianthella castanea)

Biology

Physical Description

Diablo helianthella is a perennial herb of the sunflower family (Asteraceae) that grows 10 to 50 centimeters tall (Hickman 1993). It blooms from April through June (California Native Plant Society 2001).

Habitat

Diablo helianthella associated with thin, rocky, well-drained soils on east-facing slopes. It is found in grassy openings in woodlands, chaparral, and coastal scrub, often at the transition zone between woodland and chaparral (California Natural Diversity Database 2003). It most often occurs at elevations below 2,400 feet but it has been collected from locations as high as 3,800 feet.

Species Associated with Diablo Helianthella

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenostoma fasciculata</td>
<td>chamise</td>
</tr>
<tr>
<td>Artemisia californica</td>
<td>California sage</td>
</tr>
<tr>
<td>Avena species</td>
<td>wild oats</td>
</tr>
<tr>
<td>Baccharis pilularis</td>
<td>coyote brush</td>
</tr>
<tr>
<td>Bromus species</td>
<td>brome grasses</td>
</tr>
<tr>
<td>Heteromeles arbutifolia</td>
<td>toyon</td>
</tr>
<tr>
<td>Mimulus aurantiacus</td>
<td>bush monkeyflower</td>
</tr>
<tr>
<td>Nassella species</td>
<td>needlegrass</td>
</tr>
<tr>
<td>Quercus agrifolia</td>
<td>coast live oak</td>
</tr>
<tr>
<td>Quercus douglasii</td>
<td>blue oak</td>
</tr>
<tr>
<td>Salvia species</td>
<td>sage</td>
</tr>
<tr>
<td>Toxicodendron diversilobum</td>
<td>poison-oak</td>
</tr>
<tr>
<td>Umbellularia californica</td>
<td>California bay</td>
</tr>
<tr>
<td>Wyethia species</td>
<td>mule-ears</td>
</tr>
</tbody>
</table>

Threats

Diablo helianthella is known from only a limited number of occurrences and is endangered in a portion of its range (California Native Plant Society 2001). Population trends are unknown (California Natural Diversity Database 2003), but are likely stable. Many of the occurrences on park lands are subject to impacts from recreation and associated activities, such as trail construction and
Plants

Diablo Helianthella (*Helianthella castanea*)

Maintenance, road maintenance, brush-clearing, and off-trail travel (California Natural Diversity Database 2003). Diablo helianthella grows in openings in chaparral and at chaparral margins; because chaparral species can invade these open areas in the absence of fire, fire suppression may lead to the loss of suitable habitat. Other threats include urban development, road and utility line construction, grazing, and competition from invasive exotics (California Natural Diversity Database 2003). Grazing and other ground-disturbing activities can also lead to erosion in habitat areas.

**Conservation and Management**

The long-term maintenance of Diablo helianthella may depend on fires that create openings in the woody overstory of scrub and woodland habitats in which the species occurs.

**Species Distribution Model**

**Model Assumptions**

Suitable Habitat = Oak savannah, oak woodland, chaparral/scrub above 650 feet.

**Rationale**

Diablo helianthella is endemic to the San Francisco Bay Area, occurring in the Diablo Range, Berkeley Hills, and San Bruno Mountain (California Natural Diversity Database 2003). Diablo helianthella is associated with thin, rocky, well-drained soils on east-facing slopes. It is found in grassy openings in woodlands, chaparral, and coastal scrub, often at the transition zone between woodland and chaparral (California Natural Diversity Database 2003).

**Model Results**

Figure 2 shows the modeled Diablo helianthella habitat within the ECCC HCP/NCCP inventory area. All records fall within modeled suitable habitat. This model likely overestimates the extent of suitable habitat for this species because the model does not limit suitable habitat to east-facing slopes.

**Literature Cited**

Diablo Helianthella (*Helianthella castanea*)


Brewer’s Dwarf Flax (*Hesperolinon breweri*)

**Status**

- **Federal:** None
- **State:** None
- **CNPS:** List 1B

**Population Trend**

- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Unknown

**Data Characterization**

The location database for Brewer’s dwarf flax (*Hesperolinon breweri*) includes 25 data records dated from 1885 to 1997 (California Natural Diversity Database 2001). Only 3 occurrences were documented in the last 10 years, but all occurrences are believed to be extant (California Natural Diversity Database 2001). Fourteen of the occurrences are of high precision and may be accurately located, including 8 occurrences within the inventory area.

Very little ecological information is available for Brewer’s dwarf flax. The literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the *Jepson Manual* (Hickman 1993) and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are summarized in the California Natural Diversity Database (2001).

**Range**

Brewer’s dwarf flax is endemic to California, where it is restricted to the Mount Diablo and adjacent foothills in the east San Francisco Bay Area and to the Vaca Mountains of the southern interior North Coast Ranges (Hickman 1993, California Natural Diversity Database 2001). It occurs below 2,900 feet above sea level.

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Thirteen occurrences of Brewer’s dwarf flax occur within the inventory area. Two of the occurrences are in Mount Diablo State Park, 3 in East Bay Regional Park District lands, and 7 within the Los Vaqueros Watershed. One occurrence in Antioch is historic; this population has been extirpated.
Biology

**Physical Description**

Brewer’s dwarf flax, a member of the flax family (Linaceae), is an annual herb that grows 5 to 20 centimeters tall (Hickman 1993). It blooms from May through July (California Native Plant Society 2001).

**Habitat**

The species grows on rocky soils on serpentine, sandstone, or volcanic substrates. It is associated with grassland, oak woodland, and chaparral communities. It typically appears in areas with low vegetative cover, such as the transition zone between grassland and chaparral or open areas in chaparral.

<table>
<thead>
<tr>
<th>Species Associated with Brewer’s Dwarf Flax</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Adenostoma fascicularis</em></td>
</tr>
<tr>
<td><em>Arctostaphylos species</em></td>
</tr>
<tr>
<td><em>Avena species</em></td>
</tr>
<tr>
<td><em>Calochortus species</em></td>
</tr>
<tr>
<td><em>Ceanothus cuneatus</em></td>
</tr>
<tr>
<td><em>Heteromeles arbutifolia</em></td>
</tr>
<tr>
<td><em>Nassella species</em></td>
</tr>
<tr>
<td><em>Navarretia pubescens</em></td>
</tr>
<tr>
<td><em>Perideridia kelloggii</em></td>
</tr>
<tr>
<td><em>Pinus sabiniana</em></td>
</tr>
<tr>
<td><em>Quercus species</em></td>
</tr>
<tr>
<td><em>Streptanthus species</em></td>
</tr>
<tr>
<td>chamise</td>
</tr>
<tr>
<td>manzanita</td>
</tr>
<tr>
<td>wild oat</td>
</tr>
<tr>
<td>fairy-lantern</td>
</tr>
<tr>
<td>buckbrush</td>
</tr>
<tr>
<td>toyon</td>
</tr>
<tr>
<td>needlegrass</td>
</tr>
<tr>
<td>downy navarretia</td>
</tr>
<tr>
<td>Kellogg's yampah</td>
</tr>
<tr>
<td>foothill pine</td>
</tr>
<tr>
<td>oak</td>
</tr>
<tr>
<td>jewelflower</td>
</tr>
</tbody>
</table>

**Threats**

Brewer’s dwarf flax is known from only a limited number of occurrences and is reported to be endangered in a portion of its range (California Native Plant Society 2001). Population trends are unknown (California Natural Diversity Database 2001), but are likely stable. Brewer’s dwarf flax generally occurs on public lands with few identifiable threats. Populations adjacent to trails may be subject to foot traffic or trail maintenance (California Natural Diversity Database 2001).
Conservation and Management

There are no known conservation or management activities occurring in the inventory area to address Brewer’s dwarf flax.

Species Distribution Model

Model Assumptions

Suitable Habitat: Oak woodland and chaparral/scrub + 500 feet buffer into annual grasslands

Rationale

Brewer’s dwarf flax occurs below 2,900 feet above sea level on rocky soils on serpentine, sandstone, or volcanic substrates. It is associated with grassland, oak woodland, and chaparral communities. It typically appears in areas with low vegetative cover, such as the transition zone between grassland and chaparral or open areas in chaparral.

Model Results

Figure 2 shows the modeled Brewer’s dwarf flax habitat within the inventory area. All known occurrences fall within modeled suitable habitat for this species (the occurrence in Antioch is assumed to be extirpated).

Literature Cited


California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2 (September 5, 2001 update). California Department of Fish and Game, Sacramento, CA.

Showy Madia (*Madia radiata*)

**Status**

- **Federal:** None
- **State:** None
- **CNPS:** List 1B

**Population Trend**

- **Global:** Unknown
- **State:** Unknown
- **Within Inventory Area:** Possibly extirpated

**Data Characterization**

The location database for showy madia (*Madia radiata*) includes 32 data records from 1930 to 1995 (California Natural Diversity Database 2001). Only 5 occurrences were documented in the previous 10 years. Except for the most recent observations, the occurrences are general and may not be accurately located.

Very little information is available for showy madia. The literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the *Jepson Manual* (Hickman 1993) and the California Native Plant Society (California Native Plant Society 2001). Specific observations on habitat and plant associates, threats, and other factors are present in the California Natural Diversity Data Base (California Natural Diversity Database 2001).

**Range**

Showy madia is known from scattered populations in the interior foothills of the South Coast Ranges found between 80 and 3,700 feet elevation (Hickman 1993; California Natural Diversity Database 2001).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Showy madia has been collected historically near Antioch and between Antioch and Lone Tree Valley (California Natural Diversity Database 2001). The last observation of this species in Contra Costa County was in 1941 (California Natural Diversity Database 2001).
Biology

Physical Description

Showy madia is an annual herb that blooms from March to May (California Native Plant Society 2001).

Habitat

Showy madia grows in grasslands and oak woodlands on heavy clay soils (California Natural Diversity Database 2001).

<table>
<thead>
<tr>
<th>Species Associated with Showy Madia</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancistrocarphus filagineus</td>
<td>woolly fishhooks</td>
</tr>
<tr>
<td>Astragalus didymocarpus</td>
<td>two-seeded milkvetch</td>
</tr>
<tr>
<td>Eremalche parryi</td>
<td>Parry’s mallow</td>
</tr>
<tr>
<td>Guillenia flavescens</td>
<td>yellow-flowered guillenia</td>
</tr>
<tr>
<td>Layia heterotricha</td>
<td>pale-yellow layia</td>
</tr>
<tr>
<td>Lupinus microcarpus</td>
<td>chick lupine</td>
</tr>
<tr>
<td>Monolopia major</td>
<td>cupped monolopia</td>
</tr>
<tr>
<td>Phacelia ciliata</td>
<td>Great Valley phacelia</td>
</tr>
<tr>
<td>Salvia columbariae</td>
<td>chia</td>
</tr>
</tbody>
</table>

Threats

General threats reported for showy madia include grazing, road maintenance, off-road vehicle traffic, and competition from non-native invasive plant (California Native Plant Society 2001; California Natural Diversity Database 2001). Occurrences in the vicinity of Antioch may have been extirpated by urban development, although 2 of the occurrences are on rural lands that have not yet been developed (California Natural Diversity Database 2001).

Conservation and Management

No populations of showy madia are currently known in the ECCC HCP/NCCP inventory area, although suitable habitat is likely to be present. Any populations rediscovered in the inventory area should be preserved and protected. Areas of suitable habitat could be preserved and protected that may harbor undetected occurrences of showy madia or that could be used for potential reintroduction.
Species Distribution Model

No species distribution model could be developed for showy madia because of a lack of data on the species’ habitat requirements.

Literature Cited


California Natural Diversity Database. 2001. RareFind 2, Version 2.1.2 (September 5, 2001 update). California Department of Fish and Game, Sacramento, CA.


Adobe Navarretia (*Navarretia nigelliformis* ssp. *nigelliformis*)

**Status**

**Federal:** None  
**State:** None  
**CNPS:** List 1B

**Population Trend**

**Global:** Unknown  
**State:** Unknown  
**Within Inventory Area:** Unknown

**Data Characterization**

Location databases include 12 data records for adobe navarretia from 1898 to 2000 (CalFlora 2000; California State University Chico 2002). Only 1 of these occurrences was documented in the previous 10 years. All of the occurrences are of general precision and may not be accurately located.

Very little information is available for adobe navarretia. The literature on the species pertains primarily to its taxonomy. The main sources of general information on this species are the Jepson Manual (Hickman 1993) and the location data records.

**Range**

Adobe navarretia is reported to occur in the Sierra Nevada foothills, the Central Valley, and the inner South Coast Ranges, between 325 and 3,300 feet elevation (Hickman 1993).

**Occurrences within the ECCC HCP/NCCP Inventory Area**

Adobe navarretia has been collected historically in the vicinity of Antioch (CalFlora 2000) and has been reported from the Los Vaqueros area (Ertter 1997). There are no confirmed occurrences of adobe navarretia in the inventory area.
Biology

Physical Description

Adobe navarretia is an annual herb that blooms in April and May (Munz 1959). The small flowers are yellow with brown spots below the petal lobes (Hickman 1993).

Habitat

Adobe navarretia occurs in heavy clay soils of vernal pools and other low, seasonally moist areas in grasslands (Hickman 1993). Adobe navarretia appears to be restricted to areas with a vernally moist, summer-dry hydrologic regime.

Species Associated with Adobe Navarretia

<table>
<thead>
<tr>
<th>Species</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achyrachaena mollis</td>
<td>blow-wives</td>
</tr>
<tr>
<td>Bromus hordeaceus</td>
<td>soft chess</td>
</tr>
<tr>
<td>Deschampsia danthonioides</td>
<td>Annual hairgrass</td>
</tr>
<tr>
<td>Epilobium pygmaeum</td>
<td>smooth spike-primrose</td>
</tr>
<tr>
<td>Eryngium sp.</td>
<td>coyote-thistle</td>
</tr>
<tr>
<td>Gastridium ventricosum</td>
<td>nitgrass</td>
</tr>
<tr>
<td>Hordeum marinum ssp. gussoneanum</td>
<td>Mediterranean barley</td>
</tr>
<tr>
<td>Juncus bufonius</td>
<td>toad rush</td>
</tr>
<tr>
<td>Plagiobothrys acanthocarpus</td>
<td>adobe popcorn-flower</td>
</tr>
<tr>
<td>Vulpia bromoides</td>
<td>foxtail fescue</td>
</tr>
</tbody>
</table>

Threats

Specific threats to adobe navarretia are not known, although general threats to the species would be similar to those for other vernal pool species, including habitat conversion.

Species Distribution Model

No species distribution model could be developed for adobe navarretia because of a lack of data on the species’ habitat requirements.
Literature Cited


