Appendix D
Species Accounts

Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)

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Legal Status

State: None
Federal: Threatened (U.S. Fish and Wildlife Service 1987)
Critical Habitat: Designated (U.S. Fish and Wildlife Service 2008)
Recovery Planning: Recovery plan approved (U.S. Fish and Wildlife Service 1998)

General Notes

The Bay checkerspot butterfly is one of the most-studied invertebrate taxa in the world. Starting in 1960, Dr. Paul Ehrlich, his research group at Stanford University, and numerous academic graduates or associates of the Stanford group have studied *Euphydryas* butterflies across western North America. Given its distribution in areas near Stanford, and historic presence on campus, the Bay checkerspot butterfly is the most studied of the *Euphydryas* subspecies. This butterfly has been the subject of many hundreds of articles published in peer-reviewed journals, chapters of academic books, more than a dozen doctoral dissertations and master's theses, and many field projects. Much of the accumulated knowledge, along with many of the key references, can be found in the book *On the Wings of Checkerspots: A Model System for Population Biology* (Ehrlich and Hanski 2004).

Taxonomy

The Bay checkerspot butterfly is a subspecies of the widespread Edith's checkerspot butterfly (*Euphydryas editha*). This species, a member of the family Nymphalidae, is found across much of western North America, from northern Mexico to southern Canada and from the Pacific coast to Wyoming (White and Singer 1974). Subspecies of Edith's checkerspot butterfly are generally distinguished on the basis of differences in phenotype and primary larval host plant. Phenology tends to be closely associated with larval host plant and local environment and also varies among subspecies (Singer and Parmesan 1993; Singer et al. 1993). Most genetic analyses have supported the traditional groupings of populations into subspecies. Depending on the reference, there are more than 30 accepted subspecies of Edith's checkerspot butterfly, including approximately 12 subspecies from California.

The Bay checkerspot butterfly is distinct from Luesther's checkerspot butterfly (*Euphydryas editha luestherae*), a subspecies that feeds on lousewort (*Pedicularis* sp.) and perennial paintbrushes (*Castilleja* spp.) (Murphy and Ehrlich 1980). Luesther's checkerspot butterfly is often found in chaparral in close proximity to Bay checkerspot butterfly populations. The Bay checkerspot butterfly is very similar in appearance to an unnamed form of *E. editha* that also feeds on plantain (*Plantago* sp.) and annual paintbrushes (*Castilleja* spp.), which is found in areas south of the range of the Bay checkerspot butterfly.

Edith's checkerspot butterfly is occasionally placed within the genus *Occidryas* and it has been suggested that the proper name of the Bay checkerspot butterfly is *E. editha editha*. Neither the generic name *Occidryas* nor the reassignment to *E. editha editha* are presently accepted in the scientific community.

Distribution

General

The Bay checkerspot butterfly is known from the southern and eastern portion of the greater San Francisco Bay area. Populations, most of which have been extirpated, were known from San Francisco (Twin Peaks and Mount Davidson), San Mateo County (San Bruno Mountain south to Woodside), Santa Clara County (numerous locations), Alameda County (Oakland hills), and Contra Costa County (Franklin Canyon and Morgan Territory). The subspecies is not known from areas north of San Francisco Bay. To the south, starting in San Benito County, an unnamed form of Edith's checkerspot butterfly replaces the Bay checkerspot butterfly in the area's serpentine grasslands.

Within this limited geographic region, butterfly populations are patchily distributed in serpentine grasslands. It is unclear whether the Bay checkerspot butterfly was more widely distributed within the region prior to the major changes in composition and distribution of plant species associated with the European colonization of the area (Ehrlich and Murphy 1987).

As of 2005, all populations of the Bay checkerspot butterfly on the San Francisco Peninsula were extirpated, including all populations in San Francisco, San Mateo, and northern Santa Clara counties. Bay checkerspot butterflies were reintroduced to Edgewood County Park and Natural Preserve in April 2007. In the East Bay, the Bay checkerspot butterfly has been extirpated from most of its range, but may still exist in Contra Costa County in the general vicinity of Mt. Diablo. Unfortunately, records from Contra Costa County are often confounded by the presence of the relatively common Luesther's checkerspot butterfly. In south-central Santa Clara County, the Bay checkerspot butterfly is still abundant at multiple locations. Most butterflies are found along the ridge that forms the eastern boundary of the Coyote and southern Santa Clara valleys. This ridge consists of extensive serpentine grasslands, and extends from the Silver Creek Hills, through the Edenvale Hills (sometimes called the East Hills or Coyote Hills), to Pigeon Point just north of Anderson Reservoir Dam. There are multiple populations of the butterfly along this ridge. There are smaller, scattered populations of the butterfly along the eastern foothills south of the Anderson Reservoir dam and along the western foothills of the Coyote Valley.

Factors implicated in these multiple extinctions on the Peninsula and in the East Bay include direct habitat loss through development, habitat degradation due to non-native species (likely exacerbated by nitrogen-containing pollutants), successional changes from grasslands to scrub and chaparral, periods of unfavorable or highly variable weather, and disruption of regional metapopulation dynamics. The detrimental impacts of these factors are more problematic for the butterflies because the extent of the serpentine grasslands of the Peninsula and East Bay is limited.

Occurrences within the Study Area

The majority of habitat of the Bay checkerspot butterfly and the vast majority of individuals of the subspecies are found in the area covered by this HCP/NCCP.

Historical

Bay checkerspot butterflies have been studied in central Santa Clara County since the 1960s and extensive work on the butterfly was conducted in the region during the 1980s and 1990s. Populations located in the Silver Creek Hills, Tulare Hill, and near Coyote Reservoir were study sites for many research projects in the 1960s and 1970s. In the 1980s, research on the butterfly shifted to the large concentration of butterflies present in the hills adjacent to the Kirby Canyon Sanitary Landfill.

Population declines and expansions are well documented for this subspecies, and are very common in this region. No extinctions of populations have been conclusively confirmed (a difficult task requiring multiple years of monitoring) in the area, but at various times populations located in the Silver Creek Hills, Tulare Hill, and the serpentine grasslands located near Kalana Avenue have declined to extinction or near-extinction. It is unclear if the records of isolated butterflies from Communication Hill, the hills south of Anderson Reservoir dam, and the hills west of Highland Avenue (San Martin) represent now-extirpated populations or merely transient butterflies.

Additionally, broad expansions and contractions of populations across slope exposures are common. Warm slopes (generally low elevation, and west- or south-facing) in particular often support high densities of butterflies in seasons following years with ample winter and spring rain. In seasons following drought years, few if any butterflies can be found on the warm slopes.

Recent

As of 2005 Bay checkerspot butterflies were abundant in the multiple populations found along the eastern foothills, from the Silver Creek Hills to Pigeon Point. Several of these populations regularly support more than 250,000 adult butterflies. In areas south of Pigeon Point, Bay checkerspot butterflies are present in the small patches of grassland just west of Coyote Reservoir. On the west side of the Coyote Valley, Bay checkerspot butterflies have been present in the recent past in serpentine grasslands adjacent to Hale Avenue, in areas adjacent to Kalana Avenue, in the southern portions of the Santa Teresa Hills, in the hills near Calero Reservoir, and on Tulare Hill. Survey effort in this part of the study area in uncertain, though it is believed that these sites do not consistently support this species, due to lack of beneficial management. See *Population Trends 1985–2008*, below, for site specific population information.

Natural History

Habitat Requirements

At the present time, the Bay checkerspot butterfly reproduces only in serpentine grasslands. These native species-dominated grasslands support the larval host plants, dwarf plantain (*Plantago erecta*) and purple owl's clover (*Castilleja exserta* and/or *Castilleja purpurescens*), at densities that are high enough to sustain butterfly larvae. These host plants are not serpentine-dependent species and are distributed more widely outside of the study area. Within the study area these nutrient-poor serpentine habitats likely allow these host plants to compete with other non-native grassland species that would typically out-compete them. These grasslands also tend to support many additional species that can provide nectar to the adult butterflies.

Topography is an additional factor determining habitat quality and a variety of microclimates are needed for Bay Checkerspot butterflies to persist (Singer and Ehrlich 1979; Fleishman et al. 2000). Relatively cool and moderate microclimates are critical to a butterfly population's ability to survive drought (Weiss and Murphy 1983) while warm slopes appear to be important during wet/cool years (Weiss et al. 1988). Sites lacking cool and moderate slope exposures are unable to continuously support populations of Bay checkerspot butterflies.

Patch size and proximity to other sites supporting butterflies are also factors in determining suitability of particular serpentine grasslands for Bay checkerspot butterfly populations. In general, as patch size drops below several hectares it becomes increasingly unlikely that the grassland can support a viable population. However, given the dispersal capabilities of the butterfly, small patches of serpentine grassland located a few hundred meters from groups of other small patches can support butterflies. Additionally, many relative small patches of serpentine grassland located within several kilometers of the region's large checkerspot butterfly populations are frequently occupied.

Weather is an important determinant of habitat quality (Dobkin et al. 1987; Hellmann 2002). Growing season rainfall, which delays senescence of larval host plants, is favorable for the butterfly. During periods of favorable weather, Bay checkerspot butterfly populations expand in extent and abundance. During these periods, grasslands generally considered too warm, too small, or too distant can be occupied by the butterfly.

Conversely, during periods in which there is relatively little growing season rainfall, the larval host plants senesce earlier in the year, and larvae in many locations cannot obtain sufficient food. This results in extensive contractions of the large populations as the distribution of butterflies shifts to cooler microclimates (Weiss et al. 1988). Many of the smaller and flatter patches of serpentine grassland tend to lose butterflies during these periods.

Table 1. Habitat Associations for the Bay Checkerspot Butterfly

Land Cover Type	Use by the Butterfly	Habitat Designation	Habitat Characteristics	Explanation
Serpentine grassland	Reproduction, growth, feeding—larvae and adult	Primary	Native bunch grasses; high species richness of native forbs; dwarf plantain (*Plantago erecta*); owl's clover (*Castilleja exserta*, *C. purpurascens*)	Dwarf plantain is the primary larval food plant. Two species of owl's clover are utilized as secondary larval food plants when available. Adults feed on nectar from a variety of native forbs, including species of *Mullia*, *Layia*, *Lomatium*, *Lasthenia*, *Linanthus*, and *Allium*.

Life History

Bay checkerspot butterflies are univoltine, and individuals typically have a maximum life span of only slightly longer than one year. During this year, individuals progress through six fairly distinct life history stages: egg, prediapause larva, diapause (larval dormancy), postdiapause larva, pupa, and adult.

Eggs generally are laid in masses of 50 to 200, typically on the base of the larval host plants (Labine 1968; Singer 1972). Egg masses are occasionally laid on other plants or substrate such as rocks or dirt. The primary larval host plant species is the annual dwarf plantain (*Plantago erecta*). Two annual species of owl's-clover (*Castilleja* sp.) and purple owl's-clover (*C. exserta* ssp. *exserta*) are also used as larval host plants (Hickman 1993).

The eggs hatch in approximately 10 days. Egg masses frequently disappear, apparently from predation by invertebrates or possibly vertebrates. Heavy rain or hail can also cause significant loss of eggs. Desiccation causes egg mortality under laboratory conditions, but it is not clear if this is a significant problem under field conditions.

After hatching, prediapause larvae feed on their host plants for two to six weeks, until either the larvae are large enough to enter and survive diapause (fourth instar) or have depleted the available food supply. Mortality during this phase is thought to be the primary determinant of the following year's population size; if prediapause survival is high, the population size will increase, and if prediapause survival is low, the population size will decrease. Even in "good" years at least 80% of larvae die prior to diapause (Singer 1972; Fleishman et al. 1997) and larvae resulting from egg masses laid in the mid-to late part of the season have very little chance of surviving (Singer and Ehrlich 1979). Most mortality during this stage is due to lack of food. Predation and excessive precipitation can also result in larval mortality (Dobkin et al. 1987).

Food supply can prove inadequate if the larval host plants senesce early relative to the butterfly (White 1974). This is often the case in dry years and for larvae originating from egg masses laid relatively late in the season. Low density of host plants can also lead to local depletion of resources. In general, dwarf plantain is a more consistent host plant, with densities and standing biomass being less variable than the owl's-clover species (which in some years are virtually absent). Dwarf plantain individuals, however, are typically smaller and senesce earlier than individuals of owl's-clover. While there is certainly a limit to how far larvae can disperse, even first instar larvae will easily traverse several meters in search of suitable host plants, and most larvae shift among individual plants several times.

Newly hatched larvae sometimes group together and make small webs around portions of their host plant. Field studies indicate that the proportion of larvae that make webs is variable (Labine 1968).

As the end of the spring growing season approaches, the larval host plants senesce and many of the butterfly larvae enter a period of physiological dormancy known as diapause. Alternately, many larvae die of starvation trying to reach the appropriate size needed to survive diapause or die shortly after entering diapause due to insufficient amounts of stored resources. Larvae spend diapause under rocks, debris, or plant litter, or in cracks and crevices in the soil. Diapause lasts until larval host plants germinate during the onset of the rainy season in late autumn and early winter. Dwarf plantain tends to be the primary early season food source.

Postdiapause larvae spend the next several months feeding and basking in the sun, growing quickly from small fourth instar larvae to 4 cm long seventh instar larvae. Postdiapause larvae can disperse several tens of meters, and frequently do so in search of host plants, appropriate basking areas, or areas sheltered from inclement weather. Development of larvae in warm microclimates (defined primarily by slope, aspect, and elevation) is frequently several weeks ahead of larvae in cool microclimates. These phenological differences are present even when the distance between the areas of different microclimates is quite small, on the order of ten meters.

After the larvae reach sufficient size and stage, they pupate. In most years, the majority of larvae pupate in February or March. Phenology is extremely weather dependent, and all of the major transitions it the butterfly's life cycle, including pupation, can be shifted several months. Pupae are formed in a loose web, typically at the base of vegetation or rocks. Individuals remain as pupae for three to five weeks, or longer if there are extended periods of cold and rain.

Some mortality occurs during the post-diapause and pupal stages; the magnitude varies from year to year (White 1986). Parasitoids are evident in post-diapause larvae and pupae, and a high percentage of late-developing larvae are typically parasitized. Parasitoids, however, do not appear to be a major factor in determining population size in the Bay checkerspot butterfly (parasitism is a controlling factor for populations of other species of checkerspot butterflies; Moore 1989). In some years a pathogen, which causes the darkening, liquefication, and death of butterfly larvae, is present. Field studies have observed that pupae frequently disappear, and predation has long been presumed to be the cause. In general, approximately 50% of the late (at least early sixth instar) post-diapause larvae present at a given location will survive to become an adult butterfly.

After several weeks and when the weather warms, butterflies will eclose (emerge from pupae). Newly-emerged individuals crawl to a somewhat exposed location and sun themselves until their wings have fully hardened. Male butterflies tend to emerge earlier in the season than females (Ehrlich 1965), and are on average smaller than females. Individual butterflies survive as adults for seven days to two weeks. How long adult butterflies are present in a given location depends on the number of butterflies (the more butterflies, the more prolonged the adult season), topographic diversity of the site (the more diversity, the more microclimates), and weather (Hellmann et al. 2003). The adult flight season is typically about four to six weeks in length, generally starts in March, and terminates in late April to early May. Actual starting and ending times can vary by several weeks from year to year.

The majority of female butterflies are mated soon after eclosion, occasionally before their wings have hardened fully. There is some hilltopping in the Bay checkerspot butterfly (i.e., congregation for mating at visible landmarks, often hilltops, that may have few larval or adult resources), with males in particular tending to concentrate local ridges (Ehrlich and Wheye 1986). Most female Bay checkerspot butterflies mate only once and are prevented from subsequent mating by a waxy plug deposited by the male (Labine 1964). Females lay multiple egg masses; earlier egg masses contain a greater number of eggs than later egg masses. Nectar is utilized by both male and female butterflies, and is provided by a variety of plant species, including common muilla (*Mullia maritima*), tidytips (*Layia platyglossa*), California goldfields (*Lasthenia californica*), lomatiums (*Lomatium* sp.), onions (*Allium* sp.), and several linanthus species (*Linanthus* sp.).

Rain and hail can cause substantial mortality of adult Bay checkerspot butterflies. Strong wind can also be problematic for the butterflies, often damaging their wings to the point that their ability to fly is compromised. Bay checkerspot butterfly adults are also eaten by a variety of predators. Spiders catch butterflies both in their webs and while the butterflies are not flying (Ehrlich 1965). Other invertebrates undoubtedly prey on some butterflies while the butterflies are on the ground or in the vegetation. Mammals may take some butterflies, particularly during periods when the butterflies are inactive (at night and during periods of bad weather). Birds take Bay checkerspot butterflies, but predation by birds is typically not high (Ehrlich 1965).

Although the Bay checkerspot butterfly is considered an annual univoltine species, it is possible that under some conditions, the butterfly can extend its life cycle for several years. Under laboratory conditions, individual butterflies frequently enter a second diapause (or even three or four diapauses). Given this observed ability, it is very possible that under some circumstances, post-diapause larvae occasionally re-enter diapause, thereby extending their life span from one to two years.

Table 2. Generalized Phenology of the Bay Checkerspot Butterfly

Life History Stage	December, January	February	March	April	May	June	July to November
Eggs			✓	✓	✓		
Pre-diapause larvae				✓	✓	✓	
Diapausing larvae	✓				✓	✓	✓
Post-diapause larvae	✓	✓					
Pupae		✓	✓	✓			
Adults			✓	✓			

Movement

Adult Bay checkerspot butterflies are relatively agile, and can easily fly several kilometers (Harrison 1989). Bay checkerspot butterflies have a general propensity to remain associated with serpentine grasslands, and most movements are within a single patch of serpentine grassland (Ehrlich et al. 1980; Ehrlich and Murphy 1981). Within a given patch, butterflies will frequently fly from one area to another, looking for potential mates, feeding on nectar on scattered groups of flowers, avoiding wind, avoiding other butterflies (mated females in particular tend to avoid males), and looking for oviposition sites. In smaller habitat patches, this means that individual butterflies often fly from one end of the patch to the other. In large habitat patches, those several kilometers in length or width, individual butterflies will generally stay in a portion of the overall site, usually moving much less than a kilometer from the point where they eclosed.

In areas where serpentine grasslands transition into other types of plant communities, Bay checkerspot butterflies will usually turn around and remain in the serpentine grassland (Ehrlich 1965). Butterflies that do not turn around at the edge of their serpentine habitat tend to keep flying—presumably until another patch of habitat is encountered. It is assumed that butterflies may use any land cover type as a movement corridor if the land cover is adjacent to serpentine grassland. Harrison (1989) documented colonization up to 2.8 miles from Coyote Ride, and one individual moved 3.5 miles. Another marked individual was documented to have flown 4.7 miles (U.S. Fish and Wildlife Service 1998). Based on numerous mark-recapture studies, the percentage of individuals that leave particular serpentine grassland areas is thought to be generally low, less than 10%. This percentage apparently increases as the season progresses, and may be higher in populations with very low densities of Bay checkerspot butterflies.

Even with the fairly low percentage of butterflies that leave specific sites, if the butterfly population is large (several of the Bay checkerspot butterfly populations in the HCP/NCCP study area frequently consist of 250,000+ adult butterflies), a large number of Bay checkerspot butterflies will disperse away from their natal habitat patch. For example, if a population includes 250,000 adult butterflies and 1% of the population leaves the site, then 2,500 individual butterflies are expected to leave the site. Given the patchiness of serpentine grasslands and the apparently limited ability of Bay checkerspot butterflies to locate these grasslands from more than a few hundreds of meters distant, most Bay checkerspot butterflies that leave serpentine grasslands do not find other patches of habitat. However, patches of serpentine grassland that are within a few kilometers of moderate to large populations of Bay checkerspot butterflies will receive immigrants on a regular basis; larger patches of serpentine grassland will receive more immigrants, but even very small patches will occasionally be occupied by Bay checkerspot butterflies if the patches are within five to 10 kilometers of the large populations. Conversely, as distance between patches increases, the chance of butterflies migrating between the two patches decreases.

Prediapause larvae generally do not disperse far from where they hatched, but undoubtedly some individuals disperse distances in excess of 10 meters (Launer pers. comm.). Postdiapause larvae are more prone to disperse, but it is unlikely that many move farther than 50 meters from their place of diapause (Launer pers. comm.).

Table 3. Movement Distances for Bay Checkerspot Butterfly

Type	Distance	Notes	Sources
Adults—within habitat	Depend on size of habitat patch	Generally stay associated with patch of serpentine grassland	Harrison 1989
Adults—out of habitat	Up to several kilometers	Out of habitat movement tends to be random and linear; ridges are occasionally followed	Harrison 1989
Prediapause	Generally fewer than 10 meters		Harrison 1989
Postdiapause	Generally fewer than 50 meters	Larvae tend to move toward warmer microclimates (often uphill)	Harrison 1989

Ecological Relationships and Population Dynamics

Regional population dynamics of the Bay checkerspot butterfly tend to be complex. The abundance of individual populations increases or decreases in response to site-specific characteristics (topography, patch size, management regime, etc.) and weather. Likewise, in expansive patches of serpentine grassland, particularly those with considerable topographic diversity, shifts in butterfly density across the landscape are common. Most of these shifts in density across the landscape are expansions and contractions, with the butterfly population shifting from cool and moderate microclimates during dry years, to warmer microclimates during rainy years, and then back to the cool and moderate microclimates during the next drought (Weiss et al. 1988).

Local extinctions of entire populations and of segments of large populations are not uncommon. Reestablishment of populations in areas formerly supporting distinct populations or the spatial expansion of extant populations are also not uncommon. This loose pattern of extinctions, colonizations, contractions, expansions, has led many to characterize the Bay checkerspot butterfly as a series of metapopulations.

The classical concept of a metapopulation (Levins 1969, 1970), a series of ephemeral local populations linked by dispersal, does not apply to the Bay checkerspot butterfly. A better description of the population dynamics of this species is a source-sink metapopulation (Harrison et al. 1988; Hanski 1994). The expansive populations occupying the serpentine grasslands found in the hills along the eastern edge of the Coyote Valley (variously known as the southern Silver Creek Hills, the Edenvale Hills, the East Hills, and the Coyote Hills) are large and microclimatically diverse enough that if properly managed, they may be essentially “extinction proof” (i.e., a perennial “source” population), barring any dramatic shifts in climate, land use, or habitat management. The many smaller and less diverse sites to the west and south are much more susceptible to periods of unfavorable weather, and hence more extinction prone (i.e., “sink” populations). The large populations in the eastern hills are the source of butterflies, providing butterflies that either supplement the small populations to the west or that actually reestablish populations that have been extirpated.

There have been substantial changes in plant composition and distribution since European colonization. As a result, regional population dynamics of the Bay checkerspot butterfly may be quite different than historically.

The main factor contributing to a butterfly population's decrease or increase is the availability of edible host plants for the prediapause larvae. Host plant availability is determined by two factors, biomass of the host plants and their phenology (relative to the butterflies). Plant biomass in turn is determined by weather, number of viable seeds, seed germination, seedling growth and survival, and land management (e.g., livestock grazing, competition from alien species, etc.). There is considerable annual variation in biomass of the larval host plants. The annual owl's-clover species, in particular, vary greatly spatially and temporally, and are virtually absent in some years.

The second principal factor contributing to availability of larval host plants is phenology (i.e., the timing of development, or more precisely, the relative timing of the butterfly larval development and the developmental timing of their host plants. If many of individual plants do not senesce until mid-May, as is the case when there is at least some precipitation during the early spring growing season, then the butterfly larvae should be able to find sufficient quantities of edible food. If the rains stop early in the growing season, the majority of the plants may senesce early and the majority of the butterfly larvae will have trouble finding enough food to survive.

Population Status and Trends

Global: Declining
State: Declining
Within Study Area: Declining

Threats

The Bay checkerspot butterfly is in a precarious situation, but it is not threatened with immediate extinction. There are many threats acting on the butterfly and the serpentine grasslands upon which it depends. These threats include:

Habitat loss via development. Many Bay checkerspot butterfly populations have been lost due to conversion of serpentine grasslands to residential, recreational, and commercial development.

Habitat modification via development. A number of serpentine grasslands have been partially destroyed by urban and suburban development, either directly (e.g., quarries, dumps, roads) or indirectly by adjacent land use. Water, either irrigation or runoff, from built environments can significantly alter the species composition of plants on a site, potentially rendering portions of a site unsuitable for Bay checkerspot butterflies.

Non-native species. Although serpentine grasslands are typically more resistant to invasion by non-native species than many other vegetation types, non-native species eventually degrade serpentine grasslands. Habitat management is an absolute necessity to control this threat.

Pollution. A number of pollutants, especially nitrogen-based pollutants, threaten the Bay checkerspot butterfly. Deposition of nitrogen on serpentine grasslands can radically alter the plant composition. Deposition of nitrogen acts to fertilize the nutrient-poor serpentine soil, and greatly exacerbates the problems caused by non-native species (Weiss 1999).

Succession. Given the present species composition, rates and types of disturbance, and pollutants, it appears that areas of serpentine grassland that have been recently disturbed, either by grazing or fire, are better able to support Bay checkerspot butterflies that areas that have not been recently disturbed (Weiss 1999). This probably reflects that grazing and fire tend to reduce the dominance of non-native species. It is not clear what the successional patterns were in prior to European colonization and whether Bay checkerspot butterflies were associated with any particular successional stage.

Over-collecting/poaching. Although mentioned by various agencies as being a general threat to rare butterflies, there is no evidence suggesting that the current level of illegal collecting that undoubtedly occurs is of any consequence to Bay checkerspot butterfly persistence. In fact, artificial application of heavy “predation pressure” in the form of intensive collecting was applied to the Jasper Ridge colony in 1964 and 1965, with very little reduction in population size (Ehrlich 1965).

Overstudy. Many populations of the Bay checkerspot butterfly have been studied, often quite invasively, since 1960. Several of the most intensely studied populations have gone extinct, most notably those located at Jasper Ridge on Stanford and at Edgewood County Park in San Mateo County. None of the studies designed specifically to examine the potential impacts of research on Bay checkerspot butterfly populations have identified any significant negative impacts (Harrison et al. 1991; Hellmann et al. 2003). Harrison et al. (1991) did indicate that collections may have increased the chances of extinction, with an effect ranging from negligible to a 15% increase in extinction probability over 30 years depending on model assumptions.

Weather. Both current weather and potential future changes in weather can impact the Bay checkerspot butterfly. Periods of drought and deluge both have the potential to negatively impact Bay checkerspot butterflies (Singer 1972; Hellmann 2002c). Drought tends to cause Bay checkerspot butterfly populations to retreat to areas with moderate to cool microclimates. If these microclimates are present at a site, then the population merely experiences a contraction in distribution and abundance. If a site does not have sufficient areas of moderate and cool microclimates, then extirpation of the population is a definite possibility. The impacts of excessively wet years are somewhat more difficult to quantify. Some shifts in microclimatic zone utilized by the butterfly may occur; the very cool microclimates may simply become too wet to successfully sustain butterflies. Other negative impacts of above-average precipitation include increased competition between the native forbs and mostly non-native grasses and, possibly, increased butterfly mortality due to pathogens. Extremes in annual variation of weather may also negatively impact Bay checkerspot butterfly populations.

Predicting future climate changes and the impacts of these changes on biotic systems is a highly inexact science. However, given the sensitivity of butterfly populations to host plant phenology, it is reasonable to assume that future climate change could significantly impact Bay checkerspot butterfly populations (Dennis 1993; Hellmann 2000, 2002).

Vegetation management. Both overgrazing and undergrazing have been identified as threats to this species (U.S. Fish and Wildlife Service 2009). Grazing is used to reduce standing biomass of nonnative vegetation and increase the prevalence of native forbs, including Bay checkerspot butterfly's larval hose plant. As such, grazing regimes should be monitored to ensure that species habitat is not degraded.

Gopher control. It has been observed that Bay checkerspot butterfly's larval host plants stay green and edible longer when located on or near soils recently tilled by gophers. This increases the availability of larval host plants into the dry season and may allow more larvae to reach diapause. Gopher control could decrease the availability of these tilled soiled and result in the reduction of larval host plant availability (U.S. Fish and Wildlife Service 2009).

Data Characterization

The Bay checkerspot butterfly is one of the most studied invertebrate taxon in the world. Stating in 1960, Dr. Paul Ehrlich, his research group at Stanford University, and numerous academic affiliates of the Stanford group have studied *Euphydryas* butterflies across western North America. Given its distribution in areas near Stanford, and indeed the former presence of three populations of the butterfly on campus, the Bay checkerspot butterfly is the most studied of the *Euphydryas* species and subspecies. This butterfly has been the subject of many hundreds of articles published in peer-reviewed journals, multiple chapters of academic books, more than a dozen doctoral and master's dissertations, and many field projects. Much of the accumulated knowledge, along with many of the key references can be found in the book *On the Wings of Checkerspots: A Model System for Population Biology* (Ehrlich and Hanski 2004).

Population Trends 1985–2008

Long term monitoring sites have been established along Coyote Ridge. Annual estimates of larval population size are the essential component of long-term monitoring of the Bay checkerspot butterfly. The distribution and abundance of the butterfly has been monitored at Kirby Canyon (KC) since 1985, and across most of the core populations since the 1990s. This period included a record 5-year drought (1987–1991), a strong El Nino in 1998, and other wide swings in weather.

This summary includes data for several core areas, and a discussion of broad features of the observed population dynamics that are highly relevant to conservation planning. These features include the range of population fluctuations, synchrony or asynchrony across Coyote Ridge, and responses to exceptional weather events. Also, notable population crashes in response to lack of grazing are also discussed.

Methods

Larvae are counted in a stratified sampling design developed at Kirby Canyon in the mid-1980s (Murphy and Weiss 1988). The habitat is stratified by March 21 solar radiation (insolation) into 5 "thermal strata;" Very Warm, Warm, Moderate, Cool, and Very Cool. Within each stratum, multiple samples of larval densities are taken over 1,500–3,000 m^2 areas using a timed search technique (10 person-minutes) that can be converted to absolute densities (Weiss 1996). The map of the Kirby Butterfly Trust Leasehold (Figure 3) with Thermal strata and larval sample areas shows the sample sites that have been visited in recent years. 35–40 sites are sampled within the 100 hectare leasehold each year in a window from January through March, the exact dates being weather dependent. The thermal stratification scheme is shown in color—red corresponds to Very Warm, yellow Warm, green Moderate, cyan Cool, and dark blue Very Cool. Larval sample areas are the white polygons.

Larval surveys were extended to most of Coyote Ridge in the 1990s (Weiss 1996). More than 200 sites are visited in a typical year across Coyote Ridge as a whole. Surveys were stratified by "population zones" —habitat blocks 500 or more meters across, corresponding to local topography and grazing regimes (Figure 3). These surveys monitor the health of the overall population on Coyote Ridge, and are a foundation for conservation. These surveys track local and regional population dynamics, and are now supported by a variety of mitigation sources.

Results

Population Trends at Kirby Canyon 1985–2008

Since 1985, larval abundance at KC ranged from 25,000 to 800,000 (Figure 4a). From 1985 to 1987, numbers increased from 100,000 to nearly 900,000, followed by a four-year crash down to 30,000. A one year increase in 1992 to 100,000 was followed by several years of relative stability. A sharp decrease in 1997 to 25,000 was followed by a 7-year increase to 500,000+ by 2004, followed by a sharp three year decline to 50,000 by 2007 and 2008.

The 1987–1991 population declines correspond to a multi-year drought, and the particularly sharp decline in 1989 followed a truncated rainy season with a warm March-April. The decline in 1997 followed a record warm, but cloudy/rainy winter. The decline in 2005 followed a warm, dry March–April.

An additional drive of population response was also noted in 2004–2005. On many moderate and cool slopes, larval population densities were high enough (>1 larva/m^2) in successive years that local defoliation of Plantago occurred, and sharp drops to <0.05 larvae/m^2 were observed the following year. The combination of the warm-dry spring 2004 and defoliation exacerbated the population declines.

Population Dynamics across Coyote Ridge 1992–2008

Larval population estimates in the other population zones show large fluctuations (Figures 4b–4g). The ridgetop areas just north of KC (VTA High 1 and VTA High 2, new names) showed relative stability from 1992 to 1996, sharp declines in 1997, increases through 2004, and subsequent declines through 2007 and 2007. Note that abundance in these areas, especially VTA High1, dropped to near 1000 from peaks of 100,000. These fluctuations were largely synchronous with those at KC.

On the lower slopes of the VTA parcel (VTA low), abundance peaked at 70,000 in 1994, and dropped below detection limits from 1998 to 2000. During this time, some adult butterflies were observed in this area each year, indicating persistence. Larval abundance recovered to 70,000 again by 2003, probably enhanced by immigration from large populations on the ridgetop, and fell to 10,000 by 2006–2008.

Although sampled more intermittently, the data indicate that the southern parts of the UTC property also experienced similar fluctuations. R2A (south of the fence dividing the winter-spring grazing from the spring/summer/fall grazing) peaked in 2003 and 2004, and UTC South (north of the fence) peaked a couple years later in 2006.

Sampling has been even more intermittent in UTC North (numbers not shown) but in 2008, local densities there were among the highest seen on Coyote Ridge.

Areas between UTC South and UTC North have maintained occupancy by Bay checkerspot butterfly, tended to follow the broader trends, but not enough survey sites have been done to estimate total population size.

Larval densities at lower elevations north of the VTA property, including the Los Esteros and Silicon Valley Power 40-acre mitigation parcels, have historically been lower than on the ridgetop. Larval populations in these areas have been estimated to be several hundred to several thousands. In recent years, population trends have tracked the lower slopes of VTA.

The habitat north of Metcalf Canyon (Metcalf, 114 ha included in the population estimate) has historically supported a large population of Bay checkerspot butterflies (Figure 2). Larval numbers increased from 27,000 in 1997 to 200,000 in 2000, to >400,000 in 2001, 800,000 in 2004, and then declined sharply to 83,000 in 2005, and 20,000 in 2007 followed by an increase to 35,000 in 2008.

The adjacent habitat to the northeast (Metcalf North Ridge, or San Felipe) has supported butterflies since 1997, but no quantitative estimates have been made of total numbers.

At the SE end of Coyote Ridge, the serpentine grasslands on Pigeon Point just NW of Anderson Dam has supported moderate to low densities of larvae during intermittent surveys since 1985.

Overall the subpopulations on Coyote Ridge exhibited relative stability from 1992 to 1996, a sharp decline in 1997, increases by an order of magnitude from 1997 through 2004, and subsequent declines by an order of magnitude or more through 2007 and 2008. Fluctuations were largely in synchrony with each other, but asynchronous population responses were noted at some sites in some years. Peak numbers of Bay checkerspot larvae in 2004 across all of Coyote Ridge were on the order of 2,000,000, and the 2008 estimate is on the order of 150,000 larvae.

Silver Creek Hills

The Environmental Trust of the Ranch at Silver Creek has been responsible for managing the conserved habitat in the Silver Creek Hills. Much of this area was heavily degraded by lack of grazing from 1992 through 1995 (Silver Creek Valley Country Club side) and from 1992 through 2002 on the Ranch at Silver Creek side. Populations are extant in the hundreds. Documentation is provided by Wetland Research Associates who manage the Environmental Trust.

Tulare Hill

In 2002, there were an estimated 2–3,000 larvae on Tulare Hill, but in 2003 the numbers dropped into the low hundreds, and the population declined to fewer than 100 by 2005. The northern 2/3 of Tulare Hill was ungrazed starting in 2001, and a rapid invasion of annual grasses eliminated what had once been quality habitat, leading to the. The population is just barely hanging on; in each year from 2006–2008 one individual checkerspot butterfly was observed.

Management activities on the southern parcel Tulare Hill are now being done as mitigation for NO_X and NH_3 emissions from the Metcalf Energy Center, and have maintained high habitat quality. A Safe Harbor Agreement with The Pacific Gas and Electric Company was developed from 2004 through 2008, and cattle were introduced into the northern 230+ acres that had been ungrazed since 2001. Recovery of hostplant and nectar sources is expected over the next 5–10 years depending on restoration efforts.

Other Habitat Areas

No systematic surveys of other serpentine patches west of the Coyote Valley were done from 2004 through 2008. It is likely that several of the larger patches (Hale Ave, the Kalana's) support small populations. Butterflies were observed in Rancho Canada del Oro in recent years.

Habitat conditions in the Santa Teresa Hills, especially in the County Park, continue to deteriorate as grass invasions continue in areas with no grazing. No systematic surveys for adult butterflies have been done. Grazed areas in the southeast portions of the Santa Teresa Hills (owned by IBM) continue to support high densities of Plantago erecta and nectar sources.

Existing Conservation Actions in the Study Area

The U.S. Fish and Wildlife Service published a recovery plan for serpentine plants and animals of the San Francisco Bay area in 1998, which includes the Bay checkerspot butterfly. The primary recovery tasks identified for the butterfly are protection of existing habitats, along with their habitat restoration and management, plus population monitoring and further research.

Fifteen units of critical habitat for the bay checkerspot butterfly were designated by the U.S. Fish and Wildlife Service in 2008. The designated critical habitat includes 1,692 acres in San Mateo County and 16,601 acres in Santa Clara County.

At least two HCPs have been approved that provide an incidental take permit for the Bay checkerspot. The San Bruno Mountain HCP, approved in 1982 as the first HCP in the country, includes the bay checkerspot. However, because the butterfly has not been observed on San Bruno Mountain since the mid-1980s, the permit had no provision for incidental take of the butterfly, so no permit was issued for the species. The Bay Checkerspot butterfly may be added as a covered species under an amendment to the San Bruno Mountain HCP, which is currently in development. Two HCP's were prepared by The Pacific Gas and Electric Company for the Metcalf-Edenvale reconductoring project in San José and the related Metcalf-Hicks/Vasona Line Extension from San José to Los Gatos. The Metcalf-Edenvale HCP had a three year permit term, which expired in 2001.There are at least two other agreements related to HCP's that are currently in development in the Coyote Hills.

Other agreements have led to the establishment of two preserves for the bay checkerspot butterfly. In 1986, USFWS entered into a conservation agreement with Waste Management of California, Inc. and the City of San José to protect 267 acres of habitat for a 15-year period at the Kirby Canyon Landfill in San José (Murphy 1988). In 1991, a housing and golf course project in the Silver Creek Hills of San José resulted in the perpetual protection of a 115-acre conservation area. Since 1991, additional land has also been set aside for numerous projects as mitigation for impacts to Bay checkerspot butterfly, including the Metcalf Energy Center Ecological Preserve on Tulare Hill and their Coyote Ridge parcel (131 acres total), and a parcel acquired by VTA in 2006 on Coyote Ridge for mitigation for recent highway widening projects.

Active research and monitoring on the Bay checkerspot continues by several workers affiliated with Stanford University, other institutions, and consulting firms is ongoing.

Modeled Habitat Distribution in Study Area

The serpentine habitats where this species reproduces are easily identified in the study area. Due to the extensive research on the population dynamics of this species most of these areas have been surveyed, some quite extensively. Other areas have been surveyed in a more cursory fashion merely to determine whether the species is present or not and to assess the available habitat. The suitable habitat known or expected to occur in the study area is shown in Figure 1. This map was developed using an iterative process of refinement with two experts in Bay checkerspot butterfly biology, Dr. Stuart Weiss and Dr. Alan Launer. Maps were first developed showing patches of serpentine bunchgrass grassland as mapped by the Habitat Plan (see Chapter 3 for a description of the mapping methods). These patches of serpentine grassland, referred to as "habitat units", were further refined in consultation with the experts to delineate populations of Bay checkerspot butterfly based on field research and observations.

Bay checkerspot butterfly habitat units are divided into two broad categories: core and satellite. The definitions for core and satellite habitat units are adapted from the *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998). Core habitat units are "moderate to large areas of suitable habitat that support persistent bay checkerspot populations." Satellite habitat units are "generally smaller and contain less high-quality habitat than core areas, and may occur some distance from core areas."

The Habitat Plan identified eight core habitat units found within the four "core areas" defined by the Recovery Plan. The Habitat Plan also identified 13 satellite habitat units. The status of each core and satellite habitat units is classified as “occupied” or “historic/unoccupied”. For habitat units defined as “occupied,” species is known to occupy the patch at least in some years. Where individuals were present historically, but now the site is unoccupied and likely no longer suitable, the habitat unit is defined as “historic/unoccupied” Additional areas that support serpentine bunchgrass grassland (as mapped by the HCP/NCCP) and are adjacent to known populations or are within the known dispersal distance for the adults in these populations were also delineated as either suitable but “occupancy unknown” or suitable and “potential (no records)” habitat. If the site had not been surveyed thoroughly or surveyed in the last ten years, a habitat unit was classified as “occupancy unknown”. Otherwise suitable patches of serpentine grassland within the dispersal distance of known populations were considered “potential (no records)” habitat units if land use management practices such as livestock grazing could improve conditions for the species. The habitat units are described further and the categories are explained in Table 4.

Table 4. Bay Checkerspot Butterfly Habitat Units in the Study Area

Habitat Unit[1] (from North to South)	Status in 2006[2]	Size (acres)
Target Areas		
UTC	Occupied	1,607
Kirby/East Hills	Occupied	1,334
Pigeon Point	Occupied	117
Silver Creek Hills (Central)	Occupied	208
Metcalf North Ridge[3]	Occupied	518
Metcalf	Occupied	629
Hale/Falcon Crest	Occupied	371
Cañada Garcia	Occupied	180
Kalana Avenue (1–4)	Occupied	110
Tulare Hill	Occupied	336
Santa Teresa Hills (Main)	Occupied	936
Santa Teresa Hills (North)	Potential (no records)	190
Coyote-Bear Ranch County Park	Occupied	60
Calero	Occupied	359
Subtotal Target Areas		6,955
Non-Target Areas		
Silver Creek Hills North #1	Occupied	382
Silver Creek Hills North #2	Potential (no records)	406
Pound Site	Occupied	216
Communications Hill 1	Historic/Unoccupied	230
Communications Hill 2	Historic/Unoccupied	25
San Martin/Hayes Valley	Occupancy Unknown	201
Southwest Anderson Reservoir	Occupancy Unknown	189
Valley Christian High School	Historic/Unoccupied	15
Subtotal Non-Target Areas		1,665
Grand Total		**8,621**

Notes:

[1] Habitat Unit names are based on labels used by researchers at Stanford University for long-term monitoring and ecological studies. Also see Figure 1.

[2] Historic/Unoccupied = Site formally occupied but now extirpated and no longer suitable; Occupied = Site remains suitable and Bay checkerspot butterflies observed in at least a portion of the site in some years (not occupied every year); Potential (no records) = Site contains habitat that could be made suitable with proper management (currently unoccupied); Occupancy Unknown = Site status unknown due to lack of field surveys.

[3] Metcalf North Ridge is also referred to as “San Felipe”

Sources: ICF Land Cover Maps, Stanford University Center for Conservation Biology Population Data (through 2006), and personal communications with S. Weiss and A. Launer (2006–2007).

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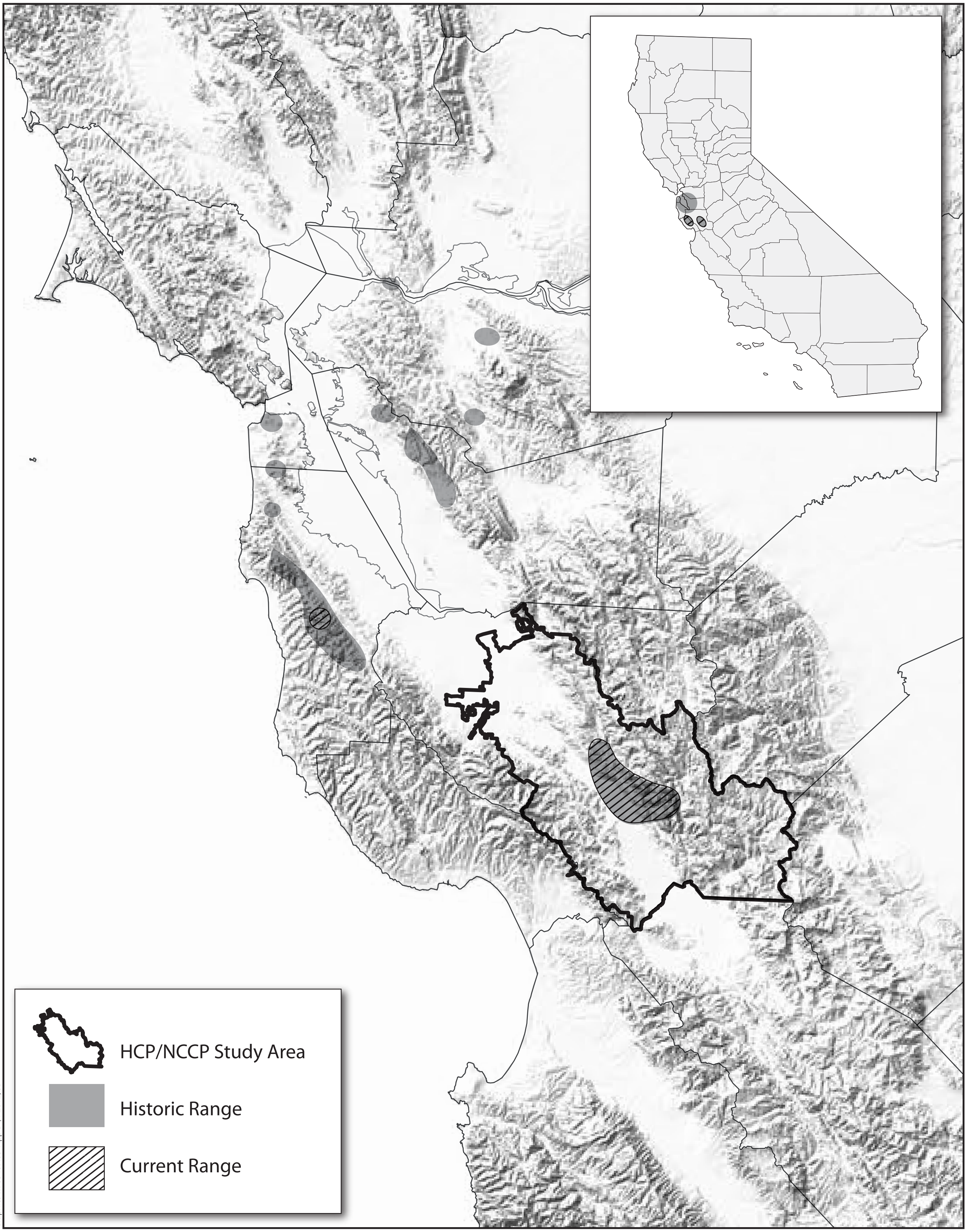

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Figure 1
Bay Checkerspot Butterfly (*Euphydryas editha bayensis*) Distribution in California

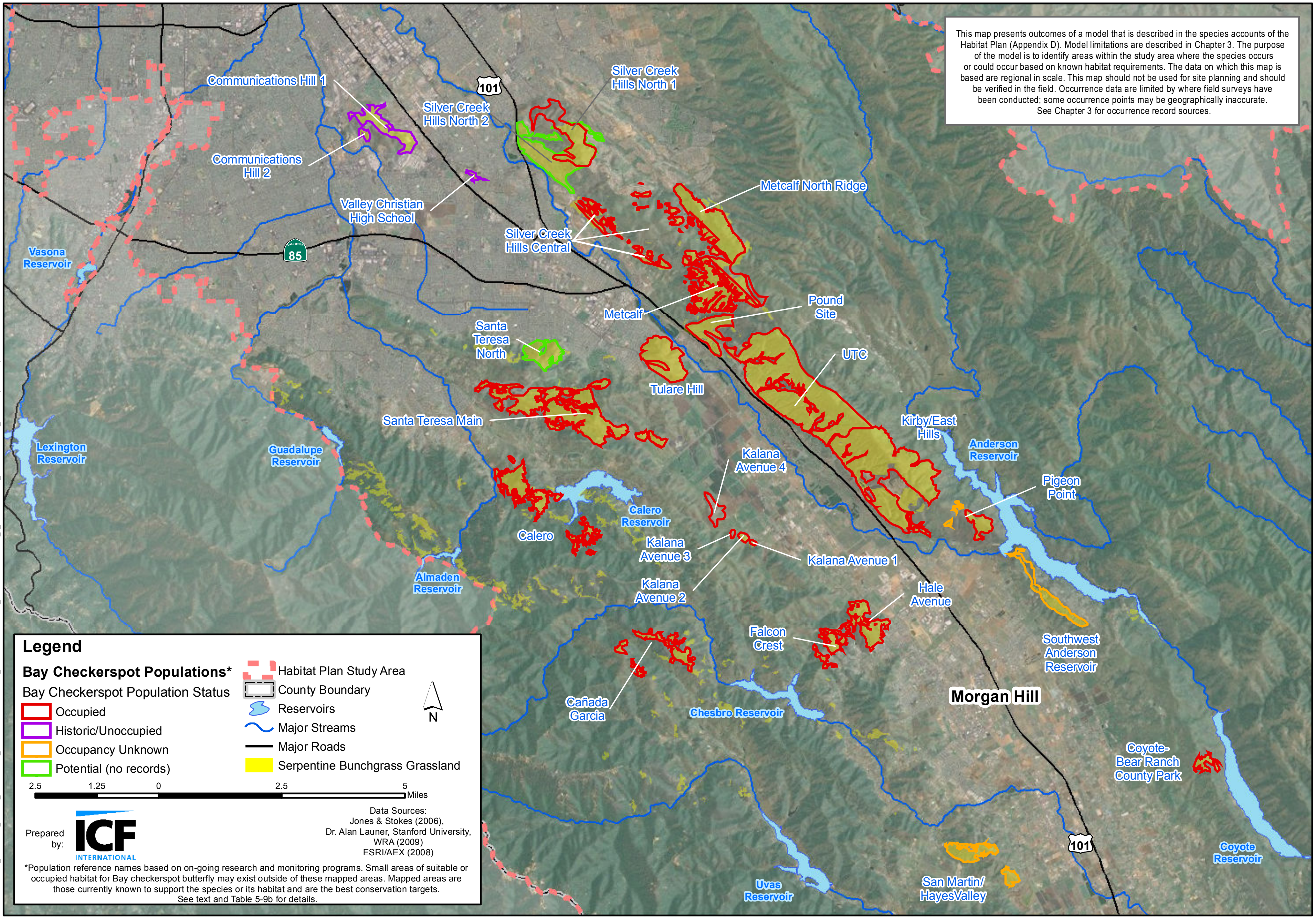

Figure 2
Bay Checkerspot Butterfly Populations - Santa Clara Valley Habitat Plan

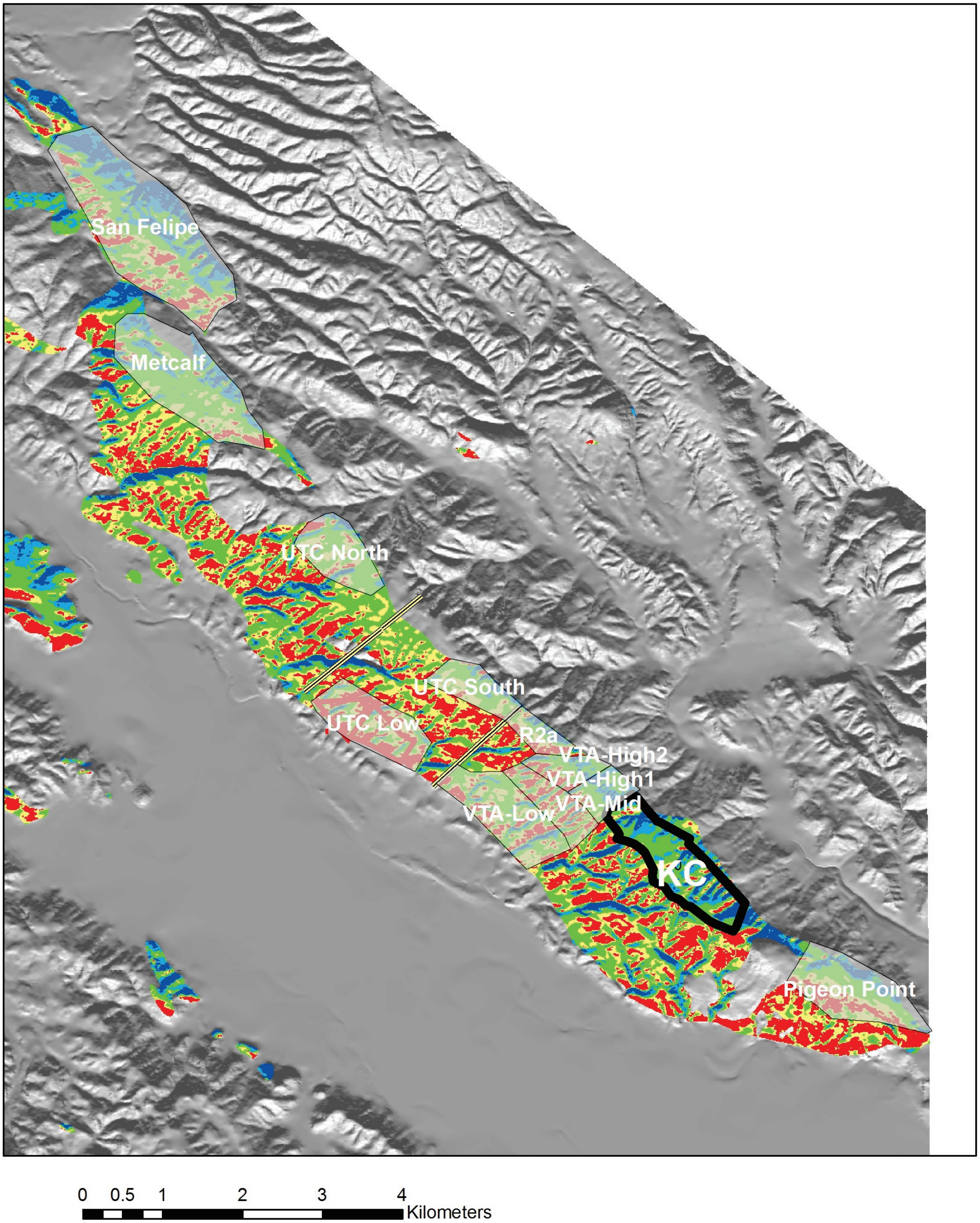

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Figure 3
Coyote Ridge Population Zones

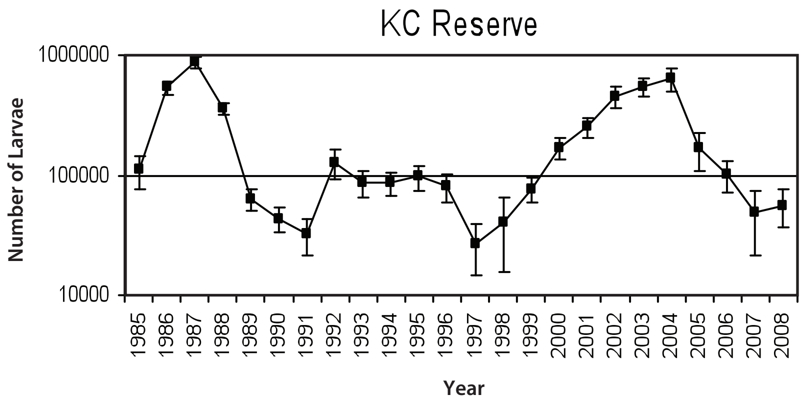

Figure 4a. Population Trends at Kirby Canyon Trust Butterfly Leasehold

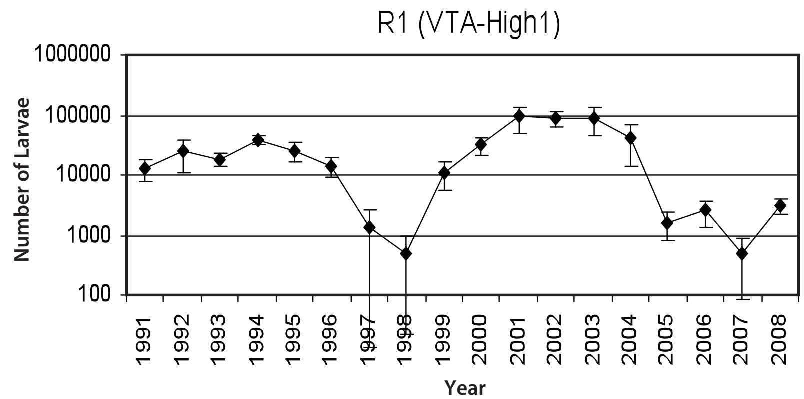

Figure 4b. Population Trends at VTA High 1

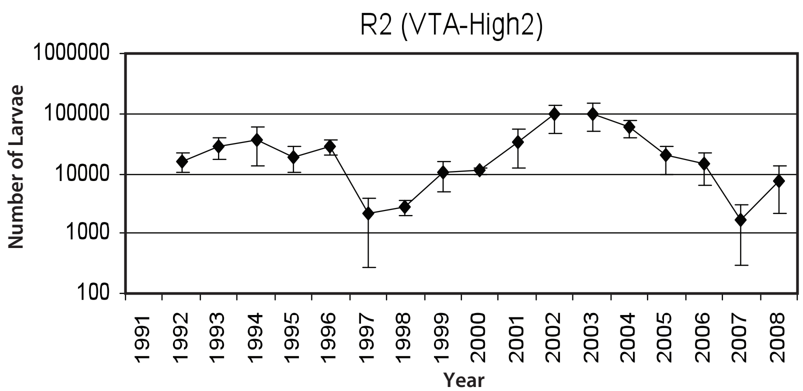

Figure 4c. Population Trends at VTA High 2

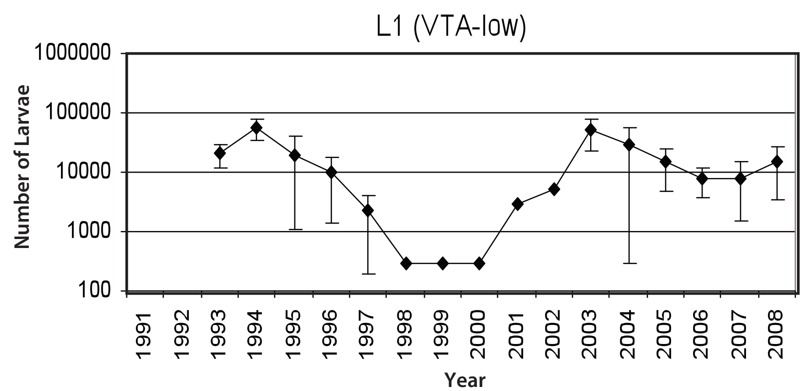

Figure 4d. Population Trends at VTA Low

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Figure 4
Population Trends

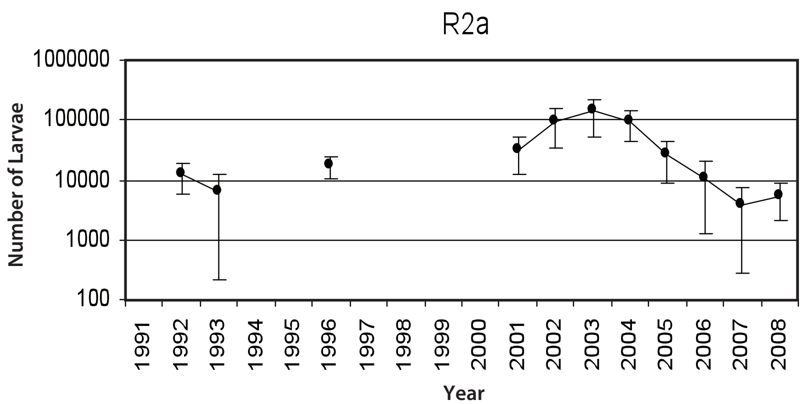

Figure 4e. Population Trends at R2a

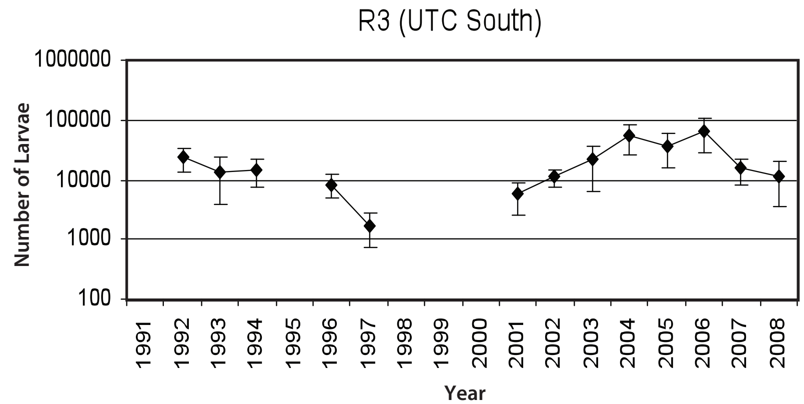

Figure 4f. Population Trends at UTC South

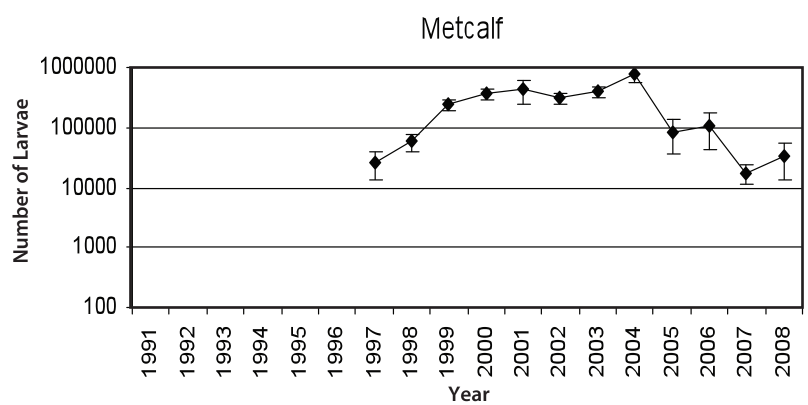

Figure 4g. Population Trends at Metcalf

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Figure 4 (continued)
Population Trends

California Tiger Salamander (*Ambystoma californiense*)

Legal Status

State: Threatened[1]
Federal: Central California population listed as Threatened (U.S. Fish and Wildlife Service 2004); Sonoma County and Santa Barbara County populations listed as Endangered (U.S. Fish and Wildlife Service 2000, 2003)[2]
Critical Habitat: Designated for the central California population only on August 23, 2005 (U.S. Fish and Wildlife Service 2005a)
Recovery Planning: None for central California population. A recovery strategy has been developed for the Sonoma County population (U.S. Fish and Wildlife Service 2005b)

Taxonomy

Formerly regarded as a subspecies of *A. tigrinum*, the California tiger salamander (*Ambystoma californiense*) was first described by Gray in 1853 based on specimens that had been collected in Monterey, California. Based on recent studies of the genetics, geographic distribution, and ecological differences among the members of *A. tigrinum* complex, the California tiger salamander has been determined to represent a distinct species (U.S. Fish and Wildlife Service 2004).

The biogeographical and genetic information supporting the recognition of the Santa Barbara County and Sonoma County populations as distinct population segments under the federal Endangered Species Act are reviewed in those listing decisions (U.S. Fish and Wildlife Service 2000, 2003). More information on the taxonomic status and a description of the species' physical characteristics can be found in the listing decision for the central California population (U.S. Fish and Wildlife Service 2004).

[1] The California Fish and Game Commission determined that the California tiger salamander should be listed as threatened on May 20, 2010. This determination still needs to be finalized by the State Office of Administrative Law. The state listing applies to the entire range of this species.
[2] The 2004 listing of the central California population of the California tiger salamander (U.S. Fish and Wildlife Service 2004a) also downgraded the Sonoma County and Santa Barbara County populations of the species from endangered to threatened. However, an August 19, 2005 ruling from U.S. District Judge William Alsup vacated this downlisting, so these populations remain listed as endangered.

Distribution

General

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 areas it once occupied (Fisher and Shaffer 1996; Stebbins 1985). The loss of California tiger salamander populations has been due primarily to habitat loss within their historic range (Fisher and Shaffer 1996) (Figure 1).

Based on genetic analysis, there are six populations of California tiger salamanders, distributed as follows: (1) Santa Rosa area of Sonoma County, (2) Bay Area (central and southern Alameda, Santa Clara, western Stanislaus, western Merced, and the majority of San Benito counties), (3) Central Valley (Yolo, Sacramento, Solano, eastern Contra Costa, northeast Alameda, San Joaquin, Stanislaus, Merced, and northwestern Madera counties), (4) southern San Joaquin Valley (portions of Madera, central Fresno, and northern Tulare and Kings counties), (5) Central Coast range (southern Santa Cruz, Monterey, northern San Luis Obispo, and portions of western San Benito, Fresno, and Kern counties), and (6) Santa Barbara County (Shaffer and Trenham 2005).

Most populations occur at elevations below 1,500 feet, but California tiger salamanders have been recorded at elevations up to 3,660 feet, just below Rose Peak in the Ohlone Regional Wilderness, Alameda County (California Department of Fish and Game 2010). 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 nonnative species (Fisher and Shaffer 1996).

Occurrences within the Study Area

Historical

There are records from throughout the study area from 1895 to 1990 (California Natural Diversity Database 2006). California tiger salamanders are thought extirpated from at least eight historical breeding areas (California Natural Diversity Database 2006). The eight extirpated sites all occur along the valley floor in the study area and follow the Highway 101 corridor. The extirpation of the species from these areas is likely due to habitat lost to development.

Recent

There are approximately 100 occurrence records from 1990 through 2005 in the study area (California Natural Diversity Database 2006; T. Marker pers. comm.). The occurrences are scattered throughout the study area and on both sides of the valley, with large clusters of occurrences in Henry W. Coe State Park and Joseph D. Grant County Park. See Figure 2 for all recent occurrences.

Natural History

Habitat Requirements

California tiger salamanders require two 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 one mile of water (Jennings and Hayes 1994). Following metamorphosis California tiger salamanders are terrestrial animals which spend most of their time underground in subterranean refuge sites, or *refugia*. Underground retreats are usually California ground squirrel (*Spermophilus beechyii*) or pocket gopher (*Thomomys bottae*) burrows and, occasionally, human-made structures. Adults emerge from underground to breed, but only for brief periods during the year. California 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 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 for cover (Holland et al. 1990). California tiger salamanders can overwinter in burrows up to one mile from their breeding sites (Jennings and Hayes 1994) and have been documented up to ~1.2 mile (Sweet pers. comm.).

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 retain water for a minimum of 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 refugia (Shaffer et al. 1994; Jennings and Hayes 1994).

California tiger salamanders primarily use California ground squirrel burrows as refuge sites (Loredo et al. 1996; Trenham 2001); Botta's pocket gopher (*Thomomys bottae*) burrows are also frequently used (Barry and Shaffer 1994; Jennings and Hayes 1994). 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).

Table 1. Habitat Associations for California Tiger Salamander

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Herbaceous-dominated	Dispersal, refugia	Dispersal	Tiger salamanders can be found up to 1.3 mile (2.1 km) from wetlands and aquatic habitats, spend majority of lives in burrows in upland habitats	U.S. Fish and Wildlife Service 2004
Wetlands	Breeding, larval development	Breeding	All life stages occur around breeding sites	U.S. Fish and Wildlife Service 2004
Aquatic	Breeding, Larval development	Breeding	All life stages may occur around breeding sites	U.S. Fish and Wildlife Service 2004

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 the winter rains, 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). This species also uses permanent human-made ponds (without predatory fish) for reproduction. 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. In ponds without vegetation, females lay eggs on objects on the pond bottom (Stebbins 1972; Shaffer and Fisher 1991; Barry and Shaffer 1994; Jennings and Hayes 1994). After breeding, adults leave the breeding ponds and return to their refugia (small mammal burrows, etc.).

After approximately two weeks, the salamander eggs begin to hatch into larvae. Once larvae reach a minimum body size they metamorphose into terrestrial juvenile salamanders. The amount of time that salamanders spend in the larval stage and the size of individuals at the time of metamorphosis seems to be dependent on many factors. Larvae in small ponds develop faster, while larvae in larger ponds that retain water for a longer period are larger at time of metamorphosis. At a minimum, salamanders require ten weeks living in ponded water to complete metamorphosis but in general development is completed in 3–6 months (Petranka 1998). If a pond dries prior to metamorphosis, the larvae will desiccate and die (U.S. Fish and Wildlife Service 2000). Juveniles disperse from aquatic breeding sites to upland habitats after metamorphosis (Storer 1925; Holland et al. 1990).

Foraging Requirements

Aquatic larvae feed on algae, small crustaceans, and small mosquito larvae for about six weeks after hatching (U.S. Fish and Wildlife Service 2000). Larger larvae feed on zooplankton, amphipods, mollusks, and smaller tadpoles of Pacific treefrogs (*Pseudacris regilla*), California red-legged frogs *(Rana aurora draytoni*), western toads (*Bufo boreas*) and spadefoot toads (*Spea* spp.) (Zeiner et al. 1988; U.S. Fish and Wildlife Service 2000). Adults eat earthworms, snails, insects, fish, and small mammals (Stebbins 1972).

Table 2. Key Seasonal Periods for California Tiger Salamander

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding/Migration	✓	✓									✓	✓
Larval development			✓	✓	✓	✓	✓	✓				
Metamorphosis					✓	✓	✓	✓				
Juvenile Dispersal	✓	✓				✓	✓	✓	✓	✓	✓	✓

Sources: Jennings and Hayes 1994; Zeiner et al. 1988

Movement

The proximity of refuge sites to aquatic breeding sites also affects the suitability of salamander habitat. Adult tiger salamanders have been observed up to 1.3 miles (2.1 km) from breeding ponds (U.S. Fish and Wildlife Service 2004). A recent trapping effort in Contra Costa County captured California tiger salamanders at distances ranging from 2,641 feet to 3,960 feet from the nearest breeding, aquatic site (U.S. Fish and Wildlife Service 2004). In a study in winter 2002–2003. Trenham and Shaffer (2005) found that 95% of tiger salamanders resided within 2040 feet (620 meters) of their breeding pond in Solano County.

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 meters) and 85 feet (26.0 meters), respectively. 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.

Dispersal of juveniles from natal ponds to underground refugia could occur throughout the year. While juveniles will move short distances from breeding ponds once they start to dry up in the late spring and summer, longer distances from breeding ponds are attained during rainy periods. Juveniles disperse from breeding sites after spending a few hours or days near the pond margin (Jennings and Hayes 1994). Juveniles have been observed to migrate up to 1 mile from breeding pools to upland areas (U.S. Fish and Wildlife Service 2004). Dispersal distance is likely phased and may increase with an increase in precipitation (Trenham 2001).

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 1996). 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. Dispersal rates are probably high enough to prevent local extirpations within a pool complex.

Table 3. Movement Distances for California Tiger Salamander

Type	Distance/Area	Location of Study	Citation
Adult migration	620 meters	Jepson Prairie Preserve	Trenham and Shaffer 2005
	2,641–3,960 feet	Contra Costa County	U.S. Fish and Wildlife Service 2004
	0.9–1.3 mile	Santa Barbara	Sweet pers. comm. 2006
Juvenile migration	630 meters	Jepson Prairie Preserve	Trenham and Shaffer 2005
	700 meters	Monterey County	Trenham et al. 2001

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).

Population Status and Trends

Global: *Declining* (NatureServe 2006) (Endemic to California)
State: Declining
Within Study Area: Unknown

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 two 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 nonnative 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 nonnative 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, predation by exotic fish appears 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 nonnative 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 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 barriers to movement or maintaining roads that support a considerable amount of vehicle traffic in areas that support California tiger salamander populations could 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 and reduced genetic diversityof 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. See **Appendix K** for more details on hybridization between California tiger salamanders and nonnative salamanders.

Data Characterization

Because this species is listed under the federal Endangered Species Act it has received much attention within its range, including within the study area. Stock ponds are one of the primary likely sources of breeding habitat within the study area. Most of these stock ponds have not been surveyed for California tiger salamanders use, particularly those in remote parts of the study area. Most of the suitable habitat that is threatened by development or other changes in land use has been adequately surveyed, and the threats to the species within the study area have been accurately identified.

Existing Conservation Actions in the Study Area

Santa Clara Valley Water District has been conducting ongoing amphibian surveys in several areas in its jurisdiction, including stock ponds in Carnadero Preserve, Palassou Ridge, and Henry W. Coe State Park (D. Padley pers. comm.). The Santa Clara County Open Space Authority conducts pond and wetland restoration on their lands that is designed to benefit California tiger salamander and other species.

Modeled Habitat Distribution in Study Area

Model Description

Assumptions

Breeding and Foraging

Potential breeding habitat within the study area is assumed to be all ponds (excluding percolation ponds), coastal and valley freshwater marshes, natural lakes, and seasonal wetlands within riparian, grassland, oak woodland, and conifer woodland land cover types.

Upland Refugia and Dispersal Habitat

Upland habitats that provide subterranean refugia for this species are assumed to be within 1.3 miles of primary habitat in grassland, chaparral and coastal scrub, oak woodland, riparian forest/scrub, riparian forest/woodland wetlands, conifer woodlands, and agricultural areas.

Rationale

California tiger salamanders require two major habitat components: aquatic breeding sites and upland or refuge sites. California tiger salamanders inhabit valley and foothill grasslands and the grassy understory of open woodlands, usually within 1.3 miles of water (U.S. Fish and Wildlife Service 2005a). 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.

Breeding salamanders migrate from upland habitats to aquatic breeding sites during 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 for cover (Holland et al. 1990). California tiger salamanders may occupy burrows up to 1.3 mile from their breeding sites during the non-breeding period (U.S. Fish and Wildlife Service 2005a).

Model Results

Figure 2 shows the modeled potential habitat for the California tiger salamander within the study area. The model output designates breeding habitat and bases upland and dispersal habitat on known movement distances determined by the best knowledge of the species. Suitable habitat for this species is spread evenly throughout the undeveloped portions of the study area, primarily due to the even distribution of stock ponds and other aquatic habitat.

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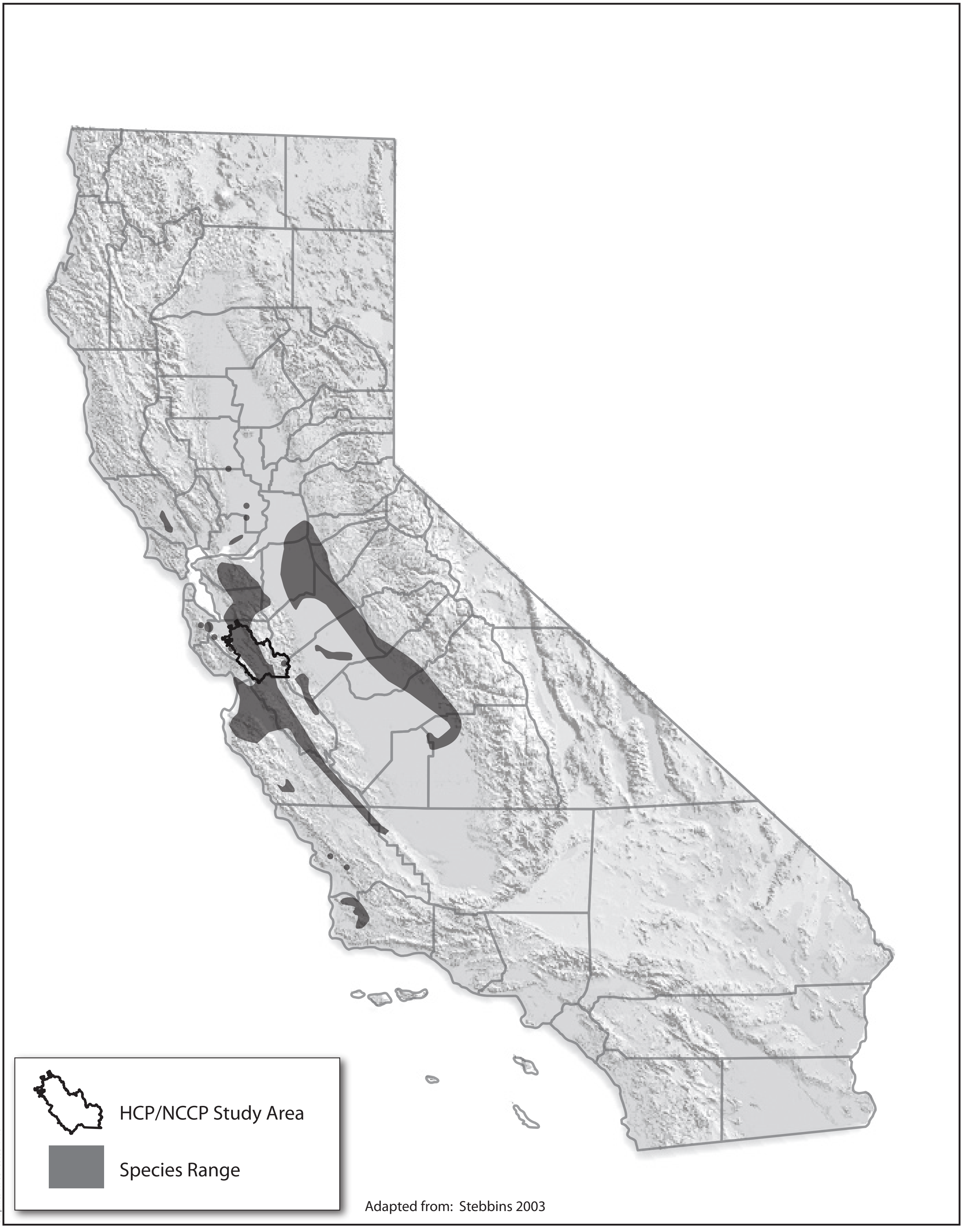

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Figure 1
California Tiger Salamander (*Ambystoma californiense*) Distribution in California

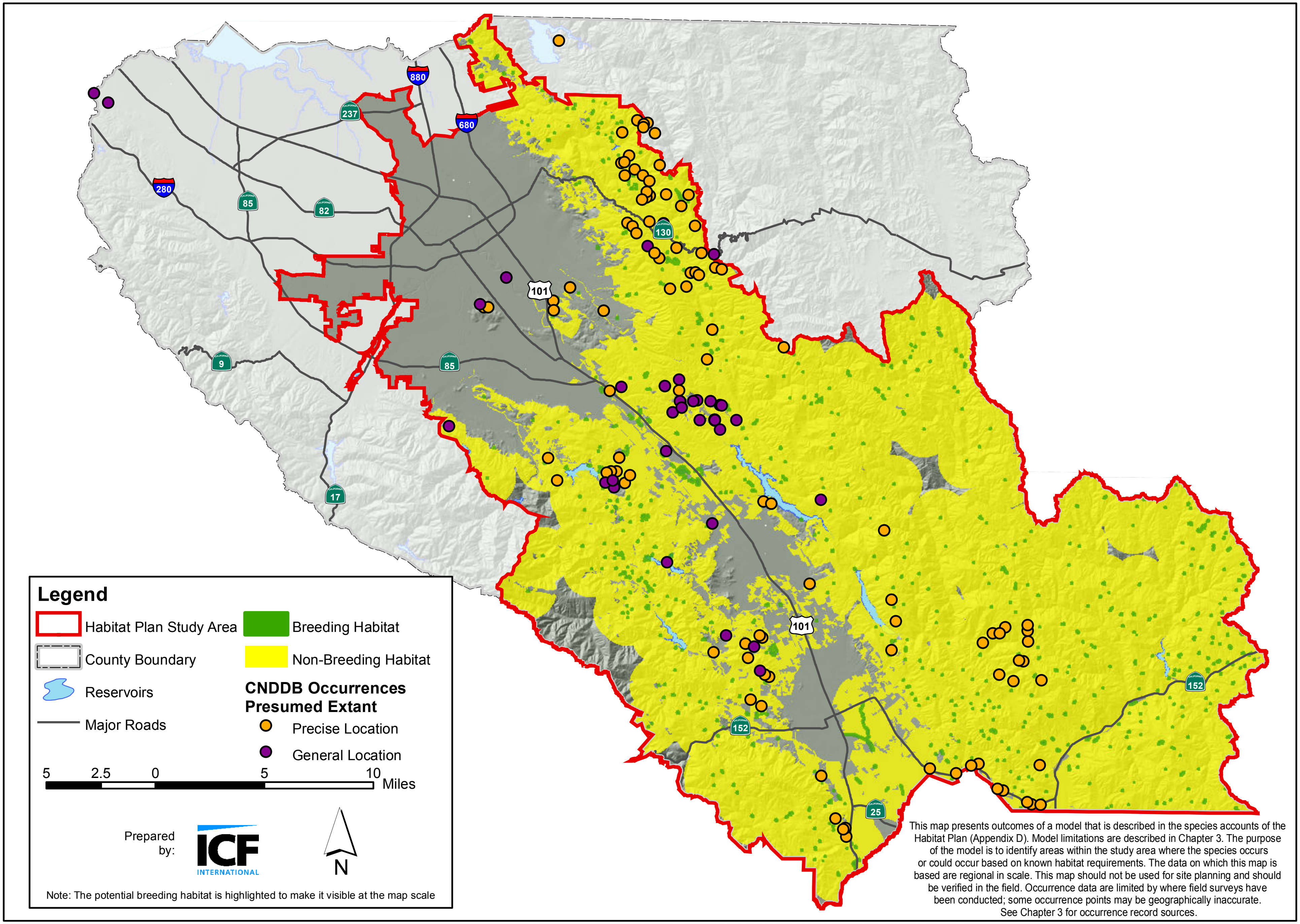

Figure 2
California Tiger Salamander Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

California Red-Legged Frog (*Rana draytonii)*

Legal Status

State: Species of Special Concern
Federal: Threatened
Critical Habitat: Designated April 2006 (U.S. Fish and Wildlife Service 2006); Revised March 2010 (U.S. Fish and Wildlife Service 2010)
Recovery Planning: Final Recovery Plan May 2002 (U.S. Fish and Wildlife Service 2002)
Notes: Status not anticipated to change during permit period

Taxonomy

The California red-legged frog and northern red-legged frog (*R. a. aurora)* are considered conspecific subspecies with a broad zone of intergradation (Shaffer et al. 2004). Some red-legged frogs found in the intervening areas (southern Del Norte to northern Marin County along the Coast Range), exhibit intergraded characteristics of both subspecies (Hayes and Krempels 1986 in U.S. Fish and Wildlife Service 2002). The two subspecies, and intergrades of the subspecies, may occur together in Mendocino County (U.S. Fish and Wildlife Service 2002).

Descriptions of the species' physical characteristics can be found in the U.S. Fish and Wildlife Service Recovery Plan (U.S. Fish and Wildlife Service 2002).

Distribution

General

The historical range of the California red-legged frog *(Rana draytonii)* 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 is in isolated patches in the Sierra Nevada, northern Coast, and Santa Monica Mountains (Hogan pers. comm.). It is still common in the San Francisco Bay area and along the central coast. In Southern California the species is believed extirpated from the Santa Rosa Ecological Reserve but persists in the Santa Monica Mountains and in San Fransquito Canyon in Newhall (Hogan pers. comm.) (Figure 1).

Occurrences within the Study Area

Historical

The red-legged frog was historically found throughout Santa Clara County. There are a number of historic red-legged frog records within the study area dating from 1904 to 1980 (Padley pers. comm.). The observations are shown in Figure 2 and represent museum and California State University at San José records (1904 through 1983), as well as unpublished California Department of Fish and Game records (no specific dates; observed before 1980).

Recent

An analysis of known locality records for red-legged frog from Santa Clara County (H.T. Harvey and Associates 1997) concluded that the species has essentially disappeared from the urbanized lowland areas of the county as well as from the brackish marshlands bordering the San Francisco Bay. Extant riparian habitats within this region are largely channelized or contain a wide variety of introduced predatory fishes and bullfrogs (Padley pers. comm.). However, red-legged frogs are still found in the foothill and mountain ranges throughout the county (H.T. Harvey and Associates 1997).

According to the California Natural Diversity Database (CNDDB), 93 occurrences of California red-legged frog have been documented within the study area (California Natural Diversity Database 2006). U.S. Fish and Wildlife Service (2002) reports that adult frogs have been observed in Upper Alameda Creek in the Sunol Regional Wilderness, and in many creeks from this area, south to Henry W. Coe State Park.

Approximately half of the occurrences are in creek and pond habitats in Henry W. Coe State Park (Figure 2). Twenty-four of the occurrences are on private property, while the remaining occurrences are on public properties, including City of San José, Santa Clara Valley Water District, and Santa Clara County properties.

Natural History

Habitat Requirements

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 1989).

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 the ponds are managed to provide suitable hydroperiod, pond structure, vegetative cover, and control of nonnative predators.

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 hayricks. The frogs will also use small mammal burrows, incised streamed channels, or areas with moist leaf litter (Jennings and Hayes 1994; U.S. Fish and Wildlife Service 1996, 2002). However, this summer movement behavior has not been observed in all California red-legged frog populations studied.

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* spp.) (U.S. Fish and Wildlife Service 2002). Aquatic larvae are mostly herbivorous algae grazers (Jennings et al. 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).

Table 1. Habitat Associations for California Red-Legged Frog

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Herbaceous-dominated	Dispersal, forage, refugia	Secondary, movement	Occur in open grasslands with seeps and springs (within 2 miles of seeps, springs, creeks, ponds, and lakes).	Such water sources are too ephemeral for breeding but may provide foraging and refugia habitat for dispersing frogs (U.S. Fish and Wildlife Service 2005)
Riparian woodland	Dispersal, forage, refugia	Secondary, year-round movement, summer	Frogs can be found up to 100 meters from emergent vegetation, undercut banks, rootballs, or small mammal burrows which all provide shelter.	U.S. Fish and Wildlife Service 2002, 2005
Riparian scrub	Dispersal, forage, refugia	Secondary, year-round movement, summer	Same as for riparian woodland.	U.S. Fish and Wildlife Service 2002, 2005
Wetlands	All life stages	Primary, breeding, refugia	All life stages may occur around breeding sites, or frogs may seek multiple habitats.	U.S. Fish and Wildlife Service 2002, 2005
Aquatic	All life stages	Primary, breeding, refugia	All life stages may occur around breeding sites, or frogs may seek multiple habitats.	U.S. Fish and Wildlife Service 2002, 2005

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). Those eggs develop into tadpoles in 20–22 days. 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). Males usually attain sexual maturity at 2 years of age and females at 3 years of age.

Table 2. Key Seasonal Periods for California Red-Legged Frog

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding	✓	✓	✓	✓							✓	✓
Larval development			✓	✓	✓	✓	✓	✓	✓			
Metamorphosis								✓	✓	✓		

Source: U.S. Fish and Wildlife Service 2002.

Movement

California red-legged frogs may move over 2 miles up or down drainages from breeding sites and have been observed using adjacent riparian woodlands up to 100 feet from the water (Rathbun et al. 1993). Dispersing frogs have been recorded to cover distances from 0.25 mile to more than 2 miles without apparent regard to topography, vegetation type, or riparian corridors (Bulger 1998). 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. Generally speaking, red-legged frogs will use the extent of a riparian corridor no matter how narrow or wide it is. The primary features driving the use of this habitat are cool moist soil under shrubs or other vegetation where frogs can find refuge for short periods before returning to the water.

On rainy nights, red-legged frogs may roam away from aquatic sites as much as one mile. Red-legged frogs often move away from the water after their first winter, causing sites where red-legged frogs were easily observed in the summer months to appear devoid of this species. Additionally, red-legged frogs sometimes disperse in response to receding water, which often occurs during the driest time of the year (U.S. Fish and Wildlife Service 2005).

Table 3. Movement Distances for California Red-Legged Frog

Type	Distance/Area	Location of Study	Citation
Dispersal/migration	0.25 to 2 miles	Santa Cruz County	Bulger et al. 2003
Dispersal/migration	9 to 48 feet	Ventura County	Rathbun et al. 1993, U.S. Fish and Wildlife Service 2005

Note: Disparity in distances between the two studies is likely a function of riparian corridor width or habitats adjacent to riparian areas.

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 variety of invertebrates and vertebrates, as well as algae and larvae. Numerous native 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 (*Didpephis virginiana*), striped skunks (*Mehpitis mephitis*), spotted skunks (*Spilogale pituorius*), 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 catesteiana*), 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).

Adult California red-legged frogs can live 8 to 10 years (Jennings et al. 1992), but the average life span is probably much lower (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.

Population Status and Trends

Population Trend

Global: Declining (NatureServe 2006)
State: Declining (Jennings et al. 1992)
Within Study Area: Declining (Jennings et al. 1992)

Although population numbers are not precisely known, the U.S. Fish and Wildlife Service estimates that California red-legged frog populations are declining at a rapid rate. A 70% reduction in the geographic range of this subspecies was witnessed in the early to mid-1990s. This decline was primarily a result of habitat loss and alteration and introduction of exotic predators (U.S. Fish and Wildlife Service 2002).

Threats

Threats to the species include removal and alteration of habitat due to urbanization, overgrazing of aquatic and riparian habitats, and predation by nonnative species. During a controlled study in 1995, Lawler et al. (1999) found that fewer than 5% of California red-legged frog tadpoles will survive in ponds with bullfrogs present. The viability of 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 the degradation, fragmentation, and loss of habitat through agriculture, mining, recreation, timber harvesting, nonnative plants, impoundments, water diversions, degraded water quality, introduced predators, and poorly managed infrastructure maintenance activities, such as road construction and repair. These activities can degrade California red-legged frog habitat by increasing disturbance, reducing water quality, or increasing competition and predation pressure.

Habitat along many stream courses has 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 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 might be an important factor in these declines.

Livestock grazing can have positive or negative impacts on breeding California red-legged frogs depending largely on intensity. Livestock grazing may decrease the suitability of riparian habitat to sustain California red-legged frog populations within the study area. Cattle degrade riparian habitat because they congregate in these areas and trample riparian vegetation. This loss of streamside vegetation can result in increased erosion, increased water temperatures, and reduced numbers of available prey. Conversely, in some grazing areas, artificially created stock ponds provide ideal breeding habitat for California red-legged frog, and grazing may help maintain pond suitability by keeping ponds from being choked with vegetation (U.S. Fish and Wildlife Service 2002).

Finally, gravel mining can degrade habitat by altering the hydrology of aquatic systems, increasing sedimentation, and degrading water quality (U.S. Fish and Wildlife Service 2002).

Data Characterization

As noted above, the CNDDB contains 93 documented occurrences of the species in the study area. Existing information should be sufficient to evaluate habitat suitability in the study area. However, much of the HCP/NCCP study area includes private lands that have not been surveyed systematically for this species. The species' ecology, dispersal, and reproduction is relatively well studied.

Existing Conservation Actions in the Study Area

Biologists from the Santa Clara Valley Water District have surveyed many areas within the streams of Santa Clara County for California red-legged frogs and plan to expand the survey program in upcoming years (U.S. Fish and Wildlife Service 2002; Padley pers. comm.). Other conservation actions for California red-legged frog known in the study area are plans to conduct bullfrog removal in key stock ponds within Henry W. Coe State Park (B. Breckling pers. comm.).

Modeled Species Distribution in Study Area

Model Description

Model Assumptions

Primary Habitat—Breeding and Foraging

All riverine, coastal and valley freshwater marshes, riparian forest/woodland wetlands, ponds (excluding percolation ponds), and natural lakes in riparian forest/scrub, grasslands, oak woodland, chaparral and coastal scrub, conifer woodland, and agriculture land cover types were considered potential breeding and foraging habitat for California red-legged frog.

Secondary Habitat—Movement and Refugia

All grassland, chaparral and coastal scrub, oak woodland, riparian forest/scrub, and conifer woodland land cover types within 100 feet of primary habitat are characterized as upland refugia. All grassland, chaparral and coastal scrub, oak woodland, riparian forest/scrub, conifer woodland, and agriculture land cover types beyond 100 feet but within 2 miles of primary habitat are characterized as dispersal habitat.

Rationale

Breeding and foraging habitat: Breeding sites used by California red-legged frogs include a variety of aquatic habitats (Stebbins 1985; Hayes and Jennings 1988). 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 Santa Clara Valley HCP/NCCP study area, stock ponds are frequently used as breeding sites by this species. All existing ponds and streams within the study area were, therefore, considered potential suitable breeding habitats for California red-legged frogs.

Movement and refugia habitat: During dry weather, California red-legged frogs likely remain in or near water. California red-legged frogs may move over 2 miles up or down drainages from breeding sites and have been observed using adjacent riparian woodlands up to 100 feet from the water (Rathbun et al. 1993). However, as ponds dry out, these frogs disperse from their breeding sites to other areas with water or to temporary shelter or aestivation sites. For this reason, all grassland, chaparral and coastal scrub, oak woodland, riparian forest/scrub, and conifer woodland land cover types within 100 feet of primary habitat are characterized as upland refugia.

Dispersing frogs have been recorded to cover distances from 0.25 mile to more than 2 miles without apparent regard to topography, vegetation type, or riparian corridors (Bulger 1998). This 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). Dispersal and migration movements are generally straight-line, point-to-point migrations rather than following specific habitat corridors (U.S. Fish and Wildlife Service 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 grassland, chaparral and coastal scrub, oak woodland, riparian forest/scrub, conifer woodland, and agriculture land cover types beyond 100 feet but within a radius of two miles from all potential breeding sites were potential migration and/or aestivation habitats for California red-legged frogs.

Model Results

Figure 2 shows the modeled potential habitat for the California red-legged frog within the study area. Due to the abundance of aquatic habitat in the moderate to high elevations of the study area the associated upland refugia and dispersal habitat is quite expansive. The known occurrences of this species fall within the modeled habitat.

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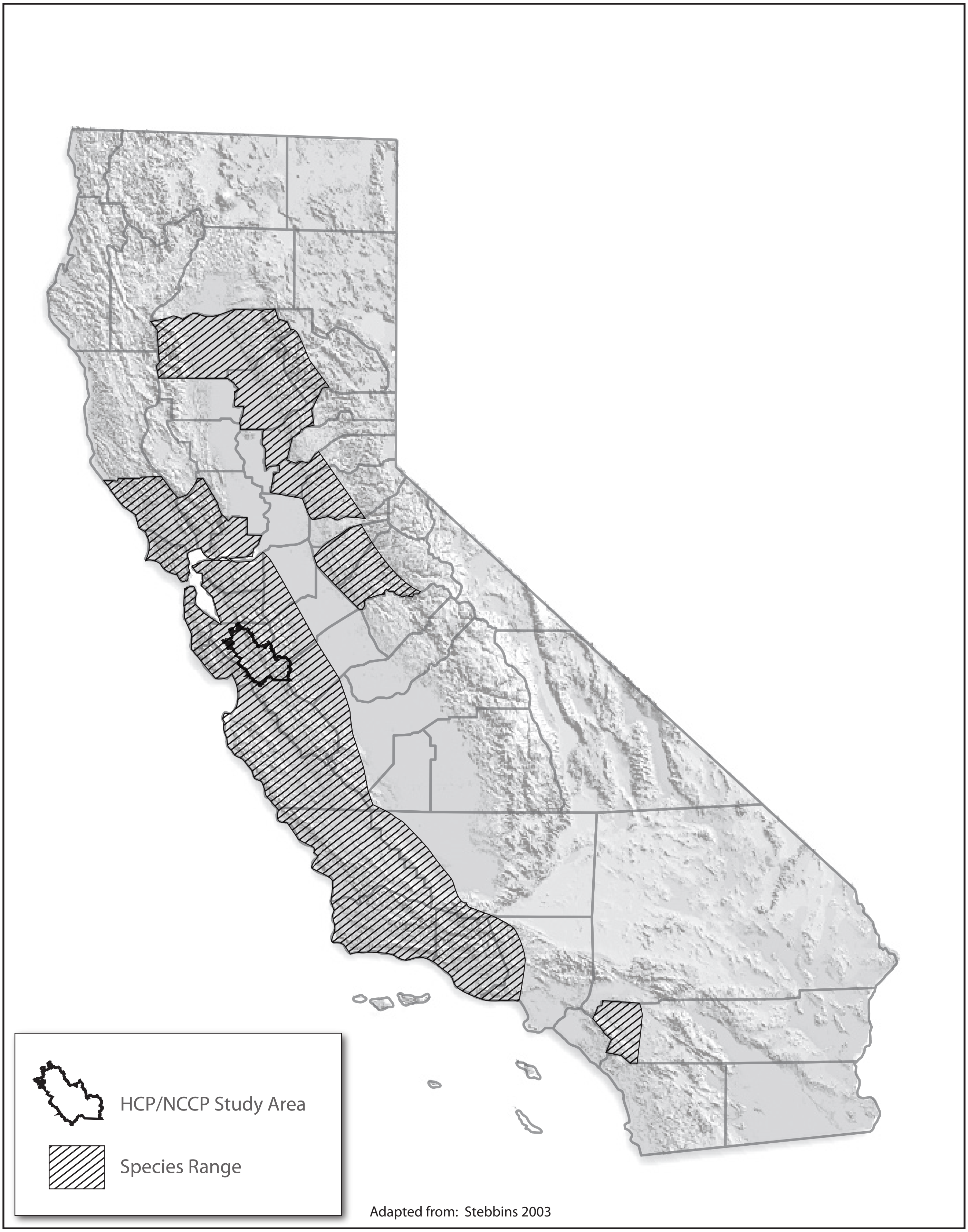

ICF INTERNATIONAL

Figure 1
California Red-Legged Frog (*Rana aurora draytonii*)
Distribution in California

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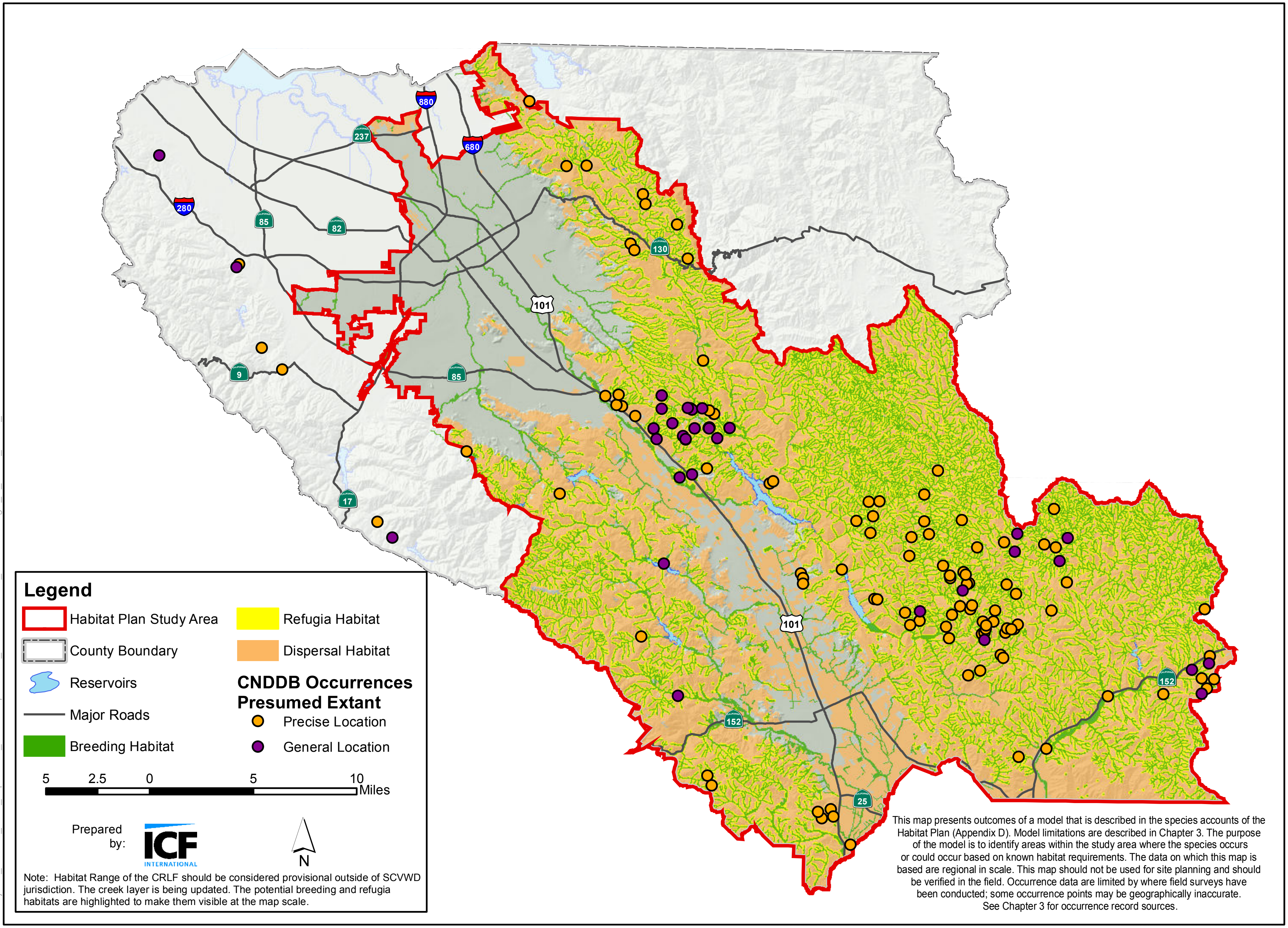

Figure 2
California Red-legged Frog Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Foothill Yellow-legged Frog (*Rana boylii*)

Legal Status

State: Species of Special Concern
Federal: None
Critical Habitat: None
Recovery Planning: None

Taxonomy

Mitochondrial DNA data suggest that *Rana aurora, R. cascadae,* and *R. muscosa* form a clade within the *R. boylii* species group (Macey et al. 2001). Descriptions of the species' physical characteristics can be found in Stebbins 2003.

Distribution

General

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 2003). The known elevation range of the species extends from near sea level to approximately 2,040 meters (6,700 feet) above sea level (Stebbins 2003). 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) (Figure 1). The foothill yellow-legged frog is still common along the north coast of California (G. Fellers cited by Stebbins and Cohen 1995). Fellers (1994) reported healthy, reproducing populations throughout suitable habitat in the Diablo Range in Alameda, western Stanislaus, Santa Clara, San Benito, and western Fresno counties.

Occurrences within the Study Area

Historical

Historically, foothill yellow-legged frogs were probably present in virtually all of the larger perennial streams in Santa Clara County with the exceptions of the lower portions of Coyote Creek and Guadalupe River (H.T. Harvey and Associates 1999). There are no CNDDB records for foothill yellow-legged frogs prior to 1990. The lack of CNDDB data could be explained by the fact that the California Department of Fish and Game did not require surveyors to submit survey results before 1995 (California Natural Diversity Database 2006).

Recent

In 1999, H.T. Harvey and Associates summarized the distribution status of the foothill yellow-legged frog for the Santa Clara Valley Water District (H.T. Harvey and Associates 1999). They concluded that, based on their analysis of known locality records, the species had essentially disappeared from the farmed and urbanized lowland areas of the county, as well as many of the perennial streams below major reservoirs. It was determined that though the species is declining throughout Santa Clara County they are still present in the Santa Cruz Mountains and fairly abundant in the foothill and mountain ranges of eastern Santa Clara County (H.T. Harvey and Associates 1999). The extant occurrences as reported by H.T. Harvey and Associates (1999) are captured in the occurrence records for Figure 2.

This species has been found in most perennial streams and rivers in the study area, particularly in the upper reaches. There are several records from the upper reaches of Coyote Creek along with records from nearly all of the streams in the Pajaro River watershed. According to the California Natural Diversity Database (2006), there are nine extant occurrence records of foothill yellow-legged frog in the study area. Seven of the occurrences are on the east side of the valley the northern most of which is in Penetencia Creek. The others are in the Santa Cruz Mountains west of Gilroy.

Natural History

Habitat Requirements

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; Bourque 2008). 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). Typical breeding and egg deposition occurs in stream habitat that has little to no slope (U.S. Forest Service 2011). 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; Kupferberg 1996). The timing of oviposition typically follows the period of high-flow discharge from winter rainfall and snowmelt (Jennings and Hayes 1994; Kupferberg 1996).

The embryos have a critical thermal maximum temperature of 26°C (Zweifel 1955).

Table 1. Habitat Associations for Foothill Yellow-Legged Frog

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Riparian Woodland	Movement	Primary	Unknown	Nussbaum et al. 1983
Riparian Scrub	Movement	Primary	Unknown	Nussbaum et al. 1983
Aquatic	Breeding	Primary	All life stages occur at aquatic sites	Ibis Environmental Inc. 2003; Morey 2005; U.S. Forest Service 2011

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 fifteen weeks is required to reach metamorphosis, which typically occurs between July and September (Storer 1925; Jennings 1988). Larvae attain adult size in two years (Storer 1925). In a study on the Eel River along the northern coast of California, foothill yellow-legged frog chose sites to lay eggs and timed egg laying to avoid fluctuations in river stage and current velocity associated with changes in river discharge (Kupferberg 1996). This suggests that stable flow and current velocities are important to create suitable reproductive sites for foothill yellow-legged frogs.

Table 2. Key Seasonal Periods for Foothill Yellow-legged Frog

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding			✓	✓	✓	✓						
Metamorphosis							✓	✓	✓			
Dispersal (metamorphosis)								✓	✓	✓		
Sources: Ibis Environmental, Inc. 2003; Twitty et al 1967.												

Movement

Foothill yellow-legged frogs are a highly aquatic amphibian, spending most or all of their life in or near streams, though frogs have been documented underground and beneath surface objects more than 50 meters (165 feet) from water (Nussbaum et al. 1983). Bourque (2008) reported the movements of radio-tracked frogs being restricted to watercourse, though movement distances were considerably longer than previously reported with mark recapture techniques. Bourque (2008) found that radio-tagged frogs were relocated on land adjacent to water 37.7% (males) and 65.6% (females). Average distance from water was <3 meters with a range from 6.9–40 meters (Bourque 2008). Distance moved from perennial, ephemeral and intermittent streams was similar. During the breeding season, from March through June, adults and subadults may move several hundred meters or more to congregate at breeding sites (Ibis Environmental, Inc. 2003). Bourque (2008) documented movements up to 578 meters (males) and 7,043 meters (females) during the breeding season. Adult male foothill yellow-legged frogs have high site fidelity during the breeding season and typically occupy small home ranges near breeding site (Bourque 2008).

Table 3. Movement Distances for Foothill Yellow-legged Frog

Type	Distance/Area	Location of Study	Citation
Breeding	300 m +	Unknown	Ibis Environmental, Inc. 2003
	578 m (males)	Tehama County, CA	Bourque 2008
	7,043 m (females), median = 525 m	Tehama County, CA	Bourque 2008
Non-breeding	155 feet	Pacific Northwest	Nussbaum et al. 1983

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. The foothill yellow-legged frog coexists with the California red-legged frog (*Rana aurora draytonii*) at some localities, but different microhabitat preferences probably diminish competition (California Wildlife Habitat Relationships System 2005).

Population Status and Trends

Global: Declining (NatureServe 2006)
State: Declining (Jennings and Hayes 1994)
Within Study Area: Declining (H.T. Harvey and Associates 1999)

Threats

Habitat loss and degradation, introduction of exotic predators, and toxic chemicals (including pesticides) pose continued and increasing threats to the long-term viability of 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; Lind 2005; Kupferberg 2009), and decreased flows can force adult frogs to move into permanent pools, where they may be more susceptible to predation (Hayes and Jennings 1988)

Threats include stream scouring (which may negatively impact frogs in streambed hibernation sites), introduced incompatible aquatic animals, riverine and riparian impacts of nonselective logging practices, and stabilization of historically fluctuating stream flows. See Lind et al. (1996), Lind (2005) and Kupferberg et al. (2009) for information on the association of population decline in watershed with dams.

Davidson et al. (2002) found evidence that airborne agrochemicals have played a significant role in the decline of this species; habitat destruction, climate change, and UV-B radiation also appeared to be contributing factors. Lind (2005) further linked changes in land use and use of air-borne toxins on the absence of foothill yellow-legged frogs in areas where they had been previously documented.

Kupferberg (1997) found that bullfrog larvae perturbed aquatic community structure and exerted detrimental effects on *Rana boylii* populations in northern California but had only a slight impact on *Pseudacris regilla.* Interspecific matings between male *R. boylii* and female bullfrogs have been observed; these interactions with nonnative bullfrogs might reduce the reproductive output of *R. boylii* (Lind et al. 2003). Centrachid fishes readily eat *Rana* eggs (Werschkul and Christensen 1977), and where introduced into foothill streams, may also contribute to the elimination of foothill yellow-legged frogs (Morey 2005).

Data Characterization

Because the California Department of Fish and Game did not require surveyors to submit survey results before 1995, any recorded occurrences before that time have gone undocumented (California Natural Diversity Database 2006). Few areas within the study area have been surveyed for this species, and several of the observations are incidental. Relatively few areas have been adequately surveyed because of the difficulty of access to private lands within the county (H.T. Harvey and Associates 1999). For this reason a more conservative approach was taken when modeling habitat for this species.

Existing Conservation Actions in the Study Area

There are no conservation efforts within the study area that directly target the recovery of this species. However, stream restoration projects that return creeks and streams to natural flow regimes will benefit this species.

Modeled Species Distribution in Study Area

Model Description

Model Assumptions

Primary Habitat—Breeding and Foraging

Low gradient streams (0 to 4% slope) or rivers not regulated by a dam, in riparian forest/scrub, grassland, oak woodland, and conifer woodland land cover types.

Secondary Habitat—Low Use Habitat

Moderate gradient streams (4% to 10% slope) or rivers 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, typically with low gradients (U.S. Forest Service 2011), with at least some cobble-sized substrate (Hayes and Jennings 1988; Jennings 1988; H.T. Harvey and Associates 1999). This species has also been found in perennial streams without cobble (Fitch 1938; Zweifel 1955) and has been documented using intermittent and ephemeral stream during fall/winter (Bourque 2008), but it is not clear whether these habitats are regularly used in Santa Clara County (Hayes and Jennings 1988; Jennings and Hayes 1994; H.T. Harvey and Associates 1999). By including all stream types in the model we compensate for under-surveyed areas. Although secondary habitat (moderate gradient streams or rivers) may not support the species and likely have fewer conservation opportunities for this species, those areas were retained in the model output because occurrences have been documented in such habitat.

Model Results

Figure 2 shows the modeled potential habitat of the foothill yellow-legged frog within the study area. Primary habitat appears to be present in portions of stream habitats with low gradients that are more likely to be perennial. Secondary habitat includes moderate gradient streams. The known occurrences in the study area fall within the modeled habitat, including in many foothill streams near areas of primary habitat.

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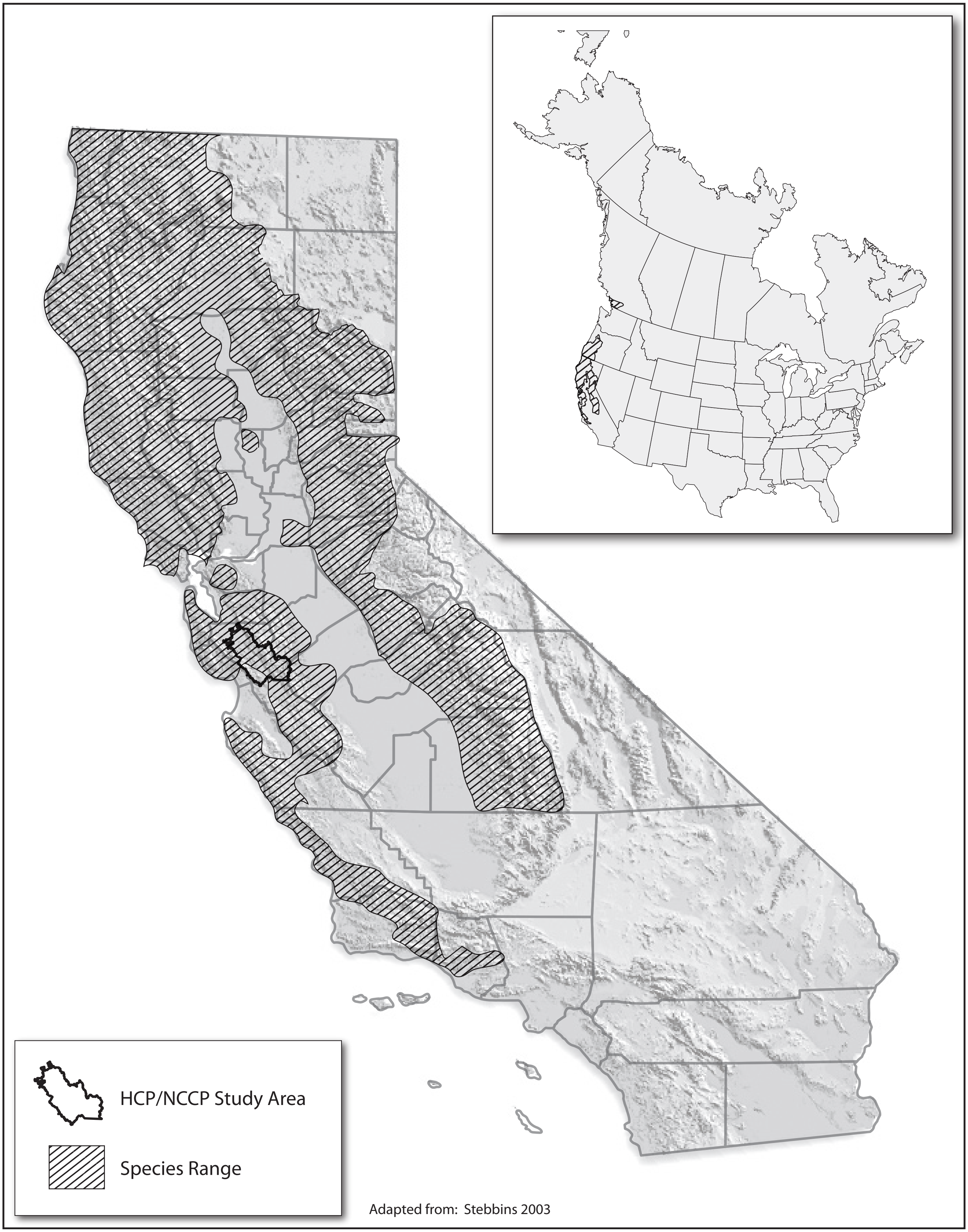

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Figure 1
Foothill Yellow-Legged Frog (*Rana boylii*) Distribution in California

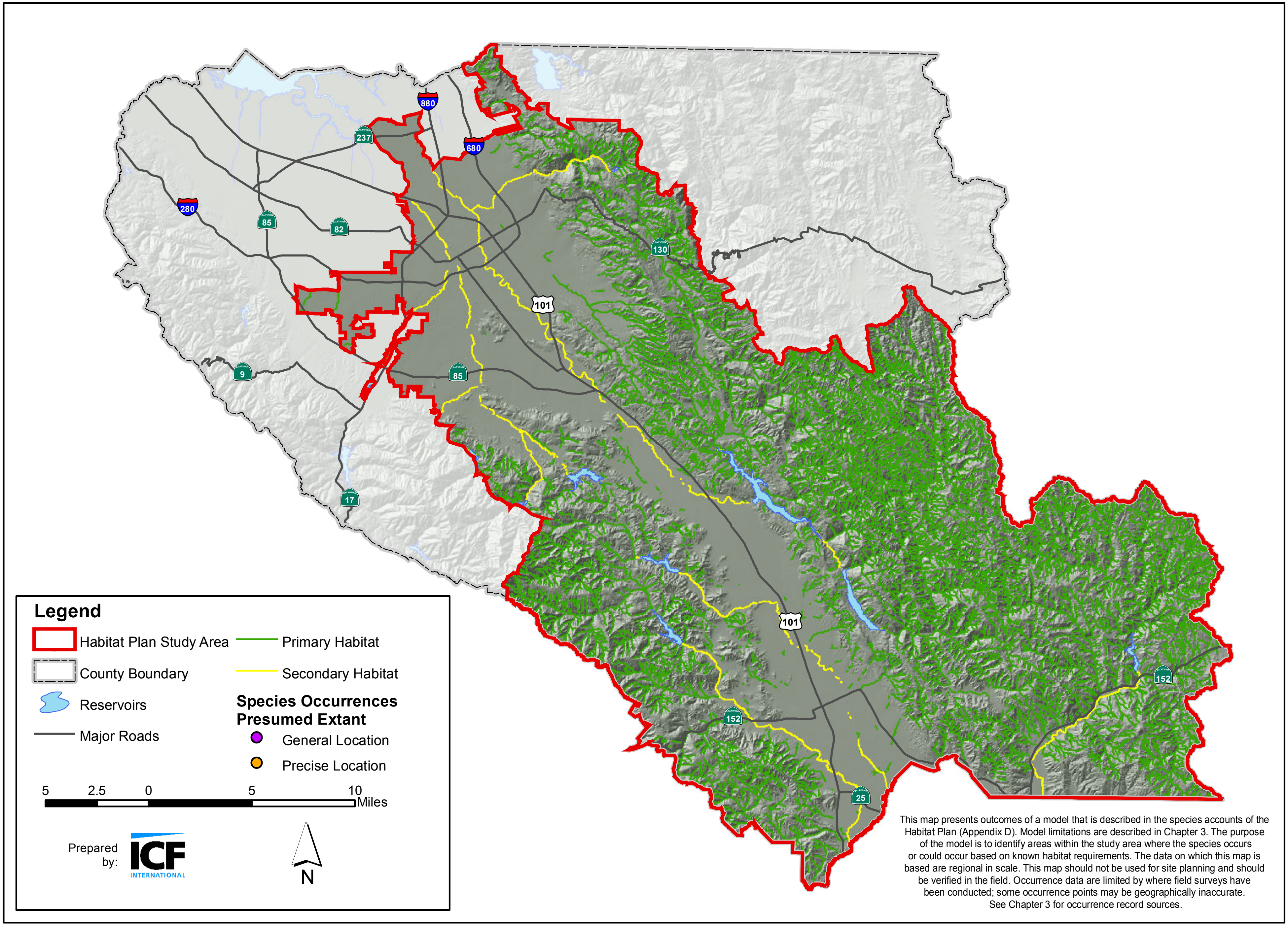

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Figure 2
Foothill Yellow-Legged Frog Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Western Pond Turtle (*Clemmys marmorata*)

Legal Status

State: Species of Special Concern; meets requirements as a rare, threatened, or endangered species under the California Environmental Quality Act (CEQA)
Federal: None
Critical Habitat: N/A
Recovery Planning: N/A

Taxonomy

Western pond turtle is the only species in its genus that occurs in the western United States. This species occurs in 90% of its historic range in the Central Valley and west of the Sierra Nevada Range but in greatly reduced numbers (Jennings and Hayes 1994). There are two recognized subspecies: the northwestern pond turtle (*Clemmys marmorata marmorata*) and the southwestern pond turtle (*Clemmys marmorata pallida*). Genetic research supports the distinctiveness of the two subspecies (Gray 1995; Janzen et al. 1997). The taxonomy is currently under review. A summary of this is outlined by NatureServe (2006). Descriptions of the species' physical characteristics can be found in Stebbins (2003).

Distribution

General

Historically, the western pond turtle had a relatively continuous distribution in most Pacific slope drainages from Klickitat County, Washington, along the Columbia River (Slater 1962) to Arroyo Santo Domingo, northern Baja California, Mexico. In California, it was historically present in most Pacific slope drainages between the Oregon and Mexican borders (Jones & Stokes 2004). The area of the Central Valley of California between the American River drainage and the Transverse Ranges is considered a zone of intergradation between the two subspecies (Seeliger 1945; U.S. Fish and Wildlife Service 1999) (Figure 1).

Occurrences within the Study Area

Historical

There are 53 documented occurrences within the study area (California Natural Diversity Database 2006). Of those 53, only 3 were documented before 1985. Though this species is thought to be historically abundant within the study area, there is little information to justify this claim. The fact that the species persists in highly altered aquatic habitat (e.g., channelized waterways and reservoirs) lends support to the idea that it was more abundant when these habitats were in a more natural state.

Recent

There are 50 known recent occurrences of this species within the study area (California Natural Diversity Database 2006). All of these occurrences were assumed to be extant at the time of documentation. Nearly all were recorded with fair to excellent confidence, leaving only one with poor confidence and seven with unknown confidence. The majority (37) of the occurrences were recorded in the southern half of Santa Clara County. Most are associated with reservoirs or creeks (namely Uvas and Llagas Creeks) as they enter reservoirs. The occurrence data may be bias in favor of areas where observers are likely to make incidental observations (reservoirs, Henry W. Coe State Park, and other park facilities). Western pond turtles have been documented throughout the Coyote Creek drainage from the upper reaches in Henry W. Coe State Park to the urbanized reaches in San José (California Natural Diversity Database 2006).

Natural History

Habitat Requirements

Western pond turtles occur in a variety of aquatic habitats from sea level to elevations of 6,500 feet. They are found in rivers, streams, lakes, ponds, wetlands, reservoirs, and brackish estuarine waters (Holland 1994; Jennings and Hayes 1994). Western pond turtles use aquatic habitats primarily for foraging, thermoregulation, and avoidance of predators. They prefer habitats with large areas for cover (such as logs, algae, and vegetation) and basking sites (such as boulders or other substrates). The species has been observed to avoid areas of open water lacking these habitat features (Holland 1994). Both adult and juvenile turtles favor aquatic habitats with access to areas of deep, slow water with underwater refugia. Hatchlings are relatively poor swimmers and tend to seek areas with shallow, warm water, free of predatory aquatic vertebrates, with at least some aquatic vegetation (Reese 1996; Holland 1994; Jones & Stokes 2004).

Western pond turtles overwinter in both aquatic and terrestrial habitats. Aquatic refugia consist of rocks, logs, mud, submerged vegetation, and undercut areas along banks. Terrestrial overwintering habitat consists of burrows in leaf litter or soil. The presence of a duff layer seems to be a general characteristic of overwintering habitat (Jones & Stokes 2004; Holland 1994; Davis 1998).

Table 1. Land Cover Type Associations for Western Pond Turtle

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Wetlands	Foraging, thermoregulation, refuge	Primary	Cover and basking sites	Holland 1994
Aquatic	Foraging, thermoregulation, refuge	Primary	Cover and basking sites	Holland 1994
Shrub dominated	Nesting	Primary	Sunny and relatively undisturbed	Rathbun et al. 2002; Jennings and Hayes 1994
Herbaceous dominated	Nesting	Primary	Sunny and relatively undisturbed; some grazing is tolerated	Rathbun et al. 2002; Jennings and Hayes 1994
Riparian woodland	Refugia, thermoregulation	Secondary	Well developed riparian corridor protects aquatic habitats	Holland 1994; Jennings and Hayes 1994
Riparian scrub	Refugia, thermoregulation	Secondary	Well developed riparian corridor protects aquatic habitats	Holland 1994; Jennings and Hayes 1994

Reproduction

Western pond turtles first breed at 10 to 14 years of age (U.S. Fish and Wildlife Service 1999; Stebbins 2003). Most females lay eggs in alternate years. Clutch size ranges from 1 to 13 eggs, with larger females generally laying larger clutches (Holland 1985a, 1991a). Gravid females leave drying creeks from May through July to deposit their eggs in sunny, upland habitats, including grazed pastures and agricultural fields (Crump 2001). Nesting has been reported to occur up to 402 meters (1,391 feet) from water (Jennings and Hayes 1994) but is usually closer, averaging 28 meters (92 feet) from aquatic habitat (Rathbun et al. 2002). Incubation lasts 80 to 100 days, and the normal hatch success is approximately 70%. Nest predation rates are high, and complete failure of nests is common.

Table 2. Key Seasonal Periods for Western Pond Turtle

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nesting					✓	✓	✓					
Movement to nest sites				✓	✓							
Hatching and dispersal							✓	✓	✓			

Sources: Jennings and Hayes 1994; Rathbun et al. 2002; Jones & Stokes 2004.

Movement

Western pond turtles utilize a home range on the order of several hundred meters (Holland 1994), with males using a larger aquatic home range than females. Individuals may occasionally make sporadic long-distance aquatic movements outside their home range (Holland 1994). Gravid females usually leave the water to nest on land in the late afternoon or evening, returning to the water by morning, although this is quite variable (Crump 2001). Nest sites have been found as far as 400 meters from the water (Reese 1996). Reese (1996) found that over the summer months (May–September), juvenile turtles have an average maximum movement of approximately 84 meters. Their mean weekly aquatic travel is 19.9 meters. Their home range is smaller than that of adults but larger than previously recognized and also includes terrestrial components (Reese 1996). Juveniles sometimes travel back and forth between low-flow portions of the river and adjacent ponds.

Table 3. Movement Distances for Western Pond Turtle

Type	Distance/Area	Location of Study	Citation
Home range (aquatic)	>100m from watercourse to upland	Oregon	Holland 1994
Movement to nesting sites from watercourse	Up to 400m	Northern California	Reese 1996
Movement to overwintering sites from home range	~167m	Northern California	Reese 1996

Ecological Relationships

Western pond turtles are considered dietary generalists, but they do not select food items based on general availability (Bury 1986). This species prefers live prey, which it captures by opportunistic foraging tactics. Individuals will also scavenge carrion and browse on plant material. Prey items are ingested in the water; it appears this species is unable to swallow in air (Holland 1994). Preferred food items include aquatic insect larvae, crustaceans (cladocerans and crayfish), and annelids. Small vertebrates (including *Rana boylii* tadpoles and egg masses) have been found during gut content analysis of *C. marmorata*, but it is unclear whether these were ingested as prey or carrion (Bury 1986; Holland 1994).

Several common predator prey on western pond turtles. These predators include, but are not limited to raccoon (*Procyon lotor*), coyote (*Canis latrans*), grey fox *(Urocyon cinereoargenteus*), and feral and domestic dogs (*Canis familiaris*) (Holland 1994). Adult turtles often show scarring on the shell and/or missing limbs, indicating attempted predation.

Hatchlings are especially vulnerable to predators because their shell is soft and they can be swallowed whole. Overland movements from the nest site to the aquatic habitat expose turtles to a wide range of terrestrial predators. Holland (1994) found a six-fold greater scarring rate on females and attributed it to greater exposure to predators during nesting movements. Exotic aquatic predators, such as bullfrogs (*Rana catesbeiana*) and largemouth bass (*Micropterus salmoides*), can be especially effective at reducing recruitment in this species when turtles arrive at the preferred aquatic microhabitat after leaving the nest site (Holland 1994).

Population Status and Trends

Global: Declining (Bury 1986; NatureServe 2006)
State: Unknown
Within Study Area: Unknown

The species is declining throughout its range, more so in Washington and Oregon than in California (NatureServe 2006). The status of the population in California is not well understood but decline is generally attributed to a loss of nesting habitat (see below).

Threats

Numerous factors, including loss, degradation, and fragmentation of habitat; disease; introduced predators and competitors; and other natural and anthropogenic conditions present ongoing threats to western pond turtles throughout 75–80% of its range (U.S. Fish and Wildlife Service 1999; Holland 1991a).

Recent studies describe populations that have adults but few juveniles, indicating that little or no reproduction is taking place (Jones & Stokes 2004). Because pond turtles are long-lived, non-reproducing populations may persist in isolated wetlands long after recruitment of young has ceased (Holland 1991a; Jennings and Hayes 1994; U.S. Fish and Wildlife Service 1999).

Data Characterization

Currently, the sizes and densities of western pond turtle populations in California are not well known. Information on dispersal, population structure, population dynamics, and the nature and dynamics of environmental factors affecting populations (including edge effects) is needed to effectively design and implement conservation plans. In addition, the current genetic diversity of existing populations should be investigated to determine metapopulation status, gene flow between populations, and long-term population viability.

Existing Conservation Actions in the Study Area

There are currently no known conservation actions in the study area that target this species. However, any creek or stream restoration that returns altered aquatic systems to a natural setting will benefit the western pond turtle.

Modeled Habitat Distribution in Study Area

Model Description

Model Assumptions

Primary Habitat—Nest Sites, Basking, Overwintering
All ponds, streams, canals/ditches, and coastal and valley freshwater marsh are considered primary habitat. In addition, areas within 150 feet of these landcover types are considered suitable nesting and overwintering habitat. There would be an exception to this rule if the landcover within this 150 feet buffer consisted of rock outcrops, vineyards, orchards or urban areas.

Secondary Habitat—Nest Sites and Movement
Movement habitat includes all land cover types within 1,200 feet of primary habitat with the exception of areas within this buffer that consist of rock outcrops, vineyards, orchards or urban areas.

Rationale

The western pond turtle is a thoroughly aquatic turtle of ponds, marshes, rivers, streams, and irrigation ditches with aquatic vegetation (Jennings and Hayes 1994). Gravid females oviposit in sunny upland habitats, on grassy banks and in grazed pastures. Nesting has been reported to occur up to 402 meters (1,391 feet) from water (Jennings and Hayes 1994), but is usually closer, averaging 28 meters (92 feet) from aquatic habitat (Rathbun et al. 2002). To accommodate this range but remain conservative, a buffer distance of 150 feet from all aquatic habitat was used to model primary habitat for this species. Nests have been observed in many soil types, from sandy to very hard. Soil must usually be at least 10 cm (4 in) deep for nesting, and nests must have a relatively high internal humidity for eggs to develop and hatch properly (Zeiner 1988). To account for long-distance dispersal to nest sites or movement between water bodies, the distance of 1,200 feet from all aquatic habitat was used to model habitat suitable for this purpose. Though this is not all inclusive of the documented 1,391 foot dispersal by Jennings and Hayes (1994), it likely still overestimate the actual upland habitat use by this species.

Model Results

Figure 2 shows the modeled potential habitat of the western pond turtle within the study area. Primary habitat is prevalent in the study area due to the abundance of streams and ponds, particularly in the areas above the valley floor. Movement habitat is found throughout the western and eastern portions of the study area adjacent to streams and ponds. The documented occurrences of western pond turtle in this study area correspond well to locations within the identified suitable habitat and movement corridors.

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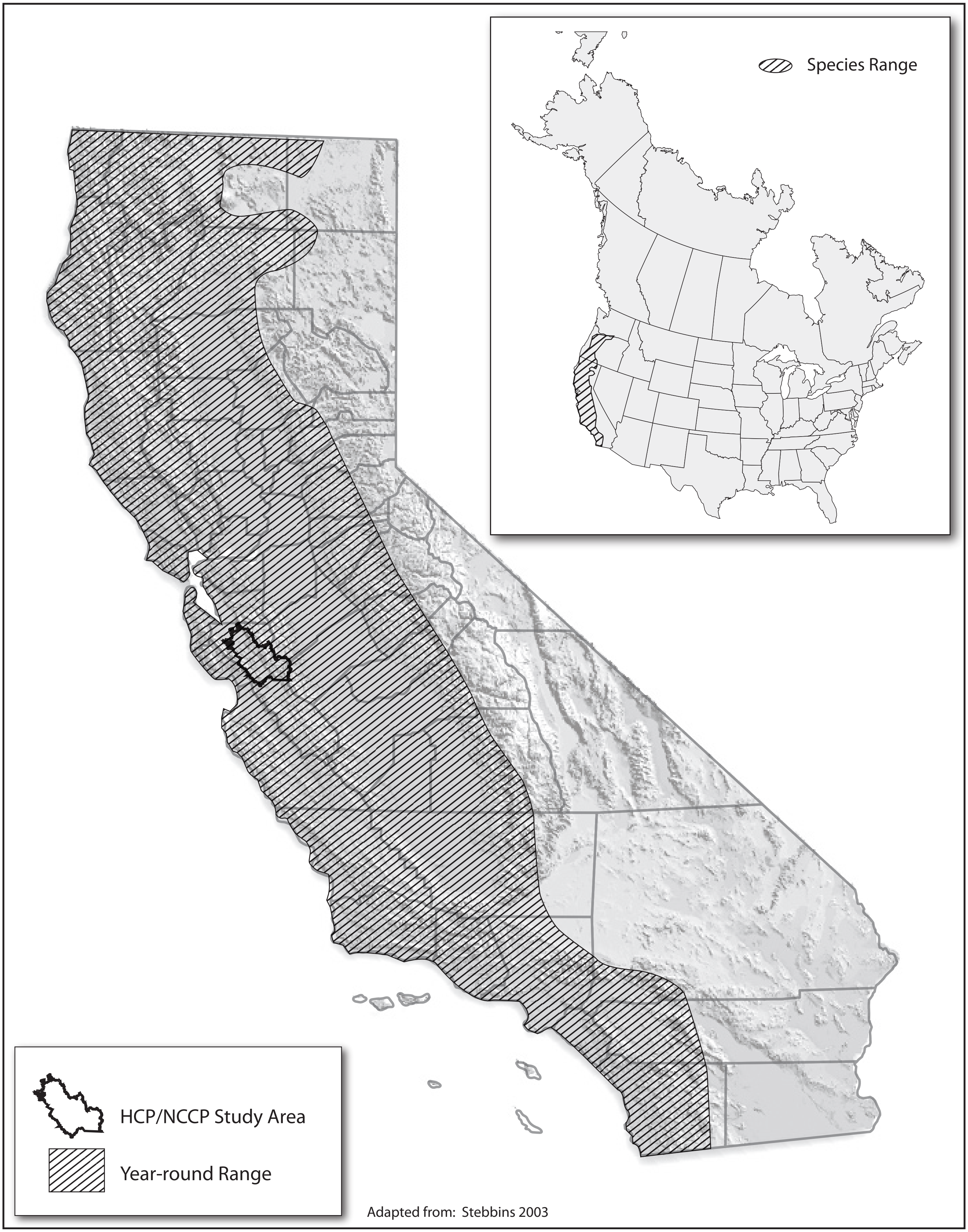

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Figure 1
Western Pond Turtle (*Clemmys marmorata*)
Distribution in California

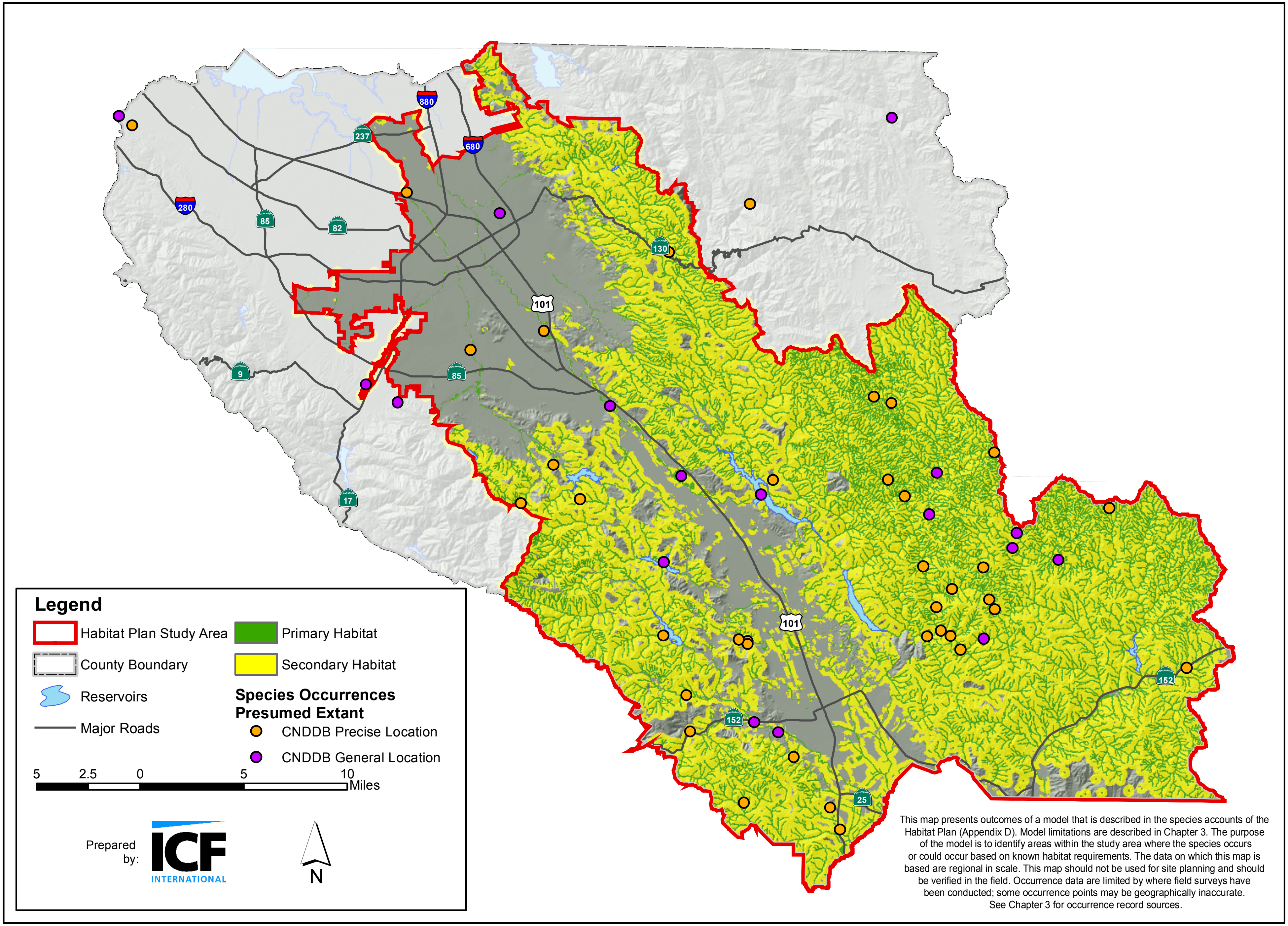

Figure 2
Western Pond Turtle Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Western Burrowing Owl (*Athene cunicularia hypugaea*)

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Legal Status

State: Bird Species of Special Concern, *Second Priority* (Shuford and Gardali 2008)
Federal: Migratory Bird Treaty Act (16 USC 703–712); National Bird of Conservation Concern (U.S. Fish and Wildlife Service 2002)
Critical Habitat: N/A
Recovery Planning: N/A
Notes: The burrowing owl has been included on the list of California Species of Special Concern since 1978 (Remsen 1978; Shuford and Gardali 2008). In 2003 a petition to list the burrowing owl as threatened or endangered under the California Endangered Species Act (Center for Biological Diversity et al. 2003) was rejected by the California Fish and Game Commission (Miller 2007). Another petition could be submitted and the owl's status could change.

Taxonomy

Up to 21 subspecies of burrowing owls have been recognized (Clark 1997), but only one subspecies (*Athene cunicularia hypugaea)* occurs in North America west of the Great Plains (Haug et al. 1993). Descriptions of the species' physical characteristics, behavior, and distribution are provided in a variety of field guides (e.g., Peterson 1990; Sibley 2000; National Geographic 2002).

Distribution and Abundance

Distribution

The western burrowing owl is found throughout non-mountainous western North America, from the Great Plains grasslands in southern portions of the western Canadian provinces south through the U.S. into Mexico (Haug et al. 1993). Other burrowing owl subspecies occur in arid, open habitats in Florida, the Caribbean Basin, and South America (Haug et al. 1993; Clark 1997) (Figure 1).

In California, the burrowing owl's range extends throughout the lowlands from the northern Central Valley to Mexico, with a small (perhaps extirpated) population in the Great Basin bioregion in northeast California (Cull and Hall 2007) and the desert regions of southeast California (Gervais et al. 2008). Breeding burrowing owls are absent from the coast north of Sonoma County and from high mountain areas, such as the Sierra Nevada and the Transverse Ranges extending east from Santa Barbara County to San Bernardino County (Gervais et al. 2008).

A statewide survey of burrowing owl abundance and distribution, exclusive of northeastern California and the eastern deserts, conducted by The Institute for Bird Populations from 1991–1993 (DeSante et al. 2007), showed that the distribution and abundance of burrowing owls in California was not uniform and owl numbers and densities varied considerably among and within the regions surveyed (see below).

Although the overall range of the burrowing owl in California has not drastically changed since summarized by Grinnell and Miller (1944), the species has disappeared as a breeding bird from portions of its former range (Center for Biological Diversity et al. 2003; DeSante et al. 2007; Miller 2007; Gervais et al. 2008). The statewide survey indicated that breeding burrowing owls had disappeared from the central coast (Marin, San Francisco, Santa Cruz, Napa, and coastal San Luis Obispo counties), Ventura County, and the Coachella Valley. At the time of the statewide survey, breeding owls had nearly been extirpated from Sonoma, Santa Barbara, Orange, coastal Monterey and San Mateo counties, where only one to two known breeding pairs remained (DeSante et al. 2007). The listing petition (Center for Biological Diversity et al. 2003; Miller 2007) suggested that breeding burrowing owls have functionally disappeared from 22% of their former range and continue to decline in an additional 23% of their range.

Abundance

Burrowing owls were first mentioned to be declining in several regions in California as early as the 1940s by Grinnell and Miller (1944) who noted that burrowing owls were becoming scarce in more settled parts of the state due, in some part, to ground squirrel shooting and eradication. All of the available information suggests that burrowing owl populations in several parts of the state declined during the second half of the 20th century. The annual Christmas Bird Count records from 1954 to 1986 showed significant owl declines in California, beginning in the 1970s (James and Ethier 1989). Most ornithologists agree that the species has been declining over the past forty years in many parts of the state (Gervais et al. 2008).

DeSante et al. (2007) estimated the state’s burrowing owl population at 9,266 pairs with 71% (6571 pairs) of California's burrowing owls (exclusive of northeastern California and the eastern deserts) occurring in the Imperial Valley (which is less than 3% of California) and 24% in the Central Valley. The remaining 5% were in the western part of the state in the San Francisco Bay area, the central coast, and southern California. They also concluded that 92% of the breeding owls in California occurred in lowland areas generally below 200 feet (60 meters) elevation.

The burrowing owl population in the San Francisco Bay area, estimated at 165 breeding pairs in the early 1990s (DeSante et al. 1997; DeSante et al. 2007) was thought to have declined 50% between the 1980s and early 1990s. Breeding owls were greatly reduced in numbers or extirpated from many portions of the San Francisco Bay area (DeSante et al. 1997; DeSante et al. 2007; Townsend and Lenihan 2007). Likewise, breeding owls have declined or disappeared throughout southwestern California (Kidd et al. 2007; Lincer and Bloom 2007; Miller 2007).

Occurrences within the Study Area

Historical

At the beginning of the 20th century, the burrowing owl was recognized as a common bird of Santa Clara County (Price 1898; Fisher 1904; Van Denburgh 1899). Several years later, Grinnell and Wythe (1927) still found that owls were a “fairly common resident in the drier, unsettled interior parts of the region,” being most abundant in Alameda, Contra Costa and Santa Clara counties. In 1951, Sibley still saw adults and young at a location in what is now downtown San José (Sibley 1952).

Early references to the status of burrowing owls in the San Francisco Bay area (Grinnell and Wythe 1927; Grinnell and Miller 1944) consisted of qualitative comments on owl distribution and numbers rather than numerical population estimates because there had been no systematic population surveys. The pattern of land use practices and their effects on owl habitat since the 1960s provides a source of information about general trends in owl numbers. In the 1960s land use (evident in historical aerial photographs) in the Santa Clara Valley was primarily agricultural with orchards and row crops most common. The process of converting orchards to other uses, including commercial development, and abandoning agricultural uses, beginning in the late 1960s and early 1970s, probably increased burrowing owl nesting opportunities. Orchards cleared for development temporarily transformed unsuitable habitat into owl foraging habitat. Such areas became nesting habitat for owls as soon as they were colonized by ground squirrels (which were ubiquitous) as long as the vegetation was maintained short. Nesting owls often occupied such lands the first spring after orchard removal. With hundreds of burrowing owls nesting in the region, lands cleared of orchards were well within dispersal distance for young from nearby territories.

In the 1970s, burrowing owls occurred along the west side of the San Francisco Bay where there were perhaps two dozen pairs in all of south San Francisco, San Mateo, and Redwood City baylands. Owls became much more common moving south around the south end of the bay where there were dozens of pairs in several colonies immediately upland of the baylands in Palo Alto, Mountain View, Sunnyvale, Santa Clara, Alviso, San José, Milpitas, and Newark. Moving up the east side of the bay owls again became less common with perhaps less than two dozen pairs in the Hayward and San Leandro baylands, and small colonies at the Oakland Airport (Thomsen 1971) and Alameda Naval Air Station.

Owls occupied cemeteries, golf courses, road medians, margins of landfills, and other types of grassland-dominated open space in this region. Owls also occupied airports (Thomsen 1971; Trulio 1994; Barclay 2007), railroad yards, and fallow agricultural fields. Development has greatly reduced, and in most areas entirely eliminated, burrowing owl habitat since the 1970s. Trulio (1998) sampled sites known to be occupied by burrowing owls in the Silicon Valley and reported that during the years where data was collected (1981–1988, 1995, and 1998), 70 (57%) of the 123 sites were developed. South of San José in the Santa Clara Valley, burrowing owl abundance declined and the species occurred in more widely scattered colonies or individual pairs, as in Morgan Hill, until the early 2000s (California Natural Diversity Database 2009).

We have no precise estimates of the burrowing owl population in the San Francisco Bay area in the second half of the 20th century because there had been no systematic population surveys until 1991–1993 (DeSante et al. 1997; DeSante et al. 2007). The burrowing owl population in the entire south San Francisco Bay area was probably in the neighborhood of 1000 pairs in the 1970s and by 1980 perhaps only 250 pairs remained (Albion Environmental, Inc. 2000a).

DeSante et al. (1997) estimated there were 873 pairs of owls in central California (i.e., Outer Coast, San Francisco Bay area, Central Valley) in the early 1990s. Estimates of the numbers in the San Francisco Bay area were 153 pairs (DeSante et al. 1997) and 165 (DeSante et al. 2007). Results of the statewide survey suggested that there had been approximately 50% declines in both the numbers of owls and the number of breeding groups in the San Francisco Bay area from the period 1986–1991 (DeSante et al. 1997; DeSante et al. 2007). Generally, burrowing owls were most abundant in colonies in grasslands growing on the alluvial plain surrounding the south end of San Francisco Bay immediately upland of south bay marshes (i.e., baylands), and few owls occurred above 200 feet elevation in this region (DeSante et al. 1997; DeSante et al. 2007).

Recent

Santa Clara County

As of July 2009, there were 53 occurrences of burrowing owls in Santa Clara County in the California Natural Diversity Database (California Natural Diversity Database 2009). Many of these occurrence records include sightings of several breeding individuals over multiple years. Forty-nine (95%) of the extant occurrences have been reported in the study area since 1990. Burrowing owls were commonly encountered during environmental assessments for development projects throughout the Santa Clara Valley. However, in many cases survey results were not reported to the California Natural Diversity Database, so this source of information is incomplete and cannot be used to derive population estimates or trends.

Using information from various unpublished sources, the burrowing owl population in Santa Clara County in 1997 was estimated to range from 120 to 141 pairs (Table 1; Albion Environmental, Inc. 2000a). Most of these owls occurred at 12 locations where there was more than one pair. At least 10 of these locations could be termed colonies averaging five or more pairs. Approximately one-third of the county population (43–47 pairs) occurred within the City of San José (Table 1; Albion Environmental, Inc. 2000a). The Santa Clara Valley Water District performed surveys at 41 sites throughout Santa Clara County in the summer of 1998, but detected no burrowing owls at any of these sites, nor in potential habitats adjacent to the project sites (Santa Clara Valley Water District 1998). A survey of 53 sites in the City of San José in 2000 estimated 39 to 40 pairs of owls (Table 1; Albion Environmental, Inc. 2000b).

The HCP/NCCP area was surveyed for breeding burrowing owls from 26 May to 23 July 2008 (Albion Environmental, Inc. 2008a). This survey was conducted at 96 locations: 84 locations inside the HCP/NCCP area and 12 immediately outside the northern and southern boundaries of the HCP/NCCP area where breeding owls were known to occur, i.e., Alviso environs and northern San Benito County. This survey resulted in an estimate of 19–20 pairs in the HCP/NCCP area, 20 to 21 pairs in the City of San José (includes pairs in Alviso outside the plan area) and 21 to 23 breeding pairs when including pairs observed just outside the north and south HCP/NCCP plan area boundaries (Table 1). However, all except two breeding pairs in the plan area were located on either San José International Airport or north San José/Alviso (Albion Environmental, Inc. 2008a).

Owls were observed at 10 (10%) of the 96 locations surveyed. Survey results were sufficient to conclude that owls were absent at 61 (64%) of the locations surveyed and burrowing owl presence/absence was inconclusive (because of limited access or visibility) at 25 (26%) of the locations surveyed. Twenty-two (23%) of the locations surveyed were completely developed and contained no habitat for burrowing owls (Albion Environmental, Inc. 2008a).

Table 1. Pairs of burrowing owls known in the City of San José in 1997, 2000 and 2008

	Number of pairs		
Location	**1997***	**2000****	**2008**
San José International Airport	15	21	8
Alviso including Water Pollution Control Plant buffer lands	17	14–15	7 (3 single adults)
Undisclosed location	3–7	1	4–5
Undisclosed location	3	1	1
Single pairs at other locations	5	2	0
Total pairs	43–47	39–40	20–21 pairs (3 single adults)

In 2009, 10 locations where burrowing owls had been observed in 2008 or in recent years were surveyed again (Albion Environmental, Inc. unpublished data). Fifteen pairs comprised of 34 adults were recorded in the HCP/NCCP area and 18 pairs, including three pairs observed outside the plan boundary, in northern San Benito County. This suggests a further decline from the 19 to 20 pairs recorded in the plan area in 2008 (Albion Environmental, Inc. 2008a), However, the survey effort in 2009 was much less thorough than in 2008 and some breeding pairs may have been missed.

The City of San José is the only area for which estimates of the numbers of pairs of owls in 1997, 2000, and 2008 can be used to suggest a regional trend across this time period. Based on an estimate of 43–47 pairs in 1997, 39–40 pairs in 2000 and 20–21 pairs in 2008 the population in the City of San José has declined approximately 50% since 1997 (Table 1; Albion Environmental, Inc. 2000a, 2000b, 2008a).

Natural History

The burrowing owl's life history and reproductive strategy show that it is relatively short-lived, reaches sexual maturity at one year old, has high fecundity and breeding adaptations to take advantage of annual fluctuations in food supply (Newton 1977), and has low juvenile (i.e., first year) and moderate adult survival rates. These characteristics suggest that burrowing owl populations should be expected to change in response to environmental conditions over short time periods.

Habitat Requirements

Throughout their range, burrowing owls require habitats with three basic attributes: open, well-drained terrain; short, sparse vegetation generally lacking trees; and underground burrows or burrow facsimiles (Klute et al. 2003; Gervais et al. 2008). During the breeding season, they may also need enough permanent cover and taller vegetation within their foraging range to provide them with sufficient prey, which includes large insects and small mammals (Haug et al. 1993; Wellicome 1997). Burrowing owls occupy grasslands, deserts, sagebrush scrub, agricultural areas (including pastures and untilled margins of cropland), earthen levees and berms, coastal uplands (especially by over-wintering migrants, California Natural Diversity Database 2009), and urban vacant lots, as well as the margins of airports, golf courses, and roads (Gervais et al. 2008).

Vegetation

Vegetative cover and height are significant factors due to the semi-fossorial nature and small size of the burrowing owl (Zarn 1974; Coulombe 1971; Green and Anthony 1989; Trulio 1994). These owls prefer open habitats that afford visibility of approaching predators (Zarn 1974) or contain elevated perches for the same purpose (Green 1983). However, they will tolerate tall vegetation (especially in the rainy season in the early part of the nesting cycle in California) if it is sparse or patchy with open spaces. Low-growing vegetation may provide hiding sites for young owls (MacCracken et al. 1985) and increase hunting efficiency (Johnsgard 1988). Green (1983) found that owls in Oregon avoided habitat with vegetation that impaired the owls' horizontal visibility and did not provide elevated perches. Owls will perch on raised burrow mounds or other topographic relief such as rocks, tall plants, fence posts, and debris piles to attain better visibility (Haug et al. 1993). Tall or dense vegetative cover that prevents visibility of approaching predators puts burrowing owls at a severe disadvantage. Green and Anthony (1989) found that owls selected areas for nesting with a greater percentage of bare ground than areas where owls did not nest. In the Columbia Basin, an average of 28% cover in occupied owl habitat was reported (Green and Anthony 1989). In Oklahoma, Butts (1973) reported that owls occupied areas where vegetation was 4 inches or less.

At Moffett Federal Airfield in Santa Clara County, occupied burrowing owl habitat contained 44–57% cover, while the average cover in unoccupied fields was 85% (Trulio 1994). Vegetation height averaged 5.6 inches directly around burrows in occupied habitat versus 10.4 inches in unoccupied fields (Trulio 1994). Owls are often found in human-altered habitats such as grazed areas, areas sprayed with herbicide, and areas where vegetation has been removed without harming burrows. These conditions allow owls to stand near the burrow entrance and effectively watch for approaching predators (Coulombe 1971; Green and Anthony 1989; Trulio 1994). Coulombe (1971) noted that burrowing owls abandoned their burrows when vegetation grew too thick or high.

Burrows

The presence of burrows, usually excavated by fossorial mammals such as ground squirrels or prairie dogs, is a critical component of suitable habitat for burrowing owls because burrows provide security for nesting and shelter from predators and weather. Studies have found that burrow tunnel cross-sections averaged 4.7 by 7.5 inches (12 by 19 centimeters [cm]) (Martin 1973), and enlarged chambers used for nesting averaged 9.8 inches wide by 4.4 inches high (25 cm wide by 11 cm high) (Butts 1973). Tunnels usually slant 15 degrees downward (Zarn 1974).

Owls use burrows dug by other animals such as ground squirrels (*Spermophilus* spp.), badgers (*Taxidea taxus*), and prairie dogs (*Cynomys* spp.), kangaroo rats (*Dipodomys* spp.) and tortoises (*Gopherus* spp.) (Zarn 1974). Burrowing owls in the western U.S. usually dig only to renovate and maintain their burrows, but they are capable of excavating entire burrows (Thomsen 1971; Barclay 2007). Owls often use unlined earthen banks along agricultural irrigation canals and ditches (Haug et al. 1993) especially in the Imperial Valley (Colombe 1971; DeSante et al. 2004; Rosenberg and Haley 2004). Sandy, well-drained soils may be favored for burrows because of the ease of enlargement and rapid drainage after rainfall (Johnsgard 1988). A family group may use up to 10 different burrow entrances in one year (Winchell 1994; Johnson 1986).

At Moffett Federal Airfield, Trulio (1994) reported an average burrow density of 63 burrows/acre in fields where owls nested. Burrow density was much higher around active owl nests, where the average burrow density was approximately 200 burrows/acre in a 24-foot radius around active nests (Trulio 1994). In fields not occupied by owls for 5 years, the average burrow density was 7 burrows/acre. Coulombe (1971) reported that the number of available burrow sites was apparently the major factor controlling the abundance of burrowing owls in the Imperial Valley of California. Grant (1965) indicated that nesting areas are always in the vicinity of perch sites such as fences, utility poles, or the raised mounds around rodent burrows. Winchell (1994) observed 136 burrowing owls utilizing 224 separate burrows, 56 of which contained nests, showing that burrowing owls use more than one burrow within their home range. Other studies have noted that it is common for juveniles to use satellite burrows farther away from the nest site as they begin to fly and disperse (Zarn 1974). Rich (1984) found that 39% of burrows used by burrowing owls were reused the following year.

In natural settings, burrowing owls often occupy burrows under protective surfaces such as rock (Rich 1984), lava flows (Gleason and Johnson 1985), and limestone (Coulombe 1971), perhaps as a protection against digging predators (Rich 1984) or collapse by natural processes. In human-modified environments owls often use burrows under the edges of concrete, asphalt, and rubble piles.

Burrowing owls also use artificial burrows installed to increase burrow availability (Collins and Landry 1977; Poulin 2000; Smith and Conway 2005; Barclay 2008), mitigate effects of development projects (Trulio 1995; Smith and Belthoff 2001), conserve individual colonies (Hjertaas 1997; Barclay 2007), facilitate reintroductions (Leupin and Low 2001; Martell et al. 2001; Poulin et al. 2006), enhance conservation (Wellicome et al. 1997; Smith and Conway 2005; Smith et al. 2005), and enable research on aspects of breeding biology not easily studied in natural burrows (Henny and Blus 1981; Haug et al. 1993; Wellicome 1997, 2005; Poulin and Todd 2006; Barclay 2008). Barclay (2007) reported a 43% occupancy rate of artificial burrows by adult owls during the nesting season at San José International Airport over an 11-year period.

Table 2. Habitat Associations for Western Burrowing Owl

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Herbaceous dominated	Nesting, shelter, refugia	Primary	Burrows mostly dug by other animals including the California ground squirrel	The presence of nest burrows, dug by fossorial mammals such as ground squirrels, seem to be a critical requirement for burrowing owls. Typically forage in habitats characterized by low-growing vegetation (Haug et al. 1993). Often use unlined earthen banks along agricultural ditches vegetation (Haug et al. 1993)
Agricultural	Nesting, shelter, refugia	Secondary	See above	See above
Ruderal	Nesting, shelter, refugia	Secondary	See above	See above; may use urban levees if suitable burrows are available (Haug et al. 1993)
Urban-Suburban	Nesting, shelter, refugia	Secondary	See above	See above; may use urban levees if suitable burrows are available (Haug et al. 1993)
Rural residential	Nesting, shelter, refugia	Secondary	See above	See above; may use urban levees if suitable burrows are available (Haug et al. 1993)

Diet

Burrowing owls are opportunistic predators that will consume arthropods, small mammals, birds, amphibians, and reptiles (Haug et al. 1993; Karalus and Eckert 1987; Gervais et al. 2008). Owls typically forage in habitats characterized by low-growing, sparse vegetation (Haug et al. 1993). Insects are often taken during the day, especially during the summer, while small mammals are taken at night. In California, crickets and meadow voles (*Microtus* sp.) were found to be the most common food items (Thomsen 1971). Nocturnal foraging can occur up to several kilometers away from the burrow; and owls concentrate their hunting on uncultivated fields, ungrazed areas, and other habitats with an abundance of small mammals (Haug and Oliphant 1990). In urban areas, burrowing owls are often attracted to streetlights, where insect prey congregates.

Reproduction

Burrowing owls reach sexual maturity at one year of age. Nesting in California generally runs from February through August, with peak activity from mid-April to mid-July (Zeiner et al. 1990; Thomsen 1971; Gervais et al. 2008). Burrowing owls are primarily monogamous and typically breed once per year; however, Gervais and Rosenberg (1999) reported burrowing owls producing a second brood of young in the Central Valley. Clutch sizes range from one to eleven eggs (Murray 1976) and average eight eggs (Haug et al. 1993). The number of eggs laid is affected by prey abundance: the more food that is provided to the female the more eggs tend to be laid (Wellicome 1997). Incubation lasts 28–30 days. Females supplemented with food can have higher reproductive success than females without supplemented food, which may explain poor reproductive success in areas with low-quality foraging habitat (Wellicome 1997). An average of 78% of potentially reproductive pairs at Moffett Airfield (Trulio 1994, 1997) produced emergent young over seven breeding seasons. Trulio and Chromczak (2007) reported an average of 51% of urban nests produced young compared to 45% of parkland nesting successful over a seven year period in northern Santa Clara County.

The female performs all the incubation and brooding and stays in the burrow nearly continuously while the male does the provisioning. Because incubation begins before the clutch is complete, eggs hatch asynchronously. Asynchronous hatching is an adaptation to annual variation in prey abundance, whereby more young can be raised during years when prey is plentiful (Newton 1977, 1979; Wellicome 2005). The young begin emerging from the nest burrow when about two weeks old, and they remain closely associated with the nest burrow or nearby satellite burrows for several weeks (Thomsen 1971). As the young mature they begin venturing farther from the natal burrow, sometimes abandoning it entirely and moving to a satellite burrow(s). Young burrowing owls fledge at 44 days but usually remain in the natal territory, and as they mature they join the adults in foraging flights at dusk (Rosenberg et al. 1998).

Table 3. Key Seasonal Periods for Western Burrowing Owl

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding		✓	✓	✓	✓	✓	✓	✓				
Migration			✓	✓					✓	✓		
Winter Movements	✓										✓	✓

Source: Haug et al. 1993.

Territory and Home Range

Thomsen (1971) calculated an average territory size (defended area around the nest burrow) of 1.98 acres (range 0.1–4.0 acres) for six territories studied at the Oakland, CA, Airport. Rosenberg and Haley (2004) reported average nearest neighbor distances from 125–166 meters (410–546 feet.) in the Imperial Valley. Martin (1973) reported an average distance of 545 feet between occupied burrows in New Mexico, yielding an estimated territory of 5.4 acres.

Home range, which is the entire area of an animal's movements for foraging, roosting, nesting and raising young, likely varies depending on local habitats present and local prey resources (Gervais et al. 2008). Rosenberg and Haley (2004) reported estimates of 114 hectares (280 acres) for the area traversed and 45 hectares (111 acres) for the area used by burrowing owls in the Imperial Valley. Rosenberg and Haley (2004) found that >80% of nocturnal foraging of telemetered owls in the Imperial Valley was within 600 meters of the nest, but long-distance movements also occurred. Home ranges for six radio-marked owls in Saskatchewan ranged from 35 to 1,200 acres with an average of 595 acres (Haug and Oliphant 1990). Activity data in this study showed that owls spent most of the daylight hours within 164 feet of the nest burrow and never traveled farther than 820 feet of the nest burrow during the day. Nocturnal activity data showed owls flew long distances to forage at night (maximum of 8859 feet, 1.6 miles) from their nest, but 95% of movements were within 1968 feet (0.4 miles) from their nest (Haug and Oliphant 1990).

Movement, Migration, and Dispersal

California supports year-round resident burrowing owls and over-wintering migrants (Gervais et al. 2008). Dispersal in burrowing owls that nest in California is variable depending on location and the age of the owls. Many owls remain resident throughout the year in their breeding locales (especially in central and southern California) while some apparently migrate or disperse in the fall (Haug et al. 1993; Coulombe 1971; Barclay et al. 2007). Owls breeding in northern California locales and at higher altitudes (e.g., Modoc Plateau) are believed to move south during the winter (Grinnell and Miller 1944; Zeiner et al. 1990). Thomsen (1971) reported that owls stayed on their breeding grounds in

Oakland during the winter and remained in their burrows in the daytime. Other researchers report that burrowing owls may “wander” during the winter months, occasionally appearing and disappearing from their breeding grounds (McCaskie et al. 1988; Martin 1973). Rosier et al. (2006) reported post-breeding dispersal ranging from 0.2 to 53 km for adult male burrowing owls in the Carrizo Plain (San Luis Obispo County).

Several years of year-round monitoring at Moffett Federal Airfield (Trulio 1994) and Mineta San José International Airport (Barclay 2007) show that the number of owls observed declines during the fall and winter months beginning in October and lasting into March. This information does not prove that owls actually leave during the winter (see banding summary below); they could be simply less visible, as shown by LaFever et al. (2008) and suggested by Thomsen (1971) and Coulombe (1971), because they spend more time in their burrows during the day. Trulio (1994) reported that the number of burrows used at Moffett Federal Airfield did not decline during the winter, suggesting owls are less visible during the winter months. In central California, burrowing owls occur only as winter visitors in some coastal areas that appear to contain suitable breeding habitat (California Natural Diversity Database 2009; Barclay unpublished data). Burrowing owls breeding north of California are believed to migrate south with some birds over-wintering in California (Coulombe 1971; Barclay et al. 2007).

Recoveries of burrowing owls banded in California are another source of information about the nature of owl migration and dispersal. The U.S. Geological Survey Bird Banding Laboratory records (through August 2003) contained 106 encounters of 4708 burrowing owls banded in California (Barclay et al. 2007). Seventy-five (71%) of these encounters occurred in the same 10-minute block of longitude and latitude where the owls were banded, and 27 (25%) occurred in the 10-minute block adjacent to where they were banded. Of the remaining four encounters of owls that were banded and recovered in California, all were less than 95 km from the block where they were banded (Barclay et al. 2007). Recoveries included four records of owls that were banded outside California (two in Idaho, one in Washington, one in British Columbia) and recovered in California. Two owls banded in California were encountered outside the state: an owl banded in June 1975 in coastal southern California (Orange County) was recovered in November 1975 at an unspecified location in Mexico; the other was banded in October 1965 in Orange County (in the same 10-minute block as the owl recovered in Mexico) and encountered two and a half years later (March 1968) in Nevada (Barclay et al. 2007).

There were 1615 burrowing owls banded in the San Francisco Bay area through 2003 (Barclay et al. 2007). Although there have been numerous sightings of color banded owls near the locations where they were banded, there have been no sightings or recoveries of these banded owls outside the Santa Clara Valley reported (through August 2003) to the Bird Banding Laboratory (Barclay et al. 2007). Four burrowing owls banded at San José International Airport have been encountered at NASA/Ames Moffett Federal Airfield approximately 7.5 miles away. These movements represent the longest distance movements of any of the over 700 burrowing owls banded at San José International Airport since 1993 (Barclay et al. 2007; Barclay unpublished data).

Site Fidelity

Burrowing owls exhibit strong site fidelity and return to nest in the same areas year after year (Martin 1973; Bent 1938; Zarn 1974). Rosenberg and Haley (2004) reported that 85% of adults remained within 400 meters of the previous year's nest in the Imperial Valley. They observed that females tended to move greater distances between breeding seasons than males and distances were greater for owls that failed at nesting. Owls often nest in the same burrows in subsequent years, although Rich (1984) reported that they tend to occupy the same burrows for one to three years before moving to other burrows. Juvenile burrowing owls use satellite burrows during dispersal (Zarn 1974). Rosier et al. (2006) reported variable post-breeding dispersal of adult owls in the Carrizo Plain (San Luis Obispo Co.). Adults that failed at nesting tended to move greater distances, up to 53 km, than adults that were successful (Rosier et al. 2006).

74% of occupied burrows were reoccupied at Moffett Airfield between 1992 and 1994 (Trulio 1994). Burrowing owls at Moffett used many of the same or nearby (within eyesight) burrows year after year. Owls used 42 different burrows during this study. Seven (17%) burrows were used all three years, and 24 (57%) were used only two of the three years. Of the 11 burrows not reused, three were destroyed, two were only used during the early spring, and six were used for nesting only once.

Burrowing owls that have been intentionally relocated have generally shown strong fidelity to the sites from which they were moved. Feeney (1997) summarized the results of 14 relocations involving 104 owls that were relocated from 1–150 miles at different times of the year for various reasons. Owls tended to remain at or return to their original sites when the "relocation" consisted of closing occupied burrows (i.e., eviction). Owls transported to relocation sites tended to disappear from those sites shortly after release. Four birds relocated 48 km (30 miles) during the breeding season returned to their original sites the same day. Bloom et al. (2003), summarizing results of burrowing owl translocations in southern California, suggested well-planned, pre-breeding season translocations from breeding enclosures are probably the best long-term management tool.

Delevoryas (1997) reported on the active relocation of five pairs of owls at the beginning of the breeding season (February) in Santa Clara County. Four pairs of owls relocated 19 miles, kept in aviaries, and released in March nested on the relocation site. Two of the relocated pairs successfully raised young. Three females that experienced failed nesting attempts returned to the capture site. Six owls remained on the relocation site for one year, two were present two years later, and at least one owl was observed on the site four years later. Failure to maintain habitat in appropriate condition for burrowing owls may have contributed to owls dispersing from the relocation site (Delevoryas 1997).

Table 4. Movement Distances for Western Burrowing Owl

Type	Distance/Area	Location of Study	Citation
Home range (male)	May forage over 2–3 square km during nesting season	Saskatchewan	Haug and Oliphant 1987
	114 hectares	Imperial Valley, CA	Rosenberg and Haley 2004
Dispersal	Juveniles disperse about 0.6 km from natal burrows after fledging	Idaho	King and Belthoff 2001
	Adults disperse an average of 3.1 km (range 0.2–53 km)	Carrizo Plain, CA	Rosier et al. 2006
Migration	Highly variable, little data; Bay Area birds may be year-round residents		Haug et al. 1993; DeSante et al. 1997; Harman and Barclay 1997

Ecological Relationships

In California western burrowing owls most commonly live in burrows created by California ground squirrels (*Spermophilis beecheyi*) (Gervais et al. 2008). Accordingly, the suitability and quality of burrowing owl habitat in the study 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 systems, 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 coyotes, other owls and hawks, skunks, weasels, and badgers for rodents and a variety of insects (Rosenberg et al. 1998).

Burrowing Owls and Development

Wesemann and Rowe (1987) and Millsap and Bear (2000) studied the relationship between burrowing owl density and reproduction along an urban development gradient in Cape Coral, Florida where development ranged from <2% to >80%. They found that burrowing owl density and productivity of successful nests increased until 45–60% of the landscape was developed, and above that level owl density and reproduction declined. Wesemann and Rowe (1987) attributed the increase in owl density up to the 60% development level to increased prey abundance on developed lots containing irrigated landscape vegetation. Above 60% development owl numbers declined even though prey abundance continued to increase. Wesemann and Rowe (1987) concluded that, above 60% development, factors not related to food availability such as disturbance, burrow destruction, pets, collisions with automobiles, and reduced open space contributed to declining owl numbers.

Analysis of the environment in terms of six basic habitat types (defined by classification of reflectance of a Landsat image, Buchanan 1996) around burrowing owl nesting locations in the Santa Clara Valley revealed there was an average of 139.5 acres of burrowing owl habitat within 0.5 miles of 62 locations where owls nested in the Santa Clara Valley in 1991 (Albion Environmental, Inc. 2000a). This translates into about 28% burrowing owl habitat (as defined during image classification) in the area within 0.5 miles of known burrowing owl nests. This proportion of burrowing owl habitat would be a useful minimum threshold to consider when evaluating the suitability of candidate burrowing owl preserve lands. This threshold of habitat availability could indicate that parcels much less than 139.5 acres where burrowing owls nest may be useful candidates for preservation, as long as the minimum threshold of habitat availability around those parcels is present.

The relationship between burrowing owls and development in Florida may have operated in the northern Santa Clara Valley and contributed to higher burrowing owl numbers and densities when this portion of the valley was less developed. Recent trends in breeding burrowing owl numbers (Table 1) suggest the threshold of development has been passed. The relationship between burrowing owl numbers and development and open space suggest the best remaining opportunities for burrowing owl habitat management and preservation are in the northern portion of the plan area, where there is more open space in the baylands.

Survival and Causes of Mortality

Survival

Estimates of juvenile survival rates (i.e., during their first year of life) range from 0.12 (Lutz and Plumpton 1997) to 0.30 (Thomsen 1971). Adult survival rates have ranged from 0.42 (Johnson 1997) to 0.81 (Thomsen 1971). Rosenberg and Haley (2004) reported annual survival rates of 0.65 for males and 0.62 for females. The maximum known age of a wild burrowing owl is 11 years (Dunning 2001). Recoveries of owls banded in California include an owl that was banded as a nestling and found dead seven years later (1974–1981) after being hit by an aircraft (Barclay et al. 2007). There is little information on lifetime reproductive success (Haug et al. 1993).

Causes of Mortality

Causes of mortality in burrowing owls include predation (by hawks, owls, badgers, foxes, domestic cats, and others (Bent 1938; Coulombe 1971; Green 1983; Haug et al. 1993), vehicular collisions, disease and parasites (Haug et al. 1993). Juvenile owls experience the greatest mortality (see above) during the post-fledging period (Clayton 1997). Vehicular collisions, which accounted for 25–60% of burrowing owl mortalities in three studies (summarized in Haug et al. 1993), are a significant cause of mortality because burrowing owls habitually perch and hunt on roadways at night (Bent 1938; Haug et al. 1993). Burrow destruction and other anthropogenic factors, especially during the breeding season, (e.g., agricultural and construction activity, disking, shooting, and pest control) also contribute to burrowing owl mortality (Zarn 1974; Thomsen 1971; Haug et al. 1993).

Some researchers have suggested that burrowing owls may be affected by secondary poisoning through ingestion of compounds used to control ground squirrels (Remsen 1978; Zarn 1974). Two studies of the effects of strychnine to control ground squirrels on predatory birds (Schmutz et al. 1989; James et al. 1990) did not document burrowing owl mortality due to strychnine. However, James et al. (1990) concluded that strychnine could have sublethal effects on burrowing owls. The potential for secondary poisoning of burrowing owls probably varies with the local prey base, the extent to which owls feed on the species being targeted for poisoning, and the type of control agents used. James and Fox (1987) reported lower productivity and possible direct mortality of owls exposed to carbofuran pesticide used to control grasshoppers in Saskatchewan.

Population Status and Trends

Global: *Declining* (NatureServe 2006)
State: *Priority 2* (Shuford and Gardali 2008)
Within Study Area: *Declining*

Threats

The most immediate threats to the burrowing owl are the conversion of grassland habitat to urban and agricultural uses other than livestock grazing and the loss of suitable agricultural lands to development (Gervais et al. 2008). Equally important is the loss of fossorial rodents, such as ground squirrels, across much of the owl's historical range (Gervais et al. 2008). Eradication programs have decimated populations of these rodents and have in turn disrupted the ecological relationships on which owls depend; because western burrowing owls typically need other animals to dig their burrows, the loss of fossorial rodents limits the extent of year-round owl habitat throughout their range (Haug et al. 1993).

Data Characterization

As of July 2009, there were 53 occurrences of burrowing owls in Santa Clara County in the California Natural Diversity Database (2009). Existing information, including surveys for nesting owls in the plan area in 2008 (Albion Environmental, Inc. 2008a) should be sufficient to evaluate the population status of this species in the planning area; however, much of the HCP/NCCP planning area includes private lands that have not been surveyed systematically for this species.

Existing Conservation Actions in the Study Area

The City of San José prepared a draft burrowing owl habitat conservation strategy and implementation plan in 2000 (Albion Environmental, Inc. 2000a), but the City Council did not adopt it. The City of San José passed a disking ordinance (Chapter 9.54) in 2000 prohibiting disking in most of the city. Mineta San José International Airport has been implementing a burrowing owl management program since the mid-1990s (Barclay 2007).

In 2003, the City of Morgan Hill adopted a citywide burrowing owl habitat mitigation plan. In October 2003, the also city adopted an ordinance making it unlawful for anyone to disk, plow, or otherwise break into or turnover soil on any property within the city if the land meets certain criteria for burrowing owl occupancy.

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 (Barclay 2007, 2008), and management of the vegetation around the burrows by mowing or controlled grazing.

Delevoryas (1997) reported on the active relocation of five pairs of owls at the beginning of the breeding season (February) in 1990 in Santa Clara County. Four pairs of owls relocated 19 miles, kept in aviaries, and released in March nested on the relocation site. Two of the relocated pairs successfully raised young. Three females that experienced failed nesting attempts returned to the capture site. Six owls remained on the relocation site for one year, two were present two years later and at least one owl was observed on the site four years later. Failure to maintain habitat in appropriate condition for burrowing owls may have contributed to owls dispersing from and not returning to the relocation site (Delevoryas 1997).

Burrowing Owl Conservation and Management Activities

Burrowing owl conservation and management have been the subjects of several plans spanning a broad spatial scale from continental to regional to site-specific. These include the tri-national North American Conservation Action Plan for the Western Burrowing Owl (Commission for Environmental Cooperation 2005), the Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States (Klute et al. 2003), Recovery Strategy for the Burrowing Owl (*Athene cunicularia*) in Canada (Environment Canada 2007), Recovery Plan for the burrowing owl in Canada (Hjertaas 1997), and Effects of management practices on grassland birds: burrowing owl (Dechant et al. 1999). The California Department of Fish and Game is preparing a Conservation Strategy for burrowing owls in California (Burkett and Johnson 2007).

Concern about range-wide declines of western burrowing owl populations in many areas was the impetus for three International Burrowing owl Symposia; the first in 1992 (Lincer and Steenhoff 1997), the second in 1998 (Wellicome and Holroyd 2001), and the third in 2006 (no proceedings). A California Burrowing Owl Symposium (Barclay et al. 2007) was convened because of concern about declines in California.

Efforts to manage burrowing owls have employed a variety of techniques to address site-specific goals and conditions. Common management activities have addressed habitat management on preserve lands (Albion Environmental, Inc. 2004; Johnson 1986; Stanton and Teresa 2007), evaluation of impacts from development projects (Albion Environmental, Inc. 1997, 1999; Bendix 2007; Smith and Belthoff 2001; Trulio 2001), prevention of disturbance during the nesting season (Koshear et al. 2007), installation of artificial burrows (Collins and Landry 1977; Poulin 2000; Smith and Conway 2005; Smith et al. 2005; Barclay 2008), and management of burrowing owls on military installations and airfields (Albion Environmental, Inc. 2008b, Barclay 2007; Garcia and Conway 2007; Rosenberg et al. 1998; Trulio 2001).

The reintroduction of burrowing owls into vacant range has been done with limited success in British Columbia (Munroe et al. 1984; Leupin and Lowe 2001), Manitoba (De Smet 1997) and Minnesota (Martell et al. 2001), and on a small experimental scale locally in the Coyote Valley (Delevoryas 1997).

Management practices have also been implemented to address the unwanted occurrence of burrowing owls in some settings. These include passive relocation (Trulio 1995; Bendix 2007) and active relocation (Feeney 1997; Bloom et al. 2003) to address the occurrence of owls in development projects (Smith and Belthoff 2001) and avoid direct impacts (i.e., take). Management has also been designed to address predation of burrowing owls on other special-status species (Garcia and Conway 2007).

Table 5. Conservation Actions in the Study Area for Western Burrowing Owl

Action	Timing	Lead Agency	Location
Burrowing owl mitigation program	On-going	San José International Airport	San José
Burrowing owl habitat mitigation program and ordinance	On-going	City of Morgan Hill	Morgan Hill
Burrowing owl mitigation program	Being considered by staff	City of San José	San José

Modeled Species Distribution in Study Area

Model Description

Model Assumptions

Occupied Nesting Habitat

Occupied nesting includes sites occupied within the previous 3 years that are surrounded by at least 140 acres of foraging habitat within 0.5 mile of the nest site. The 140 acres parameter was mapped based on aerial photo analysis of known occupied nest sites.

Potential Nesting Habitat

Any grassland, agricultural, or barren land cover types that are located outside of the 0.5 mile radius around occupied nest sites, and inside of one of the burrowing owl conservation zones shown in Figure 2.

Overwintering Only Habitat

All annual grassland, serpentine bunchgrass grassland, valley oak woodland, agricultural, and barren land cover types with flat (0–5%) or moderate (5–25%) slopes, outside of one of the burrowing owl conservation zones shown in Figure 2.

Rationale

Occupied Nesting Habitat

In the late 1990s the City of San José (2000) studied all extant burrowing owl nest locations within San José and surrounding environs, and discovered that there was an average of 140 acres of suitable habitat (out of a total of approximately 503 total acres) within 0.5 mile (i.e., the typical foraging distance). The number of breeding pairs at each colony (one or more nesting pairs located in relatively close proximity) varied from one to many. Due to the urbanized and fragmented landscape in San José, it is assumed that the available habitat supports more breeding pairs than found in burrowing owl populations away from urbanized areas.

Based on these studies, the Plan assumes that in order to remain viable, a nesting location needs to be accompanied by at least 140 acres of essential foraging habitat within 0.5 mile. The same habitat could support multiple pairs. This clumping of nesting pairs (colonies) can be observed at any of the breeding colonies in the South San Francisco Bay Area (i.e., San José International Airport, Moffett Federal Airfield, and San José/Santa Clara Water Pollution Control Plant).

Occupied burrowing owl nesting habitat modeled for the Plan is comprised of two components, a specific location containing one or more active nests, and the essential foraging habitat that supports the nest or nests. Because owls tend to re-use sites, if a burrowing owl nest site has been confirmed on a parcel at any point during the previous 3 years, then that parcel is considered a burrowing owl nest location. Based on the known propensity of burrowing owls to forage within 0.5

mile of nest sites during the breeding season (Haug and Oliphant 1990; Rosenberg and Haley 2004), essential burrowing owl foraging habitat is defined as the parcel where the documented burrowing owl nest location is located and all parcels with undeveloped, grassland or barren land, within 0.5 mile of the nest location. If any portion of a parcel with suitable foraging habitat falls within 0.5 mile, the entire parcel is considered essential foraging habitat.

To confirm the current location of nest sites a survey was commissioned in 2008, with a focused follow up in 2009, to determine the number of viable breeding locations and to estimate the number of burrows that currently support a breeding pair in the study area. Burrowing owls were only documented in five locations within the study area (Albion Environmental Inc. 2008). All of those locations were within the urban service area of the City of San José. The highest concentration of nesting burrowing owls occurred in the northern part of the study area, at the San José International Airport, the San José/Santa Clara Water Pollution Control Plant and adjacent lands, and at the VTA Cerrone bus yard. One additional pair was located in southeastern San José (Albion Environmental Inc. 2008).

Potential Nesting Habitat

Open grassland or barren lands on the valley floor that are outside of a 0.5 mile radius of occupied nest sites could potentially be successfully colonized by nesting burrowing owls in the future as long as there are no limiting factors associated with those lands. These are areas where burrowing owls have not been documented nesting in the recent past but where habitat conditions are such that individuals could successfully colonize in the future.

Overwintering Only Habitat

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 breeding, foraging, and overwintering. Within the study area annual grassland, serpentine bunchgrass grassland, valley oak woodland, and barren natural communities represent these habitats. Burrowing owls are also known to use the margins of agricultural areas, or even occasionally using the whole field when it is fallow and ground squirrels are allowed to colonize.

Model Results

Figure 2 shows modeled occupied nesting, potential nesting, and overwintering only habitat for the western burrowing owl within the study area. Burrowing owl may overwinter within areas modeled as occupied or potential nesting, but they are unlikely to nest in overwintering only modeled habitat. Suitable habitat is spread widely throughout the valley floor and along the edge of the foothills that border the valley on both sides. Most known occurrences fall within modeled habitat. Some suitable habitat in developed areas may not show up in the output because it cannot be distinguished at this mapping resolution. These are typically small vacant lots or the margins of other land cover types.

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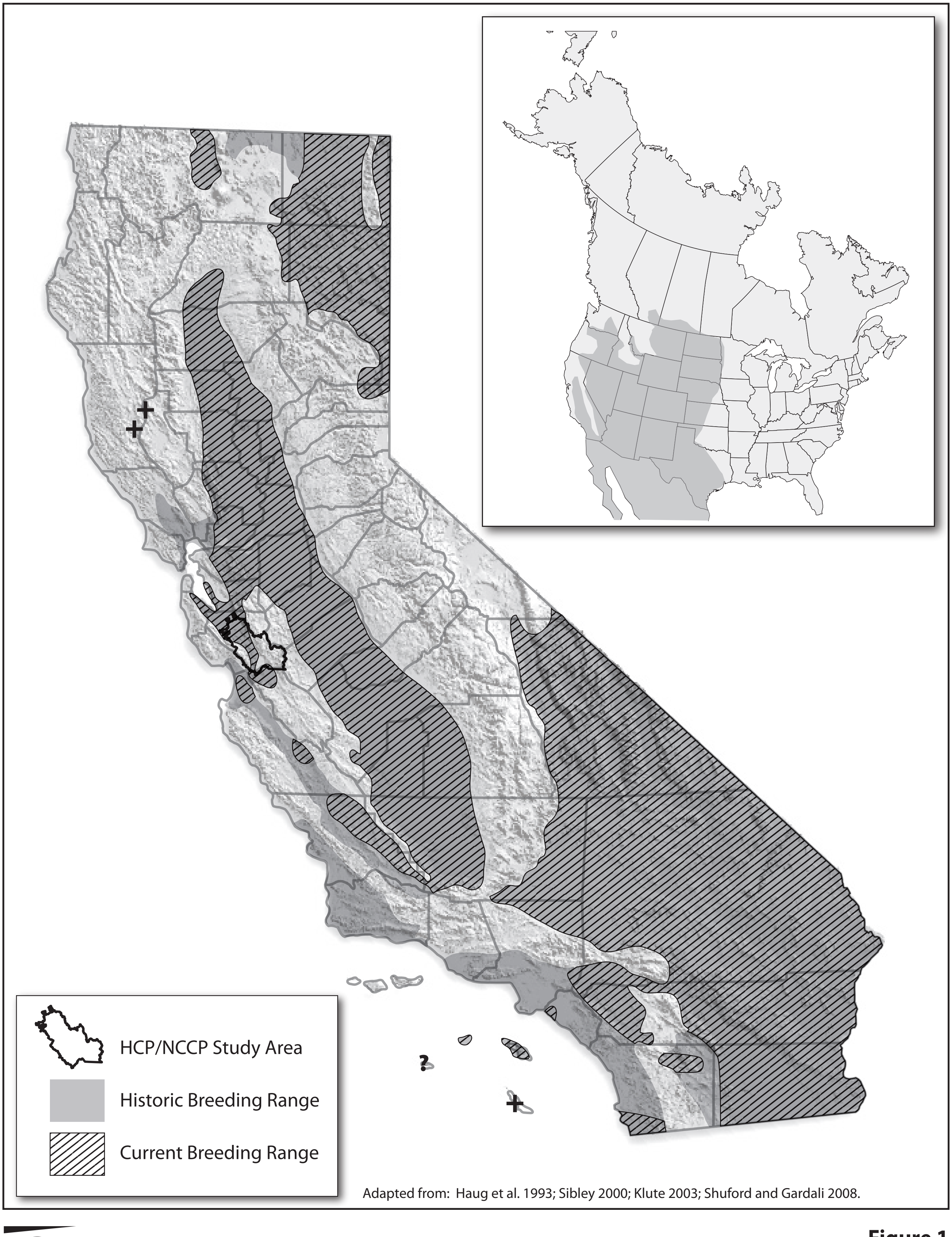

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Figure 1
Western Burrowing Owl (*Athene cunicularis hypugea*)
Distribution in California

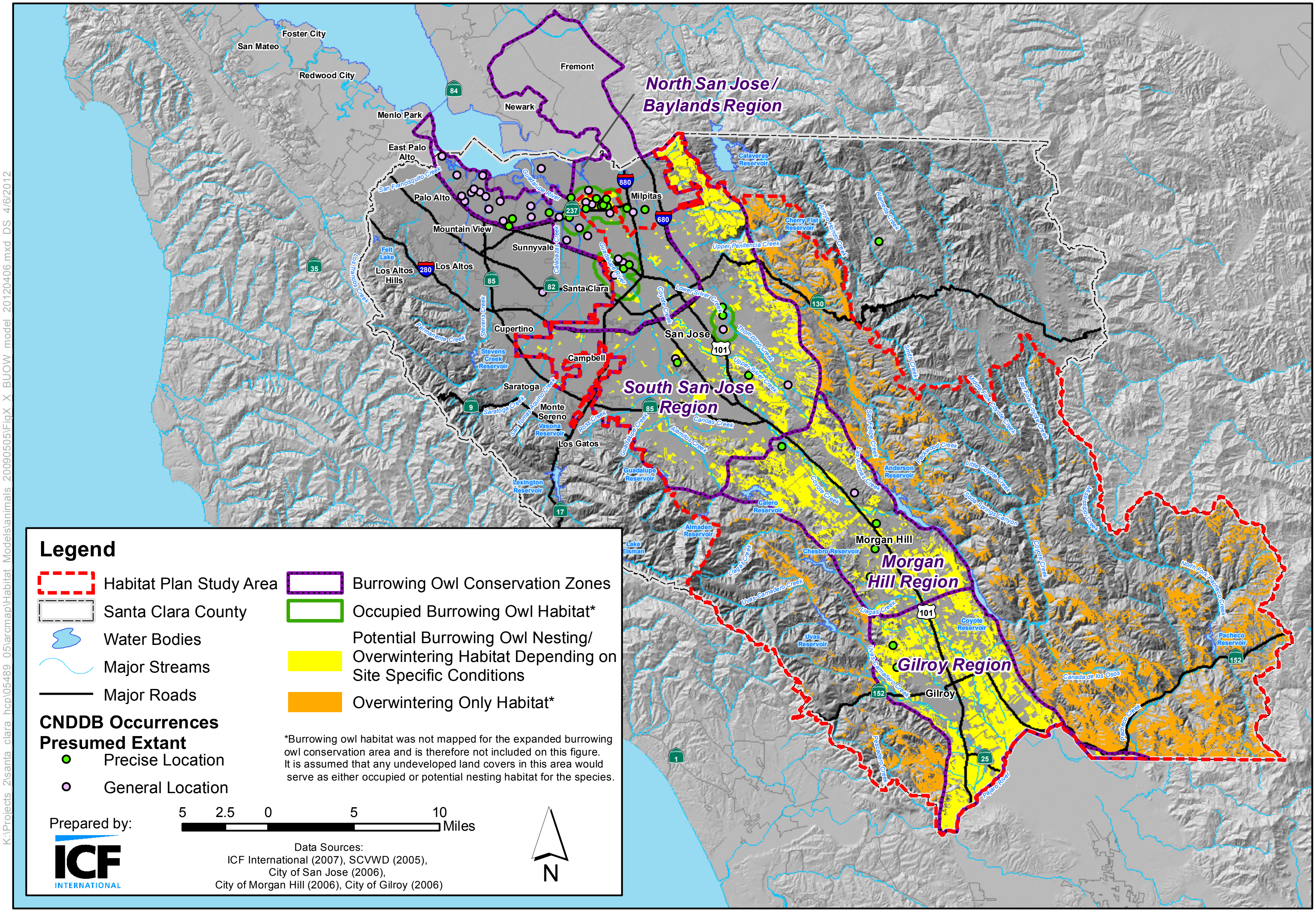

Figure 2

Burrowing Owl Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Least Bell's Vireo (*Vireo bellii pusillus*)

Legal Status

State: Endangered
Federal: Endangered, Migratory Bird Treaty Act
Critical Habitat: Designated (1994)
Recovery Planning: U.S. Fish and Wildlife Service 1998
Notes: No anticipated change in status during permit period.

Taxonomy

There are four recognized subspecies of Bell's vireo (*Vireo bellii*) including *V. b. belli*, *V. b. medius*, *V. b. arizonae*, and *V. b. pusillus*, the least Bell's vireo (American Ornithologists' Union 1957). While all subspecies are similar in appearance, least Bell's vireos are mostly gray above and pale below, while easternmost birds are greenish above and yellowish below. Southwestern subspecies are intermediate in plumage characteristics. The least Bell's vireo in California is slightly larger than Bell's vireos in Arizona or Texas (Brown 1993). Descriptions of the species' physical characteristics, behavior, and distribution are provided in a variety of field guides (e.g., Sibley 2000; National Geographic 2002; Peterson 1990).

Distribution

General

The Bell's vireo is a migratory species that breeds in North America and overwinters primarily along the Pacific Coast in southern Mexico. Breeding range for Bell's vireo is from north central to southwestern United States and into central Mexico. Breeding has been documented from southwestern California and northwestern Baja California, Mexico, to central South Dakota, east to Illinois and northwestern Indiana, south to the gulf coast and into southern Sonora, Mexico. Breeding in California usually takes place in southwestern California and northwestern Baja California, Mexico. However, recently (1997 and 2001) breeding individuals been reported as far north as southern Santa Clara County along Llagas Creek (Santa Clara Valley Water District 2002, California Natural Diversity Database 2006) (Figure 1). Additional sightings have occurred in southeastern Monterey County (Roberson 2004) and western Merced County. A successful breeding pair has also been documented in 2005 and 2006 in neighboring Stanislaus County, returning to this county for the first time in 40 years (U.S. Fish and Wildlife Service 2005). These sightings corroborate the notion that this species may be expanding back into its historical range.

Occurrences within the Study Area

Historical

Historically the breeding range of this species was widespread throughout California, including the Sacramento and San Joaquin Valleys (Grinnell and Miller 1944; U.S. Department of the Interior 1986). Santa Clara County's first record was of a nest with eggs collected by W.E. Unglish on 19 Apr 1932 in a dense willow thicket along the Pajaro River near Sargent (Unglish 1937).

Recent

One to two individuals were observed during a May 1997 survey along Llagas Creek between Highway 152 and the Pajaro River confluence, east of Gilroy, and a nest was found (Santa Clara Valley Water District 2002; California Natural Diversity Database 2006; Bousman 2007). Subsequent visits were not made to determine whether the nest was successful. In this same area, three adults were observed during surveys in May 2001, but no nests were found. The site has been revisited in subsequent years, and no individuals have been detected (Santa Clara Valley Water District 2002, 2003, 2004). However, the SCVWD has been unable to survey the reaches with the most suitable habitat because they are under private ownership (Padley pers. comm.). Dense riparian corridors (sufficient overstory with a thick shrub understory) have been identified in other waterways in southern Santa Clara County, but no least Bell's vireos have been detected by the SCVWD (Santa Clara Valley Water District 2002, 2003, 2004). In June 2006 a singing Bell's vireo was seen along Coyote Creek near the Coyote Creek Golf Club (South Bay Birders Unlimited 2006). The bird was seen singing but no additional breeding behavior was observed (Mammoser pers. comm.). The extent of this species' range in the study area is not well understood (Figure 2).

Natural History

Habitat Requirements

Least Bell's vireo is known to nest in riparian woodlands dominated by willow (Peterson et al. 2004) and Fremont's cottonwood (Kus 2002b). Suitable willow woodlands are typically dense with well-defined vegetative strata or layers. The most critical structural component of nesting habitat in California is a dense shrub layer 2–10 feet (0.6–3.0 meters) above ground (Goldwasser 1981; Franzreb 1989, Brown 1993). Individuals may forage in adjacent scrub or chaparral habitat (U.S. Fish and Wildlife Service 1986). During the winter, the least Bell's vireo utilizes scrub vegetation adjacent to watercourses or riparian gallery forests along the west coast of northern and central Mexico (Hutto 1980).

Table 1. Habitat Associations for Least Bell's Vireo

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Riparian woodland	Breeding, foraging	Primary	Typically riparian woodland dominated by willow shrubs and other thick understory vegetation	Goldwasser 1981; U.S. Fish and Wildlife Service 1986
Riparian scrub	Breeding, foraging	Primary	Typically riparian scrub dominated by willow and other thick vegetation	Goldwasser 1981; U.S. Fish and Wildlife Service 1986

Reproduction

Breeding least Bell's vireos begin arriving on their breeding grounds in late March and begin nesting in early April (Kus 2002a). Individuals may remain on the breeding grounds into early October, but nesting is typically finished by the end of July (Kus 1999). Most pairs are monogamous during the breeding season (Brown 1993). Several factors may have an effect on breeding success including development adjacent to riparian habitat, brown-headed cowbird (*Molothrus ater*) parasitism, and water management.

Table 2. Key Seasonal Periods for Least Bell's vireo

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding				✓	✓	✓	✓					
Migration		✓	✓	✓				✓	✓	✓		
Wintering	✓	✓								✓	✓	✓

Sources: Brown 1993; Kus 1999, 2002a.

Movement

Little is known about the migratory routes of this species. Individuals leave the northernmost breeding grounds by August or September (Barlow 1962). Most have left the U.S. by early October, although some may remain in the Lower Colorado River Valley until late November (Brown 1993). During spring migration, adults return to their breeding grounds in early to mid-March and reach the northern limits of the breeding range in May (Brown 1993; Kus 1999). Home range and movement during the breeding season is limited to areas within dense riparian corridors. Territories are often linear in nature, following the stream course. Size of home ranges is dependent on the quality of breeding habitat available and the number of breeding individuals that the area will support.

Table 3. Movement Distances for Least Bell’s Vireo

Type	Distance/Area	Location of Study	Citation
Home Range	1.2 acres (0.5 ha)	Kansas	Barlow 1962
	0.5–4 acres (0.2–1.6 ha)	California	Gray and Greaves 1984
	0.7 ha	California	Collins et al. 1989
Dispersal	33 feet (10m) on day 1 to 330 feet (100m) on day 5	Indiana	Hensley 1950
	100–200 feet (30–60m) on day 14		Nolan 1960
Migration	From breeding grounds to Pacific Coast of southern Mexico	North America	Brown 1993

Ecological Relationships

For successful breeding, this species is dependent on dense riparian corridors, typically along watercourses. Scrub habitats adjacent to these watercourses are equally important to the success of the species because they provide foraging opportunities as well as protection for nesting habitat. Brown-headed cowbirds have decimated Bell’s vireo populations throughout its breeding range and this subspecies is no different. Dense riparian breeding habitat that is surrounded by agricultural lands or developed areas will facilitate brown-headed cowbird abundance and lower the breeding success of riparian nesting species like the least Bell’s vireo.

Population Status and Trends

Global: *Declining* (Kus 2002a; Peterson et al. 2004; NatureServe 2005)
State: *Declining in general but recent evidence of range extensions in San Joaquin Valley*
Within Study Area: *Unknown, may be increasing*

Due to extensive alteration of riparian corridors and adjacent habitats throughout its range, this subspecies has increasingly limited breeding habitat. Although populations have shown signs of increased range in California, numbers throughout North America are in decline. At its low point in the early 1980s, the California breeding population of the Least Bell’s Vireo was estimated at only 300 pairs. Since the species was listed as endangered under the California endangered Species Act in 1980, and under the federal Endangered Species Act in 1986, riparian habitat restoration and cowbird trapping have resulted in considerable increases in Bell’s Vireo population in southern California, which now exceed 1,300 pairs (U.S. Fish and Wildlife Service 1998). The species may be expanding its range northward in California to now include Santa Clara County. Consistent breeding locations will need to be documented in Santa Clara County to confirm a range expansion into the study area.

Threats

Loss of breeding habitat due to watercourse alteration (e.g., channelization, urbanization and firewood cutting) is threatening the viability of this subspecies. In addition, nest parasitism by the brown-headed cowbird has greatly reduced nest success throughout most of its breeding range. An increase in cowbird abundance is propagated by particular land use practices (e.g., residential development, agriculture, grazing) on lands adjacent to breeding habitats (Kus 1999; NatureServe 2005).

Data Characterization

Little is known about the occurrence of this subspecies within the inventory area, aside from the recent observations along Llagas Creek. Due to ongoing monitoring efforts along waterways in southern Santa Clara County, potential habitat for this species has been identified, and surveys for breeding pairs are underway. Although this species is rare in Santa Clara County, it is possible that it could expand its range northward during the permit period.

Existing Conservation Actions in the Study Area

The Santa Clara Valley Water District (SCVWD) has conducted surveys for least Bell's vireo on Llagas Creek since 1997. Starting in 2005 the SCVWD began surveys for least Bell's vireo on Llagas Creek, Pajaro River, and Uvas Creek under its Stream Maintenance Program. Restoration efforts by the SCVWD and other groups like the Fisheries and Aquatic Habitat Collaborative Effort may benefit this subspecies.

Modeled Habitat Distribution in Study Area

Model Description

Model Assumptions

Primary Habitat—Breeding and Foraging

Breeding and foraging is limited to all riparian land cover types, including central California sycamore alluvial woodland, in the Pacheco Creek/Uvas Creek/Llagas Creek and Pajaro River watersheds in southern Santa Clara County. Though dense riparian corridors may exist in other parts of the study area, the suitable habitat model is limited to areas where the species has been documented in the recent past.

Rationale

Although this species nested along heavily vegetated watercourses and associated scrub habitats throughout California, there are no known historical occurrences in Santa Clara County (Grinnell and Miller 1944). However, during a June 1997 survey along Llagas Creek east of Gilroy, a nest was found (Santa Clara Valley Water District 2002; California Natural Diversity Database 2006). During follow-up surveys in 2001, individuals were detected, but nesting was not confirmed. A similar trend has been reported from counties just south and east of Santa Clara County, so it is likely that this species will extend its range over time. However, with the limited survey information available on suitable habitat in southern Santa Clara County and only these two recent occurrences, we are limiting the suitable habitat to the southern portion of the study area.

Model Results

Figure 2 shows the modeled potential habitat for the least Bell's vireo within the study area. The primary habitat for this species is characterized by well-developed riparian habitat and the modeled habitat corresponds to those land cover types. Due to the limited number of occurrences by the species in the study area determining the accuracy of the model is difficult. However, the known breeding occurrence in the study area does fall within the modeled habitat.

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Personal Communications

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Padley, W.D. Biologist with Ecological Services Unit, Watershed Management Operations, Santa Clara Valley Water District. March 19, 2006. Conversation with Troy Rahmig.

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Figure 1
Least Bell's Vireo (*Vireo bellii pusillus*)
Distribution in California

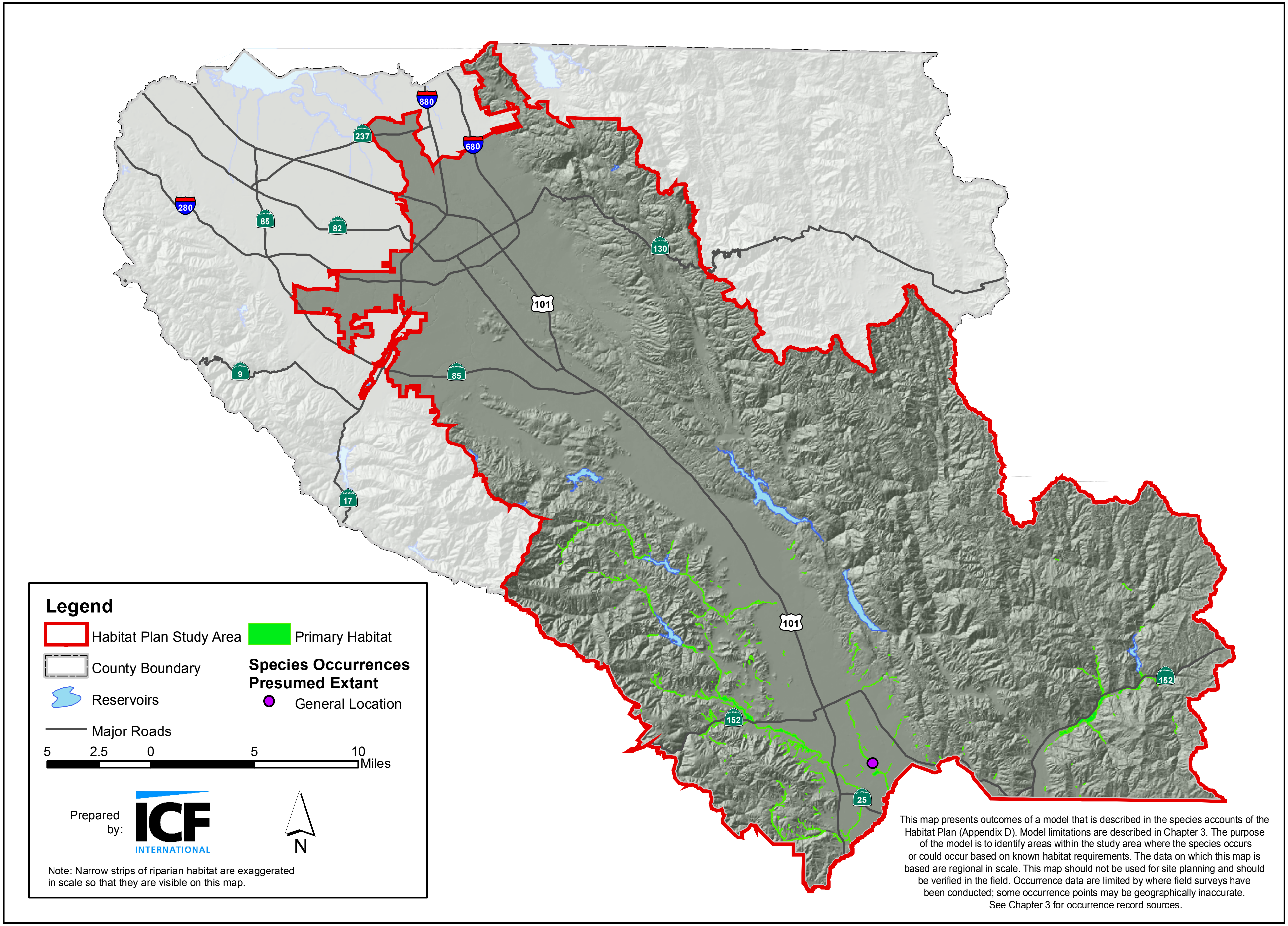

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Figure 2
Least Bell's Vireo Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Tricolored Blackbird (*Agelaius tricolor*)

Legal Status

State: Bird Species of Special Concern; meets requirements as a rare, threatened or endangered species under the California Environmental Quality Act (CEQA)
Federal: Species of Concern; Migratory Bird Treaty Act
Critical Habitat: N/A
Recovery Planning: N/A
Notes: Change in status during permit period is uncertain

Taxonomy

Tricolored blackbirds are endemic to the west coast of North America and primarily to California. Though individuals move and utilize different habitats within the region, depending on time of year, long distance migration has not been verified in this species. Banding studies by Neff (1942), DeHaven and Neff (1973), and DeHaven et al. (1975b) indicated that banding returns from tricolored blackbird *(Agelaius tricolor)* populations breeding in southern California from Santa Barbara County south to Baja California and east to the Sonoran desert were not from outside of this area. Songs of male tricolored blackbirds are not regionally distinguishable, unlike those of some red-winged blackbird populations in California (Collier 1968). No subspecies are currently recognized (American Ornithologists Union 1957; Pyle 1997). Descriptions of the species' physical characteristics, behavior, and distribution are provided in a variety of field guides (e.g., Peterson 1990; Sibley 2000; National Geographic 2002).

Distribution

General

Tricolored blackbirds are largely endemic to California, and more than 99% of the global population occurs in the state (Beedy and Hamilton 1999). 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 the western coast of Baja California (Beedy and Hamilton 1999) (Figure 1).

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).

Occurrences within the Study Area

Historical

Tricolored blackbirds have been present consistently in Santa Clara County, though their distribution has remained sporadic and ephemeral. A summary of early documentation of the species is summarized by Bousman (2007). Reports about the distribution of this species in Santa Clara County during the 20th century were of a rare and uncommon resident and included only occasional reports of small local colonies (Bousman 2007). During data collection for the Santa Clara County Breeding Bird Atlas from 1987–1993, tricolored blackbirds were recorded in 29 (17%) of atlas blocks, and breeding was confirmed in 15 of those blocks (Bousman 2007). In 1989 three colonies were documented in the county. These colonies ranged from 200–700 breeding individuals. Colony nest success was unknown for two of the colonies, and the third was abandoned in late April (California Natural Diversity Database 2006).

Recent

There are a few documented colonies within the study area and perhaps others that have gone undocumented. In 1996, a colony of 300–500 individuals was documented just outside the study area in the San Antonio Valley, but colony success was unknown (California Natural Diversity Database 2006). During a 2004 survey coordinated by the Central Valley Bird Club, the one historical occurrence of breeding tricolored blackbirds within the county did not support a colony (Green and Edson 2004). In 2006, a breeding colony of approximately 200 individuals was documented within the city limits of Morgan Hill (T. Rahmig pers. obs.). That colony was smaller in 2007 (~150 individuals) and absent during a 2008 statewide survey coordinated by California Audubon (B. Powers pers. comm.).

Tricolored blackbirds are considered "itinerant breeders" (i.e., nomadic breeders) where individuals or colonies can breed in different regions within the same year (Hamilton 1998; Hamilton 2004). Because this species wanders considerably during the breeding season, individuals could successfully breed within the study area if suitable breeding and/or foraging habitat were available. Breeding colonies of tricolored blackbirds often go unreported because of their similar appearance to the common red-winged blackbird (*Agelaius phoeniceus*).

Natural History

Habitat Requirements

Tricolored blackbirds have three basic requirements for selecting their breeding colony sites: open, accessible water; a protected nesting substrate, including either flooded, 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* spp.). 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).

Ideal foraging conditions for tricolored blackbirds are created when shallow flood-irrigation, mowing, or grazing keeps the vegetation at an optimal height (<15 cm) (Tricolored Blackbird Working Group 2007). Preferred foraging habitats include agricultural crops such as rice, alfalfa, irrigated pastures, and ripening or cut grain fields (e.g., oats wheat, silage, and rice), as well as annual grasslands, cattle feedlots, and dairies. Tricolored blackbirds also forage in remnant native habitats, including wet and dry vernal pools and other seasonal wetlands, riparian scrub habitats, and open marsh borders (Tricolored Blackbird Working Group 2007).

Table 1. Habitat Associations for Tricolored Blackbird

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Wetland	Breeding	Primary	Cattails, bulrushes, willows, Himalayan blackberries (recent shift), thistles, nettles, and other spiny or thorny plants	Beedy and Hamilton 1999
Riparian	Breeding	Primary	Riparian woodland and scrub	Beedy and Hamilton 1999
Agricultural	Foraging	Secondary	Open pastures, silage, grain fields, mowed alfalfa, pastures, dairies	Beedy and Hamilton 1999
Herbaceous dominated	Foraging	Secondary	Native and nonnative annual grasslands	Beedy and Hamilton 1999

Reproduction

Tricolored blackbirds are closely related to red-winged blackbirds, 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).

Table 2. Key Seasonal Periods for tricolored blackbird

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Colony Formation			✓	✓	✓							
Breeding			✓	✓	✓	✓	✓					
Migration			✓	✓	✓	✓	✓	✓	✓	✓		
Molting							✓	✓	✓	✓		
Source: Beedy and Hamilton 1999.												

Movement

During the breeding season, tricolored blackbirds exhibit itinerant breeding, commonly moving to different breeding sites each season (Hamilton 1998). In the northern Central Valley and northeastern California, individuals move after their first nesting attempts, whether successful or unsuccessful (Beedy and Hamilton 1997). Banding studies indicate that significant movement into the Sacramento Valley occurs during the post-breeding period (DeHaven et al. 1975b).

During winter, virtually the entire population 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). Numbers of tricolored blackbirds decrease in the Sacramento Valley and increase in the Sacramento–San Joaquin River Delta and northern 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 three weeks and move to other locations (Collier 1968), suggesting winter turnover and mobility. In early March and 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).

Table 3. Movement Distances for Tricolored Blackbird

Type	Distance/Area	Location of Study	Citation
Male territory (within colony)	20–35 square feet (0.8–3.25 m^2)	California	Lack and Emlen 1939, Orians 1961a
Dispersal	33% recovered within 10 miles (16 km) of natal colonies	California	DeHaven et al 1975b
Home range	May range widely in flocks to over 9 miles (15 km) from active colony	California	Beedy and Hamilton 1999

Ecological Relationships

Tricolored blackbirds occupy a unique niche in the Central Valley/coastal marshland ecosystems. In areas where the number of tricolored blackbirds is 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). Recently, this species has been documented breeding in silage and rice fields in the Central Valley (Hamilton 2000, 2004).

Population Status and Trends

Global: *Declining* (Beedy and Hamilton 1997, 1999)
State: *Declining* (Beedy and Hamilton 1997, 1999)
Within Study Area: *Unknown*

The U.S. Fish and Wildlife Service, the California Department of Fish and Game, and California Audubon cosponsored intensive tricolored blackbird surveys (carried out by volunteers in suitable tricolored blackbird surveys in suitable habitats throughout California) in 1994, 1997, 1999, 2000, and 2004 (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000, Green and Edson 2004). 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); 162,508 (2000), and >130,000 (low estimate for 2004). Several areas that historically supported large (>2,000 individuals) colonies in the central valley no longer have birds present (Green and Edson 2004; Hamilton 2004). The study area was not adequately surveyed during 2004, but the one historical location did not have any tricolored blackbirds present (Green and Edson 2004).

Threats

The greatest threats to this species are the direct loss and alteration of habitat; however, other human activities, as well as predation, also threaten tricolored blackbird populations in the Central Valley (Beedy and Hamilton 1999). Most native habitats that once supported nesting and foraging tricolored blackbirds have been altered by urbanization and unsuitable agricultural uses, including vineyards, orchards, and row crops (Frayer et al. 1989; Wilen and Frayer 1990). Many former agricultural areas within the historical range of tricolored blackbirds are now being urbanized. 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 that tricolored blackbird nesting colonies are destroyed in agricultural areas. Other factors that may affect the nesting success of colonies in agricultural areas include herbicide and pesticide applications, and spraying ponds for mosquito abatement (Beedy and Hamilton 1999). A primary reason for limited nesting success in agricultural areas (particularly in rice fields) is predation of fledgling by black-crowned night herons (*Nycticorax nycticorax*) (Hamilton 2004).

Data Characterization

Statewide surveys were conducted for tricolored blackbirds in California in 1994, 1997, 1999, 2000, and 2004 (Hamilton et al. 1995; Beedy and Hamilton 1997; Hamilton 2000; Green and Edson 2004). Additional surveys include data on local distribution and population trends (Neff 1937; DeHaven et al. 1975a). Because this species is nomadic and exhibits 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 of the study area, largely freshwater marshes dominated by cattails or bulrushes, or in areas with suitable willow, blackberry, thistle, or nettle habitat (Beedy and Hamilton 1999).

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. A range-wide management plan was developed in 1997 (Beedy and Hamilton 1997) and the Tricolored Blackbird Working Group is currently developing a conservation plan that is scheduled for release in mid-2006.

Existing Conservation Actions in the Study Area

There are no conservation actions occurring in the study area for tricolored blackbird. 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.

Pond creation and restoration, though typically not initiated to benefit this species, could provide potential breeding habitat if tall dense vegetation (e.g., cattails) are allowed to establish.

A tricolored blackbird conservation plan was prepared by the Tricolored Blackbird Working Group in 2007 (Tricolored Blackbird Working Group 2007).

Modeled Species Distribution in Study Area

Model Description

Model Assumptions

Primary Habitat—Breeding and Foraging

Habitats suitable for breeding and foraging during the breeding season were modeled using all riparian woodland and scrub land-cover types, coastal and valley freshwater marsh and ponds within grassland, oak woodland, riparian forest/scrub, grain/row-crop/hay/pasture, and barren land-cover types.

Secondary Habitat—Foraging and Wintering

Areas that provide suitable foraging and wintering habitats include seasonal wetlands, all grasslands, and all agricultural land-cover types.

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; Hamilton 2004), 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 for the tricolored blackbird within the study area. Primary habitat is limited within the study area and it should be noted that by including all riparian areas the available breeding habitat is likely overestimated. Breeding habitat will actually be limited to small ponds/wetlands that occur in slow water portions of these riparian corridors. Secondary (foraging) habitat is prevalent throughout the valley floor and in the low elevations of the surrounding hills.

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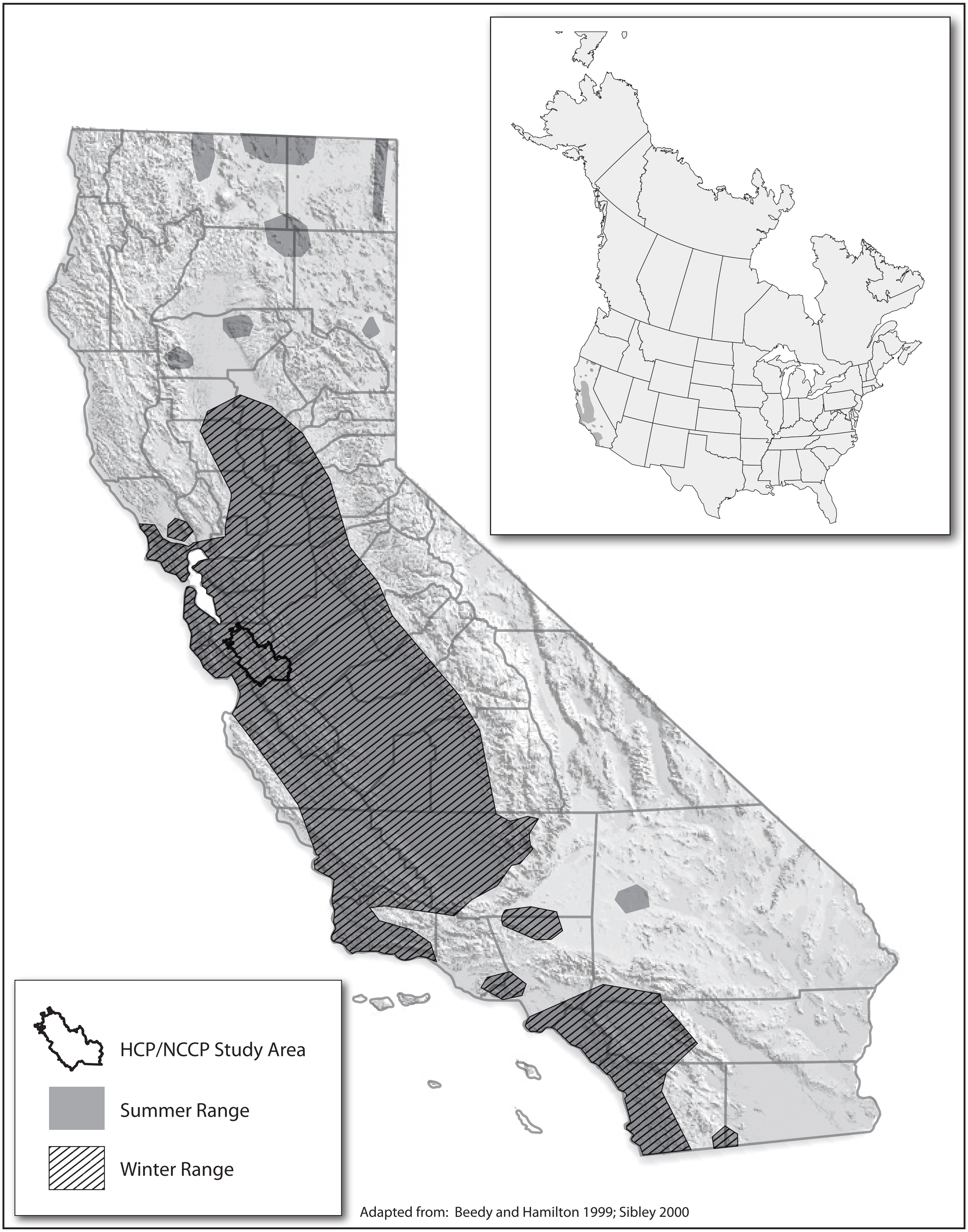

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Figure 1
Tricolored Blackbird (*Agelaius tricolor*)
Distribution in California

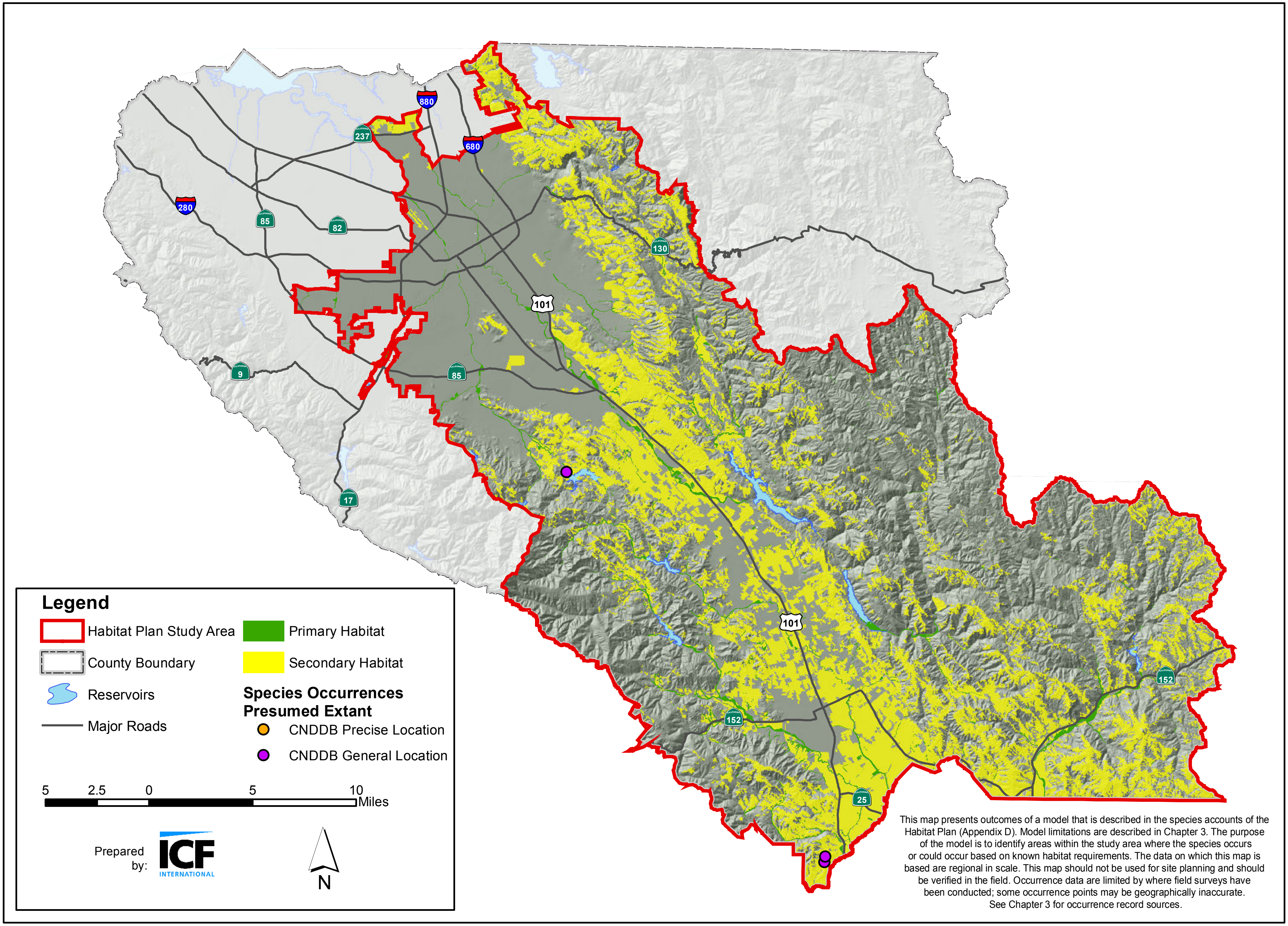

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Figure 2
Tricolored Blackbird Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

San Joaquin Kit Fox (*Vulpes macrotis mutica*)

Dr. Lloyd Glenn Ingles

Legal Status

State: Threatened
Federal: Endangered
Critical Habitat:
Recovery Planning: *Recovery Plan for Upland Species of the San Joaquin Valley, California* (U.S. Fish and Wildlife Service 1998)
Notes: Status not anticipated to change during permit term.

Taxonomy

The San Joaquin kit fox is a subspecies of the kit fox (*Vulpes macrotis*), the smallest member of the dog family in North America. Though there has been some debate as to the taxonomic relationship among North American arid land foxes, the San Joaquin kit fox remains a distinct subspecies due to its limited range in California. The details of this debate are outlined in Dragoo et al. (1990) and Schwartz et al. (2005). Descriptions of the species' physical characteristics can be found in McGrew (1979) and U.S. Fish and Wildlife Service (1998).

Distribution

General

Currently, kit foxes occur in some areas of suitable habitat on the floor of the San Joaquin Valley and in the surrounding foothills of the Coast Ranges, Sierra Nevada, and Tehachapi Mountains from Kern County north to Contra Costa, Alameda, and San Joaquin Counties (U.S. Fish and Wildlife Service 1998) (Figure 1). There are known occurrences in Alameda, Contra Costa, Fresno, Kern, Kings, Madera, Merced, Monterey, San Benito, San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Stanislaus, and Tulare Counties (California Natural Diversity Database 2006). The largest extant populations of kit fox are in Kern County (Elk Hills and Buena Vista Valley) and San Luis Obispo County in the Carrizo Plain Natural Area (U.S. Fish and Wildlife Service 1998).

Occurrences within the Study Area

Historical

Although the precise historical range of San Joaquin kit fox is unknown, it is believed to have extended from Contra Costa and San Joaquin Counties in the north to Kern County in the south. By the 1930s, the range had been reduced to the southern and western portions of the Central Valley (Grinnell et al. 1937). Surveys conducted between 1969 and 1975 extended the known range of the kit fox back into portions of its historical range in the northern San Joaquin Valley, including Contra Costa, Alameda, and San Joaquin Counties (Orloff et al. 1986). At this time, kit foxes were also found in three counties outside the originally defined historical range: Monterey, Santa Clara, and Santa Barbara counties (Orloff et al. 1986).

Recent

There are four occurrences on record from 1972–2002 for the San Joaquin kit fox in Santa Clara County (California Natural Diversity Database 2006, U.S. Fish and Wildlife Service 2006). Of those records, two are based on observation of individuals and two are derived from San Joaquin kit fox range maps from 1972–1975. The two occurrences from the 1970's are not included here due to a lack of precision and because they are based on kit fox range maps and not actual observations. In 1992 a den site was found with two surviving pups (though the adult female had apparently been killed). The best description of the location of this den site is very general, stating that it is from Hollister north to Gilroy. It is included here simply as a placeholder and to acknowledge that habitat potential may exist in this area. The second observation (2002) was of a lone individual during the fall dispersal period in Henry Coe State Park (California Natural Diversity Database 2006). A third observation, which is not in the CNDDB, was of a road kill kit fox over six miles south of the Highway 152/156 junction (U.S. Fish and Wildlife Service 2006). This occurrence falls just outside of the study area.

Genetic studies have shown that individuals from the San Luis Reservoir population, southeast of the study area, interbreed with individuals from Alameda and Contra Costa Counties (Schwartz et al. 2000 in U.S. Fish and Wildlife Service 2006). It is assumed (U.S. Fish and Wildlife Service 2006) that the Pacheco-Santa Ana watershed in the southeastern part of Santa Clara County provides movement habitat between these two areas. In the recovery plan for this species the U.S. Fish and Wildlife Service restricts the range in Santa Clara County to the Pajaro River watershed (U.S. Fish and Wildlife Service 1998).

Natural History

Habitat Requirements

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 (U.S. Fish and Wildlife Service 1998). They prefer habitats with loose-textured soils (Grinnell et al. 1937; 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 (U.S. Fish and Wildlife Service 1998, Roderick and Mathews 1999). They are seldom found in areas with shallow soils due to high water tables 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 California 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; U.S. Fish and Wildlife Service 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 are surrounded by intensively maintained agricultural lands (Knapp 1978) and adjacent to dryland farms (Jensen 1972; Orloff et al. 1986; U.S. Fish and Wildlife Service 1998).

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; U.S. Fish and Wildlife Service et al. 1998). Secondary prey taken opportunistically may include ground-nesting birds, reptiles, and insects (Laughlin 1970).

Table 1. Habitat Associations for San Joaquin Kit Fox

Land Cover Type	Land Cover Use	Habitat Designation	Habitat Parameters	Rationale
Grassland	Breeding, foraging, movement	Primary	Requires suitable burrows for denning, primarily provided by ground squirrels in the northern portion of the kit fox geographic range. Must be managed to maintain low vegetation height	Low vegetation is thought to provide clear view of potential predators. Presence of burrowing species provides burrows for refugia and a substantial prey base.
Agricultural	Foraging and movement	Secondary, Movement	Improves with the presence of suitable prey.	Periodic disking renders this type of habitat as unsuitable for denning and for some prey species.

Sources: Orloff et al. 1986; U.S. Fish and Wildlife Service 1998.

Reproduction

Kit foxes can, but do not necessarily, breed their first year. Sometime between February and late March, two to six pups are born per litter (Zoellick et al. 1987; 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.

Table 2. Key Seasonal Periods for San Joaquin Kit Fox

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Mating and Conception	✓	✓										
Litters Born		✓	✓									
Rearing (pupping)				✓	✓	✓	✓					
Dispersal							✓	✓	✓			
Denning	✓	✓	✓							✓	✓	✓

Sources: U.S. Fish and Wildlife Service 1998; Koopman et al. 2000.

Movement

Kit foxes may range up to 20 miles at night during the breeding season and somewhat less (6 miles) during the pup-rearing season (Girard 2001). The species can readily navigate a matrix of land use types. Home ranges vary from less than one 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.

Table 3. Movement Distances for San Joaquin Kit Fox

Type	Distance/Area	Location of Study	Citation
Home range	In some cases less than 1 m^2 (2.6 km^2) but generally approx. 2 m^2 (3.1 km^2) up to 12 m^2 (31.2 km^2)	Multiple areas	Morrell 1972, Knapp 1978, Zoellick et al. 1987, Speigal & Bradbury 1992, White and Ralls 1993
Dispersal	Variable, 5.0±0.9 miles (8±1.4 km) up to ~74 miles	Elk Hills near Taft	Scrivner et al. 1987

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 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.

Population Status and Trends

Global: *Declining*
(NatureServe 2006; California Department of Fish and Game 2005)
State: *Same as above*
Within Study Area: *Unknown due to lack of data*

Although the San Joaquin kit fox is known to occur within the study area, information on the extent of its range is very limited (California Natural Diversity Database 2006). Compared with populations in the southern San Joaquin Valley, 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 (Laughrin 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 features such as ground cover, dominant vegetation, land use practices, rainfall, and in some cases slope, is substantially different in the north than in the south, where kit foxes are more abundant and well studied. Because of these differences, geographic differences may exist in the demographic characteristics of these populations. However, the threats to the species are likely to be comparable in both regions of their range.

Threats

Continued fragmentation of habitat is a serious threat to this species. Increasing isolation of populations through habitat degradation and barriers to movement, such as aqueducts and busy highways, can limit dispersal to and occupancy of existing and former lands. The threat of being struck by vehicles is high, particularly for dispersing individuals.

Habitat alteration also represents a threat to this species. This is known to result from oil extraction and mining activities, changes in wildlife prevalence, and changes in vegetation structure due to nonnative species and altered grazing regimes (U.S. Fish and Wildlife Service 2010). Livestock grazing is not thought to be necessarily detrimental to the kit fox (Morrell 1975; Orloff et al. 1986), but it may affect the number of prey species available, depending on the intensity of grazing (U.S. Fish and Wildlife Service 1998). Moderate grazing is thought to benefit the species because it can potentially enhance the prey base and reduce vegetation to allow kit fox to more easily detect and avoid predators. 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.

Data Characterization

There are 16 occurrences on record from 1973–2004 for the San Joaquin kit fox in the three-county region that includes Santa Clara, Alameda, and Stanislaus Counties. Four of those records are within the HCP/NCCP study area but only two were verified. A moderate amount of literature is available for the San Joaquin kit fox because of its state threatened and federally endangered status. While numerous surveys have been conducted in the southern portion of the range, very few surveys or studies have been conducted within the northern portion of its range or in the study area. 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. Because there are few sightings within the HCP/NCCP study area and the area has been under surveyed, it is assumed that trends within the study area are consistent with those documented for the northern range of the species.

Existing Conservation Actions in the Study Area

In 1998, a recovery plan for upland species of the San Joaquin Valley was completed (U.S. Fish and Wildlife Service 1998) that 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 the plan's geographic range. No conservation areas were identified from within the HCP/NCCP study area for this species in the 1998 recovery plan or in a subsequent reserve design analysis for the entire range of the species (Haight et al. 2004). 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 suitable habitat and primary recovery areas.

The Nature Conservancy's Mount Hamilton Project includes land preservation throughout the southeastern portion of the study area. One of their target species for conservation is the San Joaquin kit fox.

Modeled Species Distribution in Study Area

Model Description

Only movement and foraging habitat was identified within the study area for this species. It is denoted on Figure 2 as secondary habitat though this has been identified as a possible movement corridor between breeding populations.

Model Assumptions

Secondary Habitat—Movement and Foraging
All grassland land cover types and seasonal wetlands and ruderal areas that are adjacent to grasslands were considered suitable movement and foraging habitat for this species. Further, valley oak/grasslands, blue oak woodland, and coast live oak woodlands within 500-feet of suitable grasslands were also considered suitable movement and foraging habitat. These parameters were only considered suitable habitat within the Pacheco and South Santa Clara Valley watersheds. Small fragments of habitat that were disconnected from contiguous habitat blocks were removed from the results to better represent actual movement potential for the species.

Secondary Habitat—Low-Use Movement
Areas that the San Joaquin kit fox may use occasionally for movement include orchards, golf courses/urban parks, and ruderal areas that are connected to movement and foraging habitat described above. These were intended to represent areas that individuals might pass through while moving between other more suitable habitat types.

Rationale

In the northern part of its range the San Joaquin kit fox now occurs primarily in foothill grasslands (Swick 1973; Hall 1983; U.S. Fish and Wildlife Service 1998), valley oak savanna and alkali grasslands (Bell 1994). They prefer habitats with loose-textured soils (Grinnell et al. 1937; Hall 1946; Morrell 1972), suitable for digging, but occur on virtually every soil type. It has been established that individuals from the San Luis Reservoir population interbreed with individuals from Alameda and Contra Costa Counties, north of the study area, leading experts to believe that southern Santa Clara County may be a movement corridor between these two areas. This habitat model was based on that assumption and habitat that is shown in Figure 2 should be considered low-use secondary habitat.

Model Results

Figure 2 shows the modeled potential habitat of the San Joaquin kit fox within the Santa Clara Valley HCP/NCCP study area. The habitat includes only the southeastern portion of the study area and is primarily located on private lands south of Henry Coe State Park. Since there are so few documented occurrences of the kit fox from within the study area it is difficult to state what the accuracy of the model is relative to actual presence of the species.

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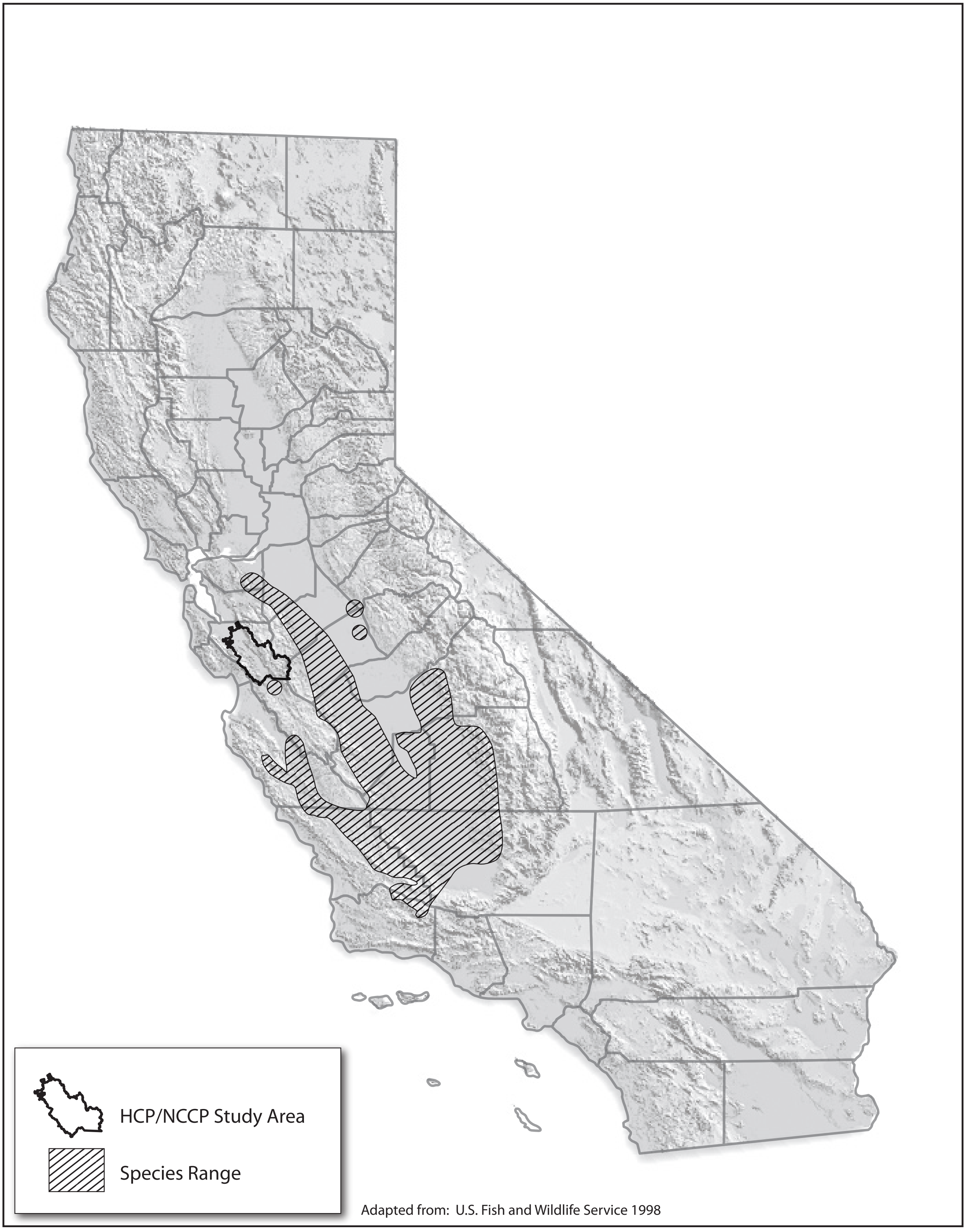

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Figure 1
San Joaquin Kit Fox (*Vulpes macrotus mutica*)
Distribution in California

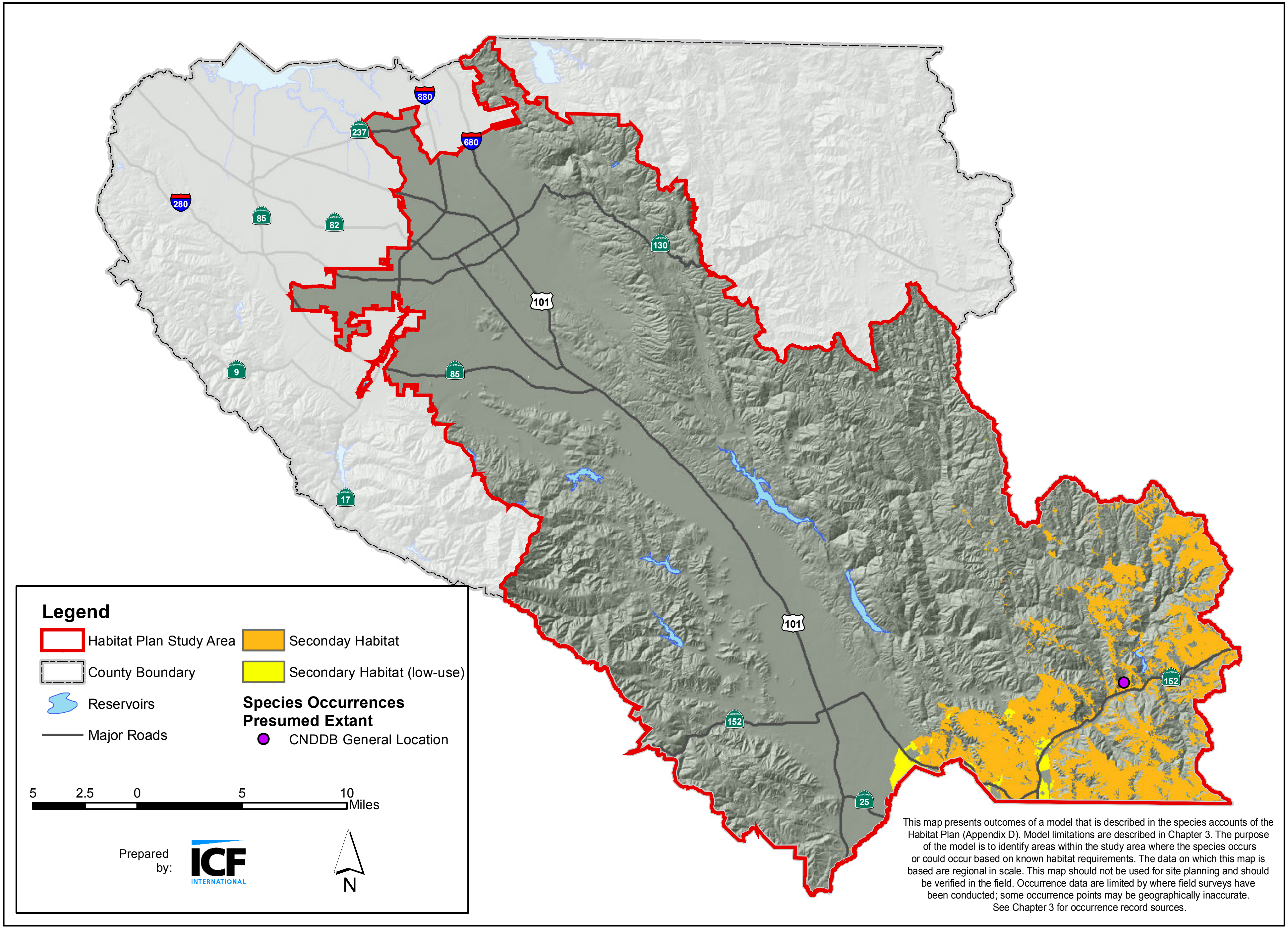

Figure 2
San Joaquin Kit Fox Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Tiburon Indian Paintbrush (*Castilleja affinis* ssp. *neglecta*)

Legal Status

State: Threatened (California Department of Fish and Game 1990); California Native Plant Society 1B.1[1]
Federal: Endangered (U.S. Fish and Wildlife Service 1995)
Critical Habitat: None
Recovery Planning: *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998)

Taxonomy

Tiburon Indian paintbrush (*Castilleja affinis* ssp. *neglecta*) was first collected in 1925 by Katherine Brandegee and described as *Castilleja neglecta* by Zeile at that time (Jepson 1925). In the updated Jepson Manual (Hickman 1993), the species was reduced to subspecific status by Chuang and Heckard.

Description

Tiburon Indian paintbrush is an herbaceous perennial traditionally placed in the figwort family (Scrophulariaceae). Paintbrush species are hemiparasites, obtaining a portion of their nutrients by parasitizing other plant species. Recent studies suggest that the genus *Castilleja* should be grouped with other parasitic and hemiparasitic plants in the Broomrape Family (Orobanchaceae) (Olmstead et al. 2001). The host plant for Tiburon Indian paintbrush is unknown.

Distribution

General

Tiburon Indian paintbrush *(Castilleja affinis* ssp. *neglecta)* is known from nine occurrences in Marin, Napa, and Santa Clara Counties (California Natural Diversity Database 2007, Stuart Weiss pers. comm.) (Figure 1). The range of the plant is approximately 30 miles (east-west) by 70 miles (north-south) (U.S. Fish and Wildlife Service 1995).

[1] 1B means rare, threatened, or endangered in California and elsewhere; 0.1 means seriously endangered in California

Occurrences within the Study Area

Historical

Both occurrences of Tiburon Indian paintbrush in the study area are presumed to be extant (California Natural Diversity Database 2007).

Extant

The two populations of the species in Santa Clara County (occurrence #7 and #9) are found along Coyote Ridge north of Morgan Hill. One occurs on land owned by Santa Clara County Waste Management, and one occurs on land owned by Castle and Cook and leased by Santa Clara County Waste Management. These populations occur on 1/3 of a hectare of land within the Kirby Canyon area. The southern population (occurrence #7) is located on the top of Paintbrush Hill and on its northeast-facing slope. The northern population is located in North Canyon on a steep north-facing slope (occurrence #7 and #9) (Stuart Weiss pers. comm.). These two populations were recently recounted in 2006. It should be noted that occurrence #7 in the California Natural Diversity Database represents both the Paintbrush Hill and North Canyon populations, while occurrence #9 refers to the North Canyon population alone (Stuart Weiss pers. comm.; California Natural Diversity Database 2007). This latter population is by far the largest occurrence in all three counties in which the species is found.

Natural History

Habitat Requirements

Tiburon Indian paintbrush is a strict serpentine endemic species found in rocky serpentine bunchgrass communities between 250 and 1,300 ft in elevation (Safford et al. 2005; California Natural Diversity Database 2007).

Associated native plants can include California gilia (*Gilia achilleifolia* ssp. *multicaulis*), California melic (*Melica californica*), California poppy (*Eschscholzia californica*), dwarf plantain (*Plantago erecta*), foothill needlegrass (*Stipa* [*Nassella*] *lepida*), hayfield tarweed (*Hemizonia congesta* ssp. *congesta*), longhorn plectritis (*Plectritis macrocera*), purple needlegrass (*Stipa* [*Nassella*] *pulchra*), purple sanicle (*Sanicula bipinnatifida*), royal larkspur (*Delphinium variegatum* ssp. *variegatum*), and slender fairyfan (*Clarkia gracilis* ssp. *gracilis*). Rare species often found in occurrence with Tiburon Indian paintbrush include Santa Clara Valley dudleya (*Dudleya abramsii* ssp. *setchellii*), Marin dwarf-flax (*Hesperolinon congestum*), serpentine reedgrass (*Calamagrostis ophitidis*), Tiburon buckwheat (*Eriogonum luteolum* var. *caninum*), Tiburon jewelflower (*Streptanthus glandulosus* ssp. *niger*), fragrant fritillary (*Fritillaria liliacea*), and Mt. Hamilton thistle (*Cirsium fontinale* var. *campylon*) (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2007). Non-native plants frequently found in association with Tiburon Indian paintbrush include Italian ryegrass (*Festuca perennis* [*Lolium multiflorum*]), slender wild oat (*Avena barbata*), and soft brome (*Bromus hordeaceus*) (U.S. Fish and Wildlife Service 1998).

Table 1. Habitat Associations for Tiburon Indian Paintbrush

Land Cover Type	Habitat Designation	Habitat Parameters	Percent Suitable	Rationale
Serpentine bunchgrass grassland	N/A	Serpentinite soils, often rocky sites with low coverage of non-native species, on north- to west-facing slopes, 250–1,300 feet	Unknown	U.S. Fish and Wildlife Service 1995; California Natural Diversity Database 2007

Population Ecology

The yellow flowers of Tiburon Indian paintbrush are hummingbird pollinated (Kevin Bryant pers. comm.). Seed dispersal occurs from June to October. The plant dies back to its woody base after seed dispersal and new growth occurs after the first winter rain. Seeds remain dormant in the soil until appropriate conditions occur, which can take several years (Martin 1989; U.S. Fish and Wildlife Service 1998). Germination may be induced by water (disintegrates the netted seed coat) and low temperatures (5 to 15 degrees Celsius or 45–59 degrees Fahrenheit) (Kevin Bryant pers. comm.; U.S. Fish and Wildlife Service 1998). Seedling establishment may be negatively affected by slow root growth, although the establishment and success of this plant is likely the result of several factors such as local climate, soils, and the amount of herbivory (Martin 1989; U.S. Fish and Wildlife Service 1998).

The size of the eight recorded populations are small (some under 100 individuals), with the largest population consisting of approximately 1,000 individuals at the North Canyon site in the Kirby Canyon area of Coyote Ridge in Santa Clara County (California Natural Diversity Database 2007; Stuart Weiss pers. comm.). The Kirby Canyon Butterfly Trust is now actively monitoring the populations in the Kirby Canyon area in order to obtain additional demographic and ecological information about the species (Stuart Weiss pers. comm.). Table 2 shows key life cycle periods for the Tiburon Indian paintbrush.

Table 2. Key Seasonal Periods for Tiburon Indian paintbrush (Kevin Bryant pers. comm.)

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination	✓	✓									✓	✓
Flowering				✓	✓	✓	✓					
Fruiting				✓	✓	✓	✓					
Seed Dispersal						✓	✓	✓	✓	✓		

Population Status and Trends

Global: Stable
State: Stable
Within Study Area: Stable but need further study

All eight occurrences of Tiburon Indian paintbrush are presumed to be extant (California Natural Diversity Database 2007). Additional monitoring needs to be carried out to determine the true status of the populations both within and outside of the study area. In Marin, the Ring Mountain population (occurrence #4) was last checked in 2006 and appears to be in a steady-state condition, while the St. Hilary's population (occurrence #2) is very small and may be in decline (D. Herlocker pers. comm.).

Threats

Population trends are uncertain, although they are likely to be stable, as the habitat in which they occur is rated fair to excellent (California Natural Diversity Database 2007). Potential threats include habitat loss through encroachment of residential development, proposed quarry expansion, herbivory by deer, trampling by dogs, foot traffic, soil slumping, competition from invasive exotic species, and disturbance from feral pig rooting (U.S. Fish and Wildlife Service 1995; California Natural Diversity Database 2007). The latter threat is especially a problem at the Paintbrush Hill site in Santa Clara County. Grazing is also listed as a threat, but may actually be beneficial in certain areas (Stuart Weiss pers. comm.).

Data Characterization

Of the eight occurrences listed in the California Natural Diversity Database for Tiburon Indian paintbrush, five of these have been documented in the previous 10 years, and all have been documented within the last 19 years. All of these occurrences are believed to be extant; most are of high precision and may be accurately located.

There is still much to learn regarding the population ecology and demographics of Tiburon Indian paintbrush. The main sources of general information on the Tiburon Indian paintbrush are *The Jepson Manual* (Chuang and Heckard 1993), a master's thesis (Martin 1989), and the California Native Plant Society (2001). Specific observations on habitat and plant associates, threats, and other factors are found in the California Natural Diversity Database (2007) and in the Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area (U.S. Fish and Wildlife Service 1998). Additional information can be found in the Final Rule listing the species as endangered (60 Federal Register 6671–6685, February 3, 1995).

Existing Conservation Actions in the Study Area

In Santa Clara County, the northern population (North Canyon) of Tiburon Indian paintbrush is on privately owned land which Santa Clara County Waste Management may look to acquire and protect as a mitigation site for the Kirby Canyon Landfill. The southern population (Paintbrush Hill) is currently functioning as a mitigation site for the Landfill and is located on a reserve for bay checkerspot butterfly conservation (U.S. Fish and Wildlife Service 1998). Both populations are being monitored and managed by the Kirby Canyon Butterfly Trust, which plans to begin collecting seed from these populations in the near future. They are working on a way to reduce damage caused by feral pig rooting in the southern site while still maintaining cattle grazing, which appears to keep invasive non-native species in check (Stuart Weiss pers. comm.).

Modeled Habitat Distribution in Study Area

A model was not developed for Tiburon Indian paintbrush because the serpentinite soils at the two Santa Clara occurrences appear to be unique and quite different than other serpentinite soils in the area.

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Personal Communications

Bryant, Kevin. President, Santa Clara County Chapter of the California Native Plant Society. April 2007—Phone Call.

Weiss, Stuart. Biologist, Creekside Center for Earth Observation. April 2007 and July 2008—Phone Calls.

Herlocker, D. Marin County Open Space District. May 2007—Email.

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Figure 1
Tiburon Indian paintbrush (*Castilleja affinis* ssp. *neglecta*)
Distribution in California

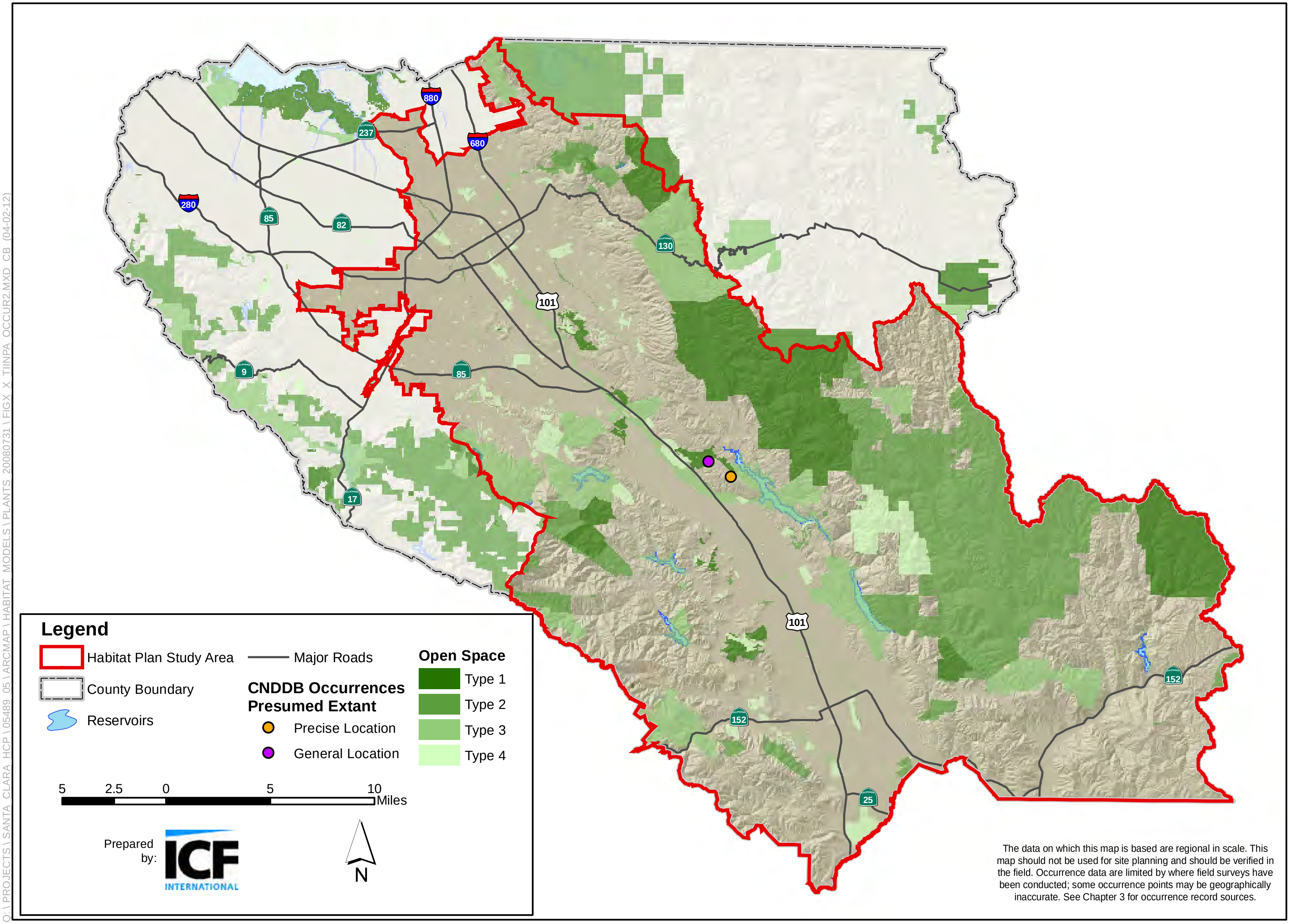

Figure 2
Tiburon Indian Paintbrush Occurence Records - Santa Clara Valley Habitat Plan

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Coyote Ceanothus (*Ceanothus ferrisiae*)

Legal Status

State: California Native Plant Society 1B.1[1]
Federal: Endangered (U.S. Fish and Wildlife Service 1995)
Critical Habitat: None
Recovery Planning: *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998); *Ceanothus ferrisiae (Coyote ceanothus) 5-Year Review: Summary and Evaluation.* (U.S. Fish and Wildlife Service 2011)

Taxonomy

Coyote ceanothus (*Ceanothus ferrisiae* McMinn) is the accepted name for this species (Integrated Taxonomic Information System 2012). McMinn (1933) originally described the species based on specimens collected above Coyote Creek, along Madrone Springs Road. Coyote ceanothus is a member of the buckthorn family (Rhamnaceae).

Description

Descriptions of the species' physical characteristics can be found in McMinn (1959), Munz and Keck (1959), Schmidt (1993), Corelli and Chandik (1995), and U.S. Fish and Wildlife Service (1998 and 2011). Coyote ceanothus is an erect evergreen shrub 1–2 m tall, with long spreading primary branches and short lateral branches (McMinn 1959). Its leaves are usually opposite and round, while the leaf margins are short-toothed to entire (Corelli and Chandik 1995). Its white flowers are in clusters and the seed capsules have three apical horns (U.S. Fish and Wildlife Service 1998).

Distribution

General

Coyote ceanothus is known from three occurrences in the Mt. Hamilton Range in Santa Clara County (Figure 1; U.S. Fish and Wildlife Service 2011). This species is endemic to California and is only found in Santa Clara County.

[1] 1B means rare, threatened, or endangered in California and elsewhere; 0.1 means seriously endangered in California.

Occurrences within the Study Area

Historical

There is one reported occurrence in Santa Clara County from Croy Canyon in 1929 (California Natural Diversity Database Occurrence #4). However, field surveys at the same locality in 1985 and 1987 failed to locate any plants (California Natural Diversity Database 2006). According to the U.S. Fish and Wildlife Service and the California Natural Diversity Database, the record may be erroneous (U.S. Fish and Wildlife Service 1998, California Natural Diversity Database 2006).

Extant

The CNDDB lists four extant occurrences of Coyote ceanothus, all of which are within 4 miles of each another (U.S. Fish and Wildlife Service 1995; U.S. Fish and Wildlife Service 1998; California Native Plant Society 2006). However, for the purposes of this Plan, the two occurrences in the vicinity of Anderson Dam (CNDDB Occurrence numbers 6 and 8) are considered one occurrence. The other two occurrences are at Kirby Canyon and near Llagas Avenue north of Morgan Hill (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006). All three occurrences are on private land, except for a small part of the Anderson Dam occurrence, which partially falls within Anderson Lake County Park (California Natural Diversity Database Occurrence #8).

Natural History

Habitat Requirements

Coyote ceanothus is generally found growing on dry slopes in chaparral, grassland, and coastal scrub on serpentine soils, from approximately 400–1,500 feet (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006; California Native Plant Society 2006). Species commonly associated with Coyote ceanothus are California sagebrush *(Artemisia californica*), foothill pine (*Pinus sabiniana*), bigberry manzanita (*Arctostaphylos glauca*), toyon (*Heteromeles arbutifolia*), California coffeeberry (*Frangula* [*Rhamnus*] *californica*), and leather oak (*Quercus durata*) (U.S. Fish and Wildlife Service 1998). Some occurrences of Coyote ceanothus are almost pure stands of this species (U.S. Fish and Wildlife Service 2011).

Table 1. Habitat Associations for Coyote Ceanothus

Land Cover Type	Habitat Designation	Habitat Parameters	Percent Suitable	Rationale
Mixed serpentine chaparral	Primary habitat	Dry shallow slopes 400–1,500 feet	High	U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006; California Native Plant Society 2006
Serpentine bunchgrass grassland	Primary habitat	400–1,500 feet	High	Same as above

Population Ecology

Recent research and observation strongly suggest that periodic fire may be crucial for germination and regeneration of senescent stands of this plant (U.S. Fish and Wildlife Service 2011). The only known observancationsof seedlings in nature occurred after fires in Kirby Canyon (K. Freas 1996 in U.S. Fish and Wildlife Service 1998) and at Anderson Reservoir (J. Hillman 2006; U.S. Fish and Wildlife Service 2011). The latter population burned in 2003 and significant recruitment was observed in 2004. Many young shrubs of the same size and age class were also observed at that site in 2006. In surveys conducted in the 1980s, there were few young shrubs and no signs of reproduction present in the Anderson Dam populations (Schmidt 1996 in U.S. Fish and Wildlife Service 1998). At least one ceanothus expert feels that Coyote ceanothus may require some frequency of burning in order to maintain healthy populations that include young shrubs.

The lack of seedling recruitment seen in natural populations may also be due to seed or seedling mortality caused by factors such as seed predation, grazing and browsing, lack of sufficient precipitation to maintain young plants through dry summer following germination, or several of these together. Key seasonal periods for the species are listed in Table 2.

Table 2. Key Seasonal Periods for Coyote Ceanothus

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination	✓	✓								✓	✓	✓
Flowering	✓	✓	✓	✓	✓							
Fruiting		✓	✓	✓	✓	✓						
Seed Dispersal					✓	✓	✓	✓	✓	✓	✓	

Population Status and Trends

Global: *Declining* (NatureServe 2006)
State: *Declining* (NatureServe 2006)
Within Study Area: *Declining* (California Native Plant Society 2006; NatureServe 2006)

The four documented occurrences include approximately 189,475 plants in total based on estimates from the Recovery Plan (U.S. Fish and Wildlife Service 1998) and a field survey conducted in 2009 by the SCVWD of the population near Anderson Dam (SCVWD, unpublished data). The largest population by far, approximately 188,475 individuals, is near Anderson Dam. The majority of the plants in the larger of the two subpopulations near the Dam emerged following a fire in 2003 (U.S. Fish and Wildlife Service 2011). The two occurrences located there may have been continuous prior to construction of the Dam (U.S. Fish and Wildlife Service 1998). The smallest population burned during the Kirby Canyon fire in 1992. Although only 5% of the individuals survived, around 2,000 seedlings were seen in the spring of 1993. Approximately 100 seedlings were individually caged to ward off grazers and seemed to be doing well when observed the following year (K. Freas pers. comm. 1996 in U.S. Fish and Wildlife Service 1998). Approximately 150 plants were observed during a survey of the Kirby Canyon population in the fall of 2010 (U.S. Fish and Wildlife Service 2011). Approximately 500 individuals, all of the same age class, were observed in the third population at Llagas Avenue north of Morgan Hill in 1997 (California Department of Fish and Game 1997 in U.S. Fish and Wildlife Service 1998). During surveys in the fall of 2010 around 600 to 650 plants were observed in this same location (U.S. Fish and Wildlife Service 2011).

Threats

Documented threats to Coyote ceanothus include habitat loss and fragmentation, residential development, illegal trash dumping, recreation, landfill activities, lack of natural recruitment, altered fire regimes, grazing, and genetic isolation and limited insect-mediated gene flow (U.S. Fish and Wildlife Service 1998; 2011). The largest population near Anderson Dam is bisected by an existing gas utility line operated by The Pacific Gas and Electric Company (K. Devitorrio pers. comm.). Routine and emergency maintenance of this underground gas line may impact this key population. This population could also be threatened by Santa Clara Valley Water District work on the reservoir and dam maintenance, including the proposed seismic retrofit of the dam. Trail maintenance by Santa Clara County Parks could also pose a threat to this species.

Data Characterization

Because Coyote ceanothus is a large and conspicuous shrub, it is thought that most of the occurrences of this species are known. However, it is possible that some individuals and populations have been overlooked because they are mistaken for more common species of *Ceanothus*, including the closely related buckbrush (*C. cuneatus*). Further, some hybridization between Coyote ceanothus and buckbrush is suspected to occur and some hybrid populations may exist on Pallousou Ridge adjacent to Henry Coe State Park (T. Cochrane pers. comm.) and in other areas.

Recent research, in addition to anecdotal accounts, indicates that interspecific hybridization occurs between species of *Ceanothus* (Hardig et al., 2000; U.S. Fish and Wildlife Service 2011) and it is now widely accepted that hybrid speciation has occurred in the subgenus *Cerastes*, of which Coyote ceanothus is a species (Hardig et al. 2000). Ongoing genetic studies on this plant may provide additional information on the genetic status, genetic diversity, and population structure of Coyote ceanothus (U.S. Fish and Wildlife Service 2011). This research may provide useful information for the restoration and recovery of this species.

A good account of the habitat and occurrences of Coyote ceanothus can be found in the *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998) and in *Ceanothus ferrisiae (Coyote ceanothus) 5-Year Review: Summary and Evaluation* (U.S. Fish and Wildlife Service 2011). The documented habitat requirements of this species suggest that it should be more widespread than it is, indicating that our knowledge of the species population dynamics are incomplete. The species' habitat requirements may be highly specialized, or other factors are preventing the species' spread into otherwise suitable areas.

Existing Conservation Actions in the Study Area

Waste Management, Inc. and The Nature Conservancy funded K. Freas's research (mentioned above) on Coyote ceanothus (U.S. Fish and Wildlife Service 1998). In the summer of 1992, the Kirby Canyon population burned. The following spring, 2,000 seedlings were observed and were fenced to protect them from grazing. Additional caging on some plants was added to protect against deer and rabbit grazing (K. Freas pers. comm. 1996 in U.S. Fish and Wildlife Service 1998).The Santa Clara Valley Water District was involved in mitigating for impacts on Coyote ceanothus resulting from the enlargement of the spillway to Anderson Dam (Santa Clara Valley Water District 1993 in U.S. Fish and Wildlife Service 1998). Two shrubs were successfully transplanted in 1997 (C. Roessler pers. comm. 1996 in U.S. Fish and Wildlife Service 1998), however they did not survive (R. Austin 2006). Waste Management, Inc. and Santa Clara Valley Water District have done some revegetation work with Coyote ceanothus that has not impacted the status of the species (K. Freas pers. comm. 1996 and D. Amshoff pers. comm. 1997 in U.S. Fish and Wildlife Service 1998). There are no on-going conservation efforts for Coyote ceanothus known to occur in the study area. A Santa Clara Valley Water District spillway modification project in 1992 planted approximately 175 seedlings; their current status is not known.

Table 4. Conservation Actions in the Study Area for Coyote Ceanothus

Action	Timing	Lead Agency	Location
Population ecology research	Implemented	Waste Management, Inc. and Nature Conservancy	Kirby Canyon population
Revegetation experimentation	Implemented	Waste Management, Inc. and Santa Clara Valley Water District	Anderson Dam population
Translocation	Implemented, Unsuccessful	Santa Clara Valley Water District	Anderson Dam population
Seedling outplanting	Implemented	Santa Clara Valley Water District	Need to find out from J. Hillman

Modeled Habitat Distribution in Study Area

A habitat distribution model was not developed for this species because of the extremely limited range of the species and the uncertainty in its localized habitat requirements. A habitat model based on known habitat requirements that have been mapped at a regional scale (i.e., land cover types for this HCP/NCCP) would result in a model that greatly overestimates available habitat.

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Figure 1
Coyote Ceanothus (*Ceanothus ferrisiae*)
Distribution in California

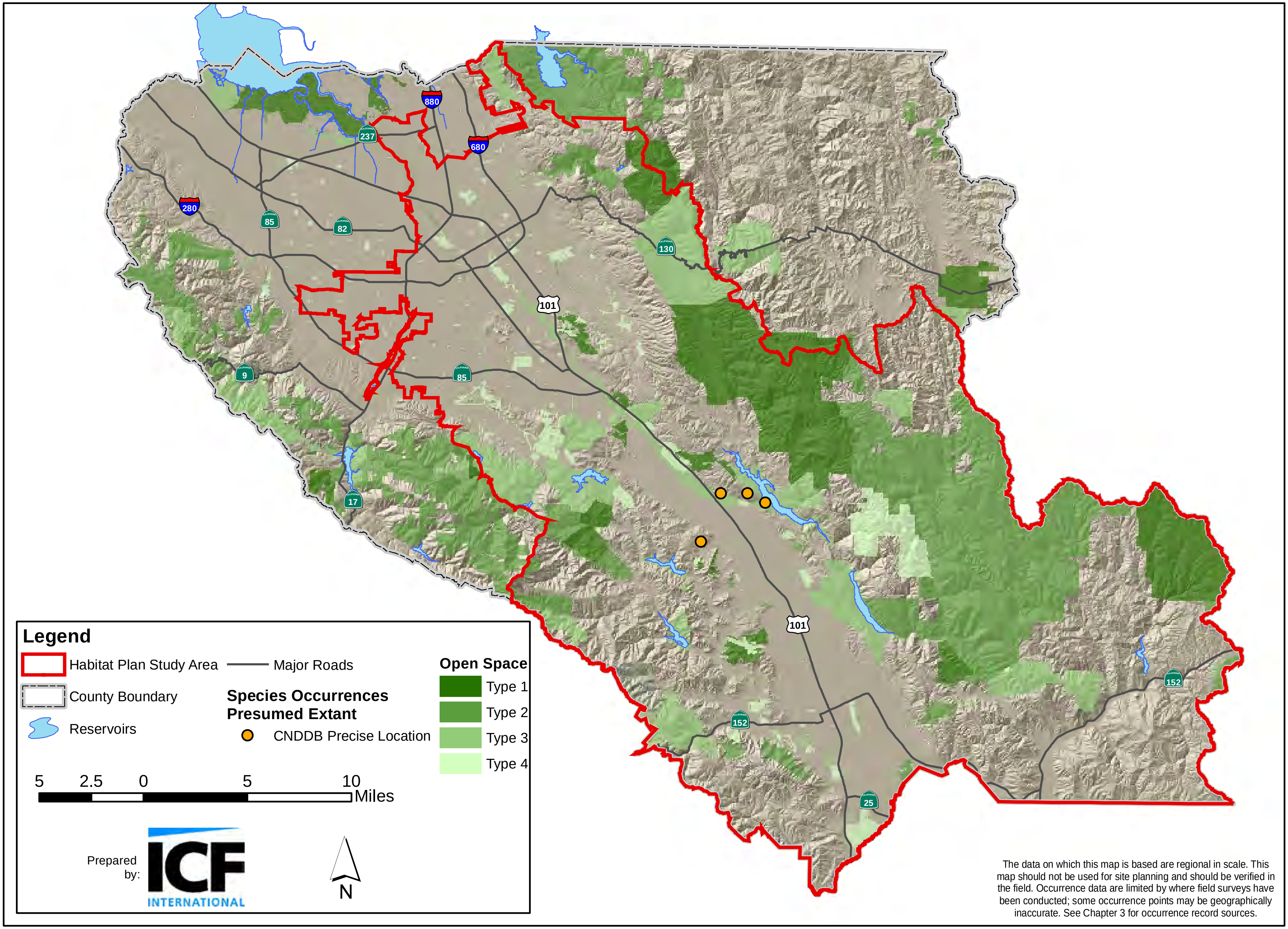

Figure 2
Coyote Ceanothus Occurence Records - Santa Clara Valley Habitat Plan

Mount Hamilton Thistle (*Cirsium fontinale* var. *campylon*)

Legal Status

State: California Native Plant Society List 1B.2[1]
Federal: None
Critical Habitat: N/A
Recovery Planning: *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998)

Taxonomy

Mount Hamilton thistle was originally described by Helen Sharsmith, based on collections from Del Puerto Canyon in the Mount Hamilton Range of western Stanislaus County (Sharsmith 1939). Sharsmith (1939: 89–90) discussed the close morphological and ecological similarities between this species and the two varieties of *Cirsium fontinale*. These similarities later led to the recognition of Mount Hamilton thistle as a variety of *Cirsium fontinale* (Keil and Turner 1992: 313). Mt. Hamilton thistle is within the aster family (Asteraceae).

Description

Descriptions of the species' physical characteristics can be found in Sharsmith (1939: 85–86, Figure 1), Munz (1959: 1,276), Abrams and Ferris (1960: 538, Fig. 5934), and Keil and Turner (1993: 236). Mt. Hamilton thistle is a large herbaceous perennial thistle up to 2 to 6.5 feet tall with a single stem. The plant has woolly, spine-tipped leaves that are up to approximately 2 feet long at the base. The large flower heads have recurved bracts and often droop substantially.

Distribution

General

Mount Hamilton thistle is endemic to the San Francisco Bay Area and occurs in Santa Clara, Stanislaus, and Alameda Counties. There are two clusters of populations, one in the Mount Hamilton Ranges, the other in the Santa Cruz Mountains (Figure 1). There are a total of 48 occurrences of Mount Hamilton thistle are known within its range, 40 of which occur within the study area.

[1] 1B means rare, threatened, or endangered in California and elsewhere; .2 means fairly endangered in California.

Thirty-one of the occurrences within the study area are listed with the California Natural Diversity Database (CNDDB) (2010). The remaining nine occurrences are not listed with the CNDDB and are detailed below.

Occurrences within the Study Area

Extant

Forty occurrences of Mount Hamilton thistle are known to occur in the study area, all of which have been documented within the last 20 years. Occurrences in the study area are generally found in two areas (Figure 2): In the Santa Teresa Hills and East of Highway 101 in the low hills and canyons along Coyote Ridge and the Silver Creek Hills. Thirty-one occurrences were reported in the CNDDB (2010). In addition,, two occurrences were reported on the United Technologies Corporation property (T. Marker pers. comm.), four occurrences were found on Santa Clara County Park lands, two occurrences were found on Rancho San Vicente, and one occurrence was recently reported by SCVWD on or near their facilities. Occurrences in northeastern Santa Clara County are outside the study area.

Natural History

Habitat Requirements

Mount Hamilton thistle occurs on serpentine soils in seeps and springs and along intermittent and perennial streams. The surrounding habitat is often serpentine bunchgrass grassland, although sometimes the occurrences are within foothill pine woodland or coast live oak forest and woodland (Table 1). The occurrences range in elevation from 320 feet to 2,900 feet.

Species primarily associated with Mount Hamilton thistle include seep monkeyflower (*Mimulus guttatus*) and hedge-nettle (*Stachys pycnantha*), as well as sedge species (*Carex* spp.), iris-leaved rush (*Juncus xiphioides*), and hoary coffeeberry (*Frangula* [*Rhamnus*] *californica* ssp. *tomentella*). Additional associates include Brewer's willow (*Salix breweri*), California poppy (*Eschscholzia californica*), columbine (*Aquilegia eximia*), common yarrow (*Achillea millefolium*), long-rayed triteleia (*Triteleia peduncularis*), and beardless wild rye (*Leymus* [*Elymus*] *triticoides*) (Pilz 1967; U.S. Fish and Wildlife Service 1998).

Table 1. Habitat Associations for Mount Hamilton Thistle

Land Cover Type	Habitat Designation	Habitat Parameters	Rationale
Serpentine bunchgrass grassland	Primary habitat (in suitable aquatic habitat)	In seeps and springs and along intermittent and perennial streams, 320–2,900 feet elevation.	California Natural Diversity Database 2010
Serpentine seep	Primary habitat	In seeps and springs and along intermittent and perennial streams, 320–2,900 feet elevation.	
Foothill pine—oak woodland[1]	Primary habitat (in suitable aquatic habitat)	In seeps and springs and along intermittent and perennial streams, 320–2,900 feet elevation.	California Natural Diversity Database 2010
Coast live oak forest and woodland[1]	Primary habitat (in suitable aquatic habitat)	In seeps and springs and along intermittent and perennial streams, 320–2,900 feet elevation.	California Natural Diversity Database 2010

[1] The species occurs in serpentine seeps within this woodland type, but does not occur in terrestrial habitat of this woodland type.

Population Ecology

Mount Hamilton thistle generally occurs in small stands of a few plants to several thousand plants, although some larger stands are known (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2010). One location in Santa Clara County in 1992 supported over 18,000 plants (California Natural Diversity Database 2010). The reproductive biology and demography of this species are unknown.

The highly restricted habitat requirements of this species likely greatly limits the species' distribution and abundance. Research indicates that native insects play an important role in the population biology of another endangered *Cirsium* species. Experimental treatments to exclude or reduce moth larvae, weevil larvae, aphids, spittle bugs, and mealybugs from juvenile rosettes of the endangered Pitcher's thistle (*Cirsium pitcheri*) in rare dune habitat of Michigan resulted in substantial increases in plant survival, growth, and seed production where these insects were common (Bevill et al. 1999). These results also suggest that native insects can influence the spatial distribution of native plants. The susceptibility of Mount Hamilton thistle to native or exotic insect herbivory is unknown.

Table 2. Key Seasonal Periods for Mount Hamilton Thistle

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination	✓	✓	✓	✓						✓	✓	✓
Flowering		(✓)	(✓)	✓	✓	✓	✓	✓	✓	(✓)		
Fruiting			✓	✓	✓	✓	✓	✓	✓	✓	✓	
Seed Dispersal			✓	✓	✓	✓	✓	✓	✓	✓	✓	

Notes: (✓) Indicates flowering period during certain years.

Population Status and Trends

Global: Unknown, but may be stable
State: Same
Within Study Area: Same

All occurrences of Mount Hamilton thistle are presumed to be extant (California Natural Diversity Database 2010). Populations of this species are conspicuous and have not shown any obvious signs of population decline or range contraction (Weiss pers. comm.).

Threats

Reported threats to populations of Mount Hamilton thistle in the study area include alteration of hydrologic regimes, urbanization and cattle grazing (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2010). Urbanization potential is very limited within the range of the species due to its occurrence in deep canyons outside areas designated for urban development. The effects of livestock grazing on this species are unknown. The spiny leaves likely limit grazing of plant tissue but Mount Hamilton thistle may be susceptible to trampling by cattle due to their occurrence in and near livestock water sources. Road construction or future landfills may pose a threat. Expansion of the Kirby Canyon Landfill is expected to remove at least one population or portion of a population of Mount Hamilton thistle.

The introduction of aggressive insect herbivores is a common technique to control invasive weedy thistles. Native thistles have been shown to be negatively affected by these biological control agents. For example, Louda and O'Brien (2002) demonstrated that the Eurasian weevil (*Larinus planus*), which is distributed in North America for the control of Canada thistle (*Cirsium arvense*), had spread to native populations of Tracy's thistle (*Cirsium undulatum* var. *tracyi*) in Colorado. Canada thistle is found throughout most of California, including Santa Clara County (Bossard et al. 2000).

A European flower-head weevil *Rhinocyllus conicus* introduced to control exotic thistles was found to destroy flower heads of many native thistles, including *C.*

fontinale (Turner et al. 1987; Turner and Herr 1996). Another study found *R. conicus* feeding on other native thistles in southern California (Goeden and Ricker 1986). A study in 2005 found *R. conicus* in the seed heads of *C. fontinale* var. *campylon* (J. Hillman 2006) however work done by Herr (2000) found no evidence of biologically significant impact of the weevil on native Californian Cirsiums, including *C. fontinale* var. *campylon*. This flower-head weevil is approved by the U.S. Department of Agriculture for control of exotic thistles common in the study area including bull thistle (*Cirsium vulgare*), milk thistle (*Silybum marianum*), and Italian thistle (*Carduus pycnocephalus*). However, studies have not shown this biocontrol agent to be particularly effective at controlling these invasive plants (Bossard et al. 2000). Its effects on *C. fontinale* var. *campylon* are unknown but the research cited above suggests that biological control of invasive weeds may be a threat to this rare native taxa.

Data Characterization

Available information is likely to adequately characterize the species' habitat requirements. However, very little data is available on the species' population biology, and no data is available on the management needs of the species. More information is also needed on threats to this species in the study area.

Existing Conservation Actions in the Study Area

No conservation actions in the study area have directly targeted Mount Hamilton thistle. Protection of some habitat along Coyote Ridge to provide mitigation for impacts to Bay checkerspot butterfly and serpentine grassland, along with improved livestock management in this area have indirectly benefited Mount Hamilton thistle.

Modeled Habitat Distribution in Study Area

Model Description

Model Assumptions

Primary habitat within the study area is defined as serpentine seeps or serpentine soils or grasslands within 25 feet of riverine habitat. This species is only found within the Guadalupe and Coyote watersheds.

Rationale

Mount Hamilton thistle occurs on areas with serpentine characteristics. This can be any combination of serpentine soils, seeps or springs, typically along streams. The surrounding habitat is often serpentine bunchgrass grassland. The occurrences range in elevation from 320 feet to 2,900 feet.

Model Results

Figure 2 shows the modeled potential habitat for the Mt. Hamilton thistle within the study area. The potential habitat is confined to known serpentine areas, mostly along Coyote Ridge and in the Santa Teresa Hills. Most of the known occurrences fall within the modeled habitat. Some occurrences may fall outside modeled habitat due to the mapping limitations of springs of serpentine origin.

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Weiss, Stuart. Biologist. Field visit to Coyote Ridge, spring 2006.

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Figure 1
Mount Hamilton Thistle (*Cirsium fontinale* var. *campylon*)
Distribution in California

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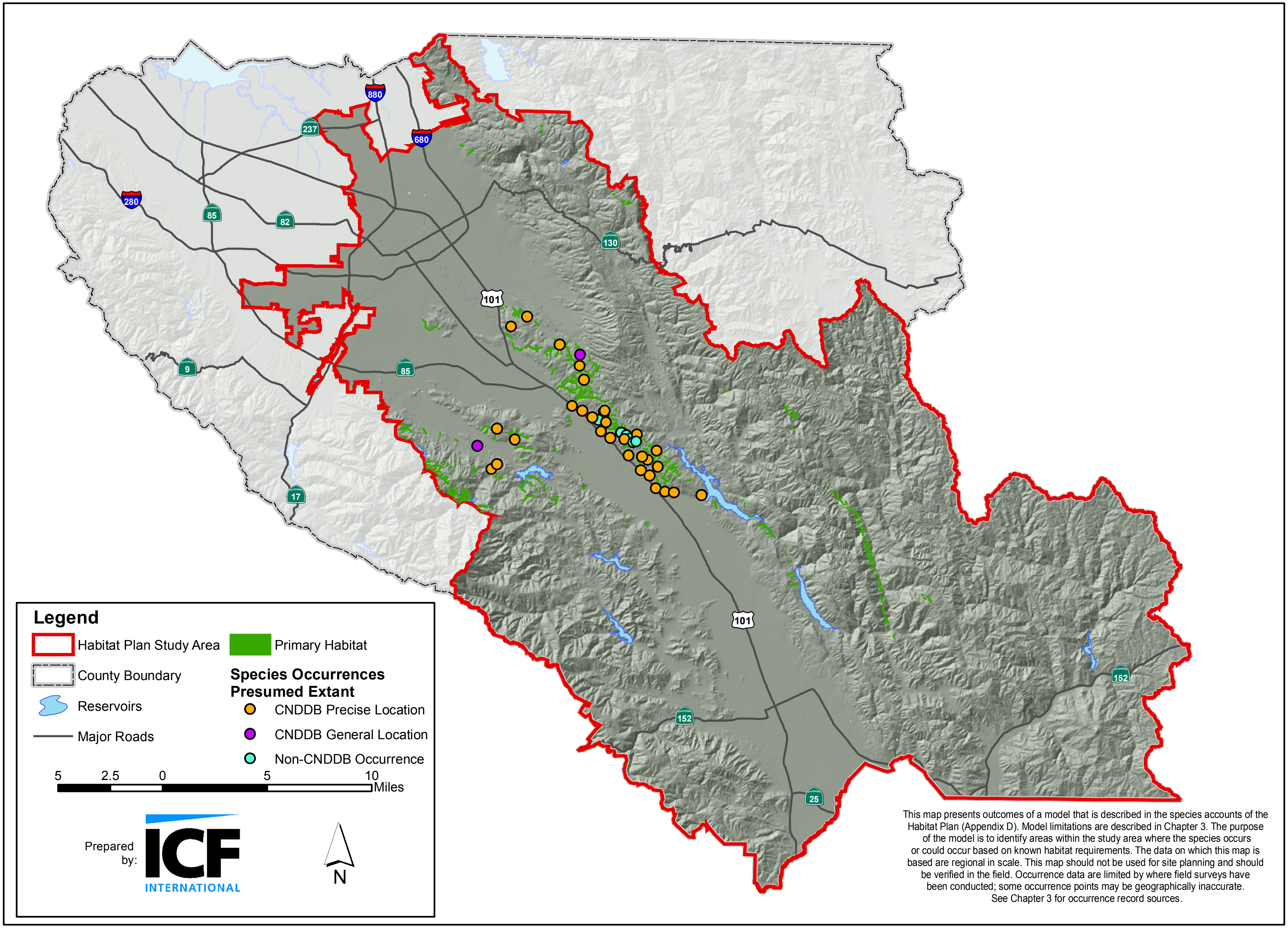

Figure 2
Mount Hamilton Thistle Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Santa Clara Valley Dudleya (*Dudleya abramsii* ssp. *setchellii*)

© Janell Hillman

Legal Status

State: California Native Plant Society 1B.1[1]
Federal: Endangered (U.S. Fish and Wildlife Service 1995)
Critical Habitat: None
Recovery Planning: *Recovery Plan for Serpentine Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998)

Taxonomy

Santa Clara Valley dudleya was first collected by the famous botanist Willis Jepson on Tulare Hill at the turn of the last century (Jepson 1901). The species was originally described as *Cotyledon laxa* var. *setchelli*. In 1903, this taxa was elevated to full species status and transferred to the new genus *Dudleya* (Britton and Rose 1903). The taxa was subsequently reduced to the subspecies level as *Dudleya cymosa* ssp. *setchelli* (Moran 1959; Nakai 1987). It was elevated from subspecies to species level by Bartel in his treatment of the genus, resurrecting the original species name from 1903 (Hickman 1993). Most recently, it was again reduced to the subspecies level as *Dudleya abramsii* ssp. *setchellii* (Baldwin et al. 2012). Santa Clara Valley dudleya is a member of the stonecrop family (Crassulaceae).

Description

Descriptions of the species' physical characteristics can be found in Hickman (1993) and in the *Recovery Plan for Serpentine Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998). Santa Clara Valley dudleya is a perennial with succulent leaves one to three inches long and 0.3 to 0.6 inches wide. The species produces two to three flowering stalks up to 8 inches tall with pale yellow flowers in a terminal inflorescence.

[1] 1B means rare, threatened, or endangered in California and elsewhere; .1 means seriously endangered in California

Distribution

General

Santa Clara Valley dudleya is only found in Santa Clara County in the vicinity of Coyote Valley, from San José south about 20 miles to San Martin, at elevations of 300–900 feet (Figure 1).

Occurrences within the Study Area

Two hundred and seven occurrences have been documented within the study area between 1989 and 2012, and all of these are presumed to be extant (Figure 2) (H.T. Harvey and Associates 2000; California Natural Diversity Database 2010, 2012; T. Marker pers. comm.). The estimated number of individuals known for the species varies greatly due in part to the variation in the methodology of counting the rosettes which are formed as individual plants spread vegetatively (Jones & Stokes 1998). Forty-nine occurrences were reported in the California Natural Diversity Database (20122012), 109 occurrences from the United Technologies Corporation (T. Marker pers. comm.), 48 occurrences from Santa Clara County Parks, and one from the Santa Clara Valley Water District.

An unconfirmed occurrence in the study area documented in 2006 is not included as a known occurrence (RCL Ecology Biological Consulting 2006). The occurrence was found near Highway 152 approximately 2 miles east of Casa de Fruta. There was no record of the occurrence in CNDDB and the identity of the plant has not been confirmed since its documentation. Still, this unconfirmed occurrence is significant as it was found further south than any other known occurrence.

Natural History

Habitat Requirements

Santa Clara Valley dudleya is restricted to rocky outcrops in serpentine grassland and oak woodland at elevations between 300 and 900 feet. McCarten (1993) suggests that suitable rock outcrops must have deep enough crevices for this species' roots, which are at least 6 inches long. Not all serpentine rock outcrops, therefore, may be suitable for Santa Clara Valley dudleya. Table 1 lists expected land cover associations for this species.

The rock outcrops where this species is found are otherwise largely unvegetated. However, adjacent serpentine grasslands typically are dominated by a mixture of native grasses, such as purple needlegrass (*Stipa* [*Nasella*] *pulchra*), and non-native grasses, such as wild oats (*Avena* spp.) and soft chess (*Bromus hordeaceus*). Native forbs are also common associates of this species, including lomatium (*Lomatium* spp.), soap plant (*Chlorogalum pomeridianum*), dwarf plantain (*Plantago erecta*), California poppy (*Eschscholzia californica*), and naked buckwheat (*Eriogonum nudum*) (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2010). Santa Clara Valley dudleya may also occur on serpentine rock outcrops in oak woodland or savanna, where coast live oak (*Quercus agrifolia*) and valley oak (*Quercus lobata*) have been reported as associates (California Natural Diversity Database 2010).

Table 1. Habitat Associations for Santa Clara Valley Dudleya

Land Cover Type	Suitability	Rationale
Serpentine bunchgrass grassland	Moderate	Rock outcrops present in serpentine grassland may be below the minimum mapping unit size but still provide habitat.
Serpentine rock outcrop/barrens	High	Primary habitat for species (California Natural Diversity Database 2010; U.S. Fish and Wildlife Service 1998)
Valley oak woodland	Low	Reported from serpentine rock outcrops within Valley Oak savannah (California Natural Diversity Database 2010)
Coast live oak forest and woodland	Low	May occur on serpentine rock outcrops in cismontane woodland (California Native Plant Society 2006). Coast live oak is reported as an associate (California Natural Diversity Database 2010).
Mixed oak woodland and forest	Low	May occur on serpentine rock outcrops in cismontane woodland (California Native Plant Society 2006). Coast live oak is reported as an associate (California Natural Diversity Database 2010).

Population Ecology

Santa Clara Valley dudleya produces wind-dispersed seeds (McCarten 1993), and also reproduces vegetatively by forming rosettes that either remain attached to the parent plant or separate from it. (Plants that remain attached to parents make counting unique individuals difficult.) Individual plants live for up to 10 years. Seedling germination is high in wet years, but seedling survival is low, often less than 5% (McCarten 1993; U.S. Fish and Wildlife Service 1998). The highest seedling survival rates were on east- and north-facing slopes, suggesting that dessication may be a major source of seedling mortality (McCarten 1993; Jones & Stokes 1998). Suitable microhabitats on rock outcrops (crevices with enough soil to retain moisture) may greatly limit the population size of this species. Table 2 shows key seasonal periods for Santa Clara Valley dudleya.

Table 2. Key Seasonal Periods for Santa Clara Valley Dudleya

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination (unknown)										✓	✓	✓
Flowering				✓	✓	✓	✓					
Fruiting (unknown)						✓	✓	✓				
Seed Dispersal (unknown)	(✓)	(✓)	(✓)	(✓)	(✓)	✓	✓	✓	(✓)	(✓)	(✓)	(✓)

Notes: (✓) Indicates seed disperals period in some years

Population Status and Trends

Global: *Stable?*
State: *Stable?*
Within Study Area: *Stable?*

Insufficient data are available to characterize long-term demographic trends within populations (California Natural Diversity Database 2010). However, it has been suggested that populations of Santa Clara Valley dudleya may be stable because of the stability of their microhabitats in crevices on serpentine rock outcrops (S. Weiss pers. comm.). Population monitoring is needed to confirm this hypothesis.

Threats

The primary threats to Santa Clara Valley dudleya are overgrazing, development, and competition from non-native species (U.S. Fish and Wildlife Service 1998; Weiss 1999; California Native Plant Society 2006; California Natural Diversity Database 2010). Overcollecting is also a significant threat to Santa Clara Valley dudleya because of its attractiveness to collectors, accessible population sites, and slow growth rate (U.S. Fish and Wildlife Service 1995). Other threats may include feral pigs, off-road vehicle use, and foot traffic (California Native Plant Society 2006; California Natural Diversity Database 2010).

Data Characterization

The general habitat requirements of Santa Clara Valley dudleya and the species distribution within its narrow range are relatively well understood. For example, a County-wide survey for this species was conducted in 2000 (H.T. Harvey and Associates 2000), and local botanists with the California Native Plant Society have been devoting significant attention to identifying and protecting local populations (D. Mayhall pers. comm.). The species' microhabitat requirements are not well understood, nor are the species' demography or pollination biology. The management needs of the species also need investigation.

Existing Conservation Actions in the Study Area

The recovery plan for Santa Clara Valley dudleya calls for protection and management of extant populations, as well as educational outreach in the San José area and collection and banking of seed (U.S. Fish and Wildlife Service 1998). Recommended research topics to inform conservation efforts include research on the effects of vegetation management on the species, demographic and dispersal studies, and research on the efficacy of seed germination and propagation techniques.

Protection of mitigation lands on Coyote Ridge and other sites such as the Valley Christian High School site (Jones & Stokes 1998) have preserved some habitat for Santa Clara Valley dudleya.

Modeled Habitat Distribution in Study Area

A habitat distribution model for Santa Clara Valley dudleya could not be developed because of the highly specialized and localized habitat requirements of the species. It is restricted to serpentine outcrops within annual grassland and oak woodland. However, only rock outcrops with sufficient crevice depth and soil depth within these crevices are likely to support the species. Serpentine rock outcrops were mapped in the study area, but only the largest outcrops were visible on the aerial photographs. This land cover type is therefore likely underrepresented on the land cover map. This species has received significant attention by the local botanical community in the last 5–10 years, particularly leading up to and since listing the species as endangered in 1995. As a result, the species' distribution is assumed to be well understood, and many large populations are known and mapped. New populations are still being discovered and it is likely that there are many unknown populations, the discovery of which will expand our estimate of total population size. However, because this species is relatively easily located and locally somewhat widespread, there is less need for a habitat distribution model to predict unknown occurrences.

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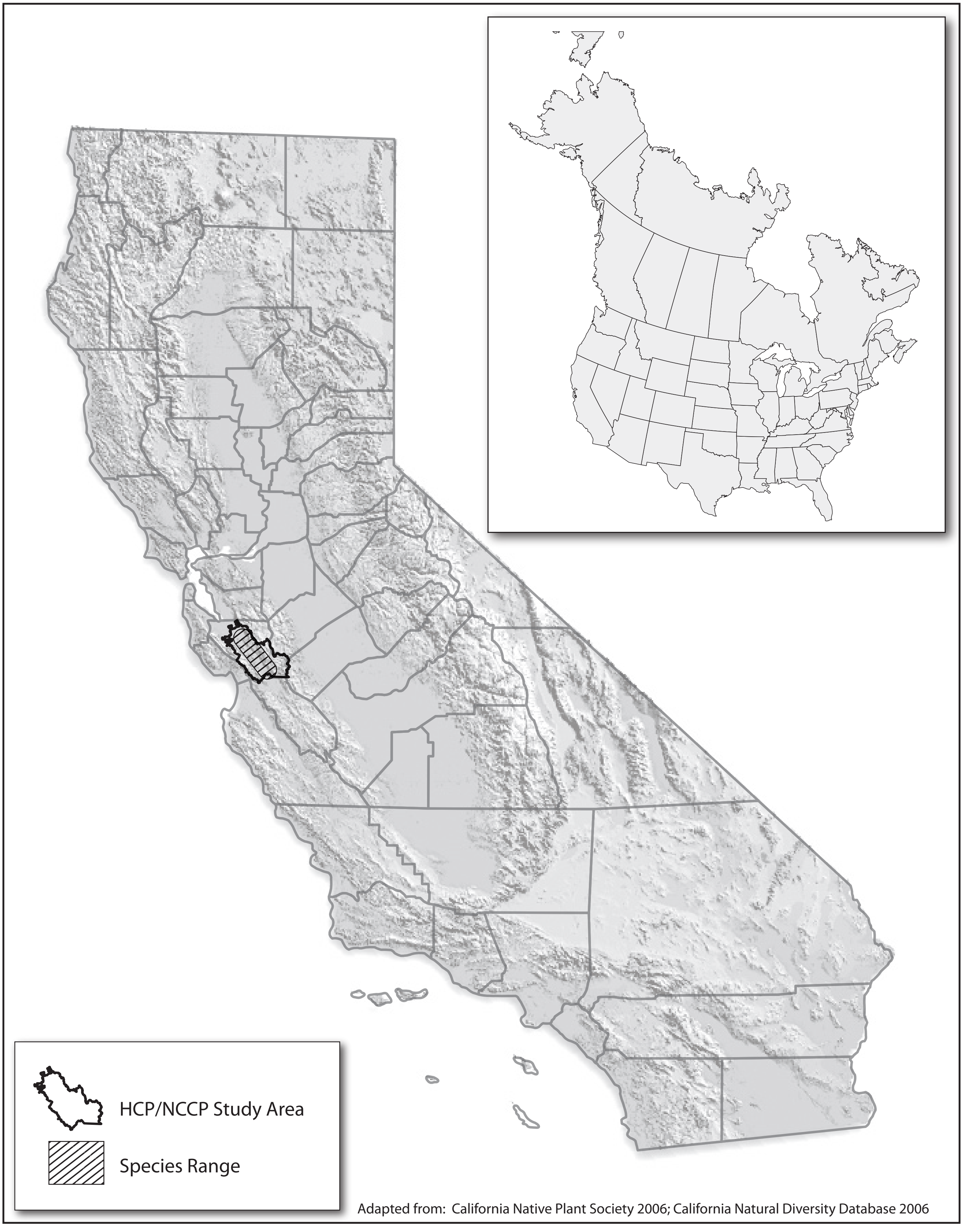

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Figure 1
Santa Clara Valley Dudleya Collinsia (*Dudleya setchellii*)
Distribution in California

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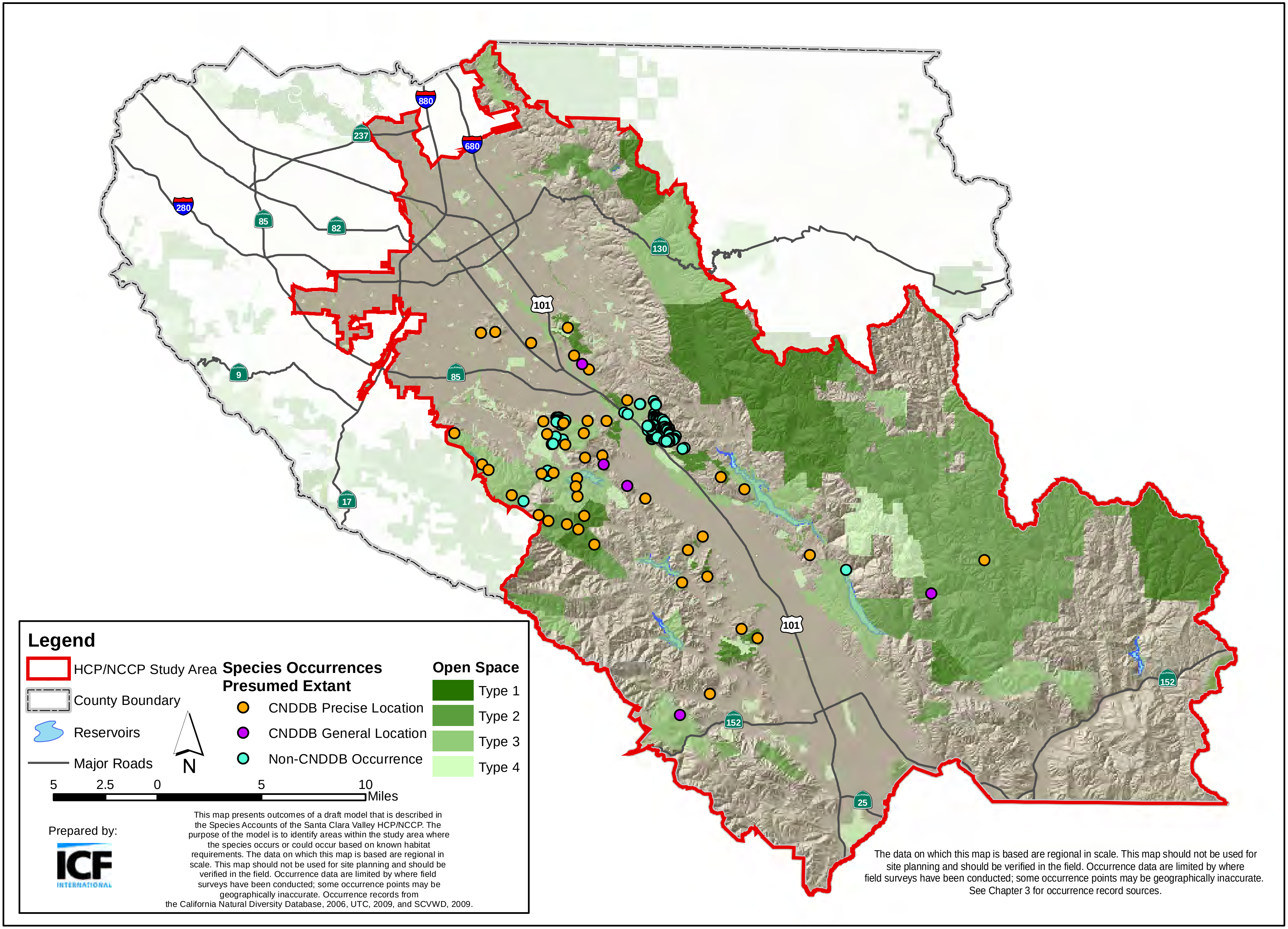

Figure 2
Santa Clara Valley Dudleya Occurrence Records - Santa Clara Valley Habitat Plan

Fragrant Fritillary (*Fritillaria liliacea* Lindl.)

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California Academy of Sciences

Legal Status

State: California Native Plant Society List 1B.2[1]
Federal: None
Critical Habitat: None
Recovery Planning: None

Taxonomy

Fragrant fritillary (*Fritillaria liliacea*) is the accepted nomenclature. See *Madroño* 7:133–159 (1944) for revised nomenclature (Corelli and Chandik 1995). Fragrant fritillary is in the lily family (Liliaceae).

Description

Descriptions of the species' physical characteristics can be found in Baranova (1981); Hickman (1993), and in Corelli and Chandik (1995). Fragrant fritillary, a bulbiferous monocot, is a perennial herb possessing a white flower that grows up to 35 cm in height (Calflora 2006; Hickman 1993). The lower leaves are opposite, mostly basal, and somewhat succulent while the upper leaves are alternate and smaller (Corelli and Chandik 1995).

Distribution

General

Fragrant fritillary is known from 59 occurrences (California Natural Diversity Data Base 2006) throughout its range. It is endemic to western central California, ranging from Sonoma and Solano Counties south to Monterey County (Figure 1, California Natural Diversity Database 2006).

[1] 1B means rare, threatened, or endangered in California and elsewhere; .2 means fairly endangered in California.

Occurrences within the Study Area

Historical

A specimen of fragrant fritillary was collected prior to 1941 in Alum Rock Park in the vicinity of the Alum Rock Spring (California Natural Diversity Database occurrence #33). A survey of this area conducted in 1994 found the habitat extant, but failed to locate any occurrences of the species, so the current status of this population is unknown (California Natural Diversity Database 2006).

Extant

There are eight reported occurrences of fragrant fritillary in the study area (Figure 2, California Natural Diversity Database 2010). Four occurrences are located on private land. Three of these (#25–27) are located east of Santa Clara Valley, southeast of Metcalf Canyon and less than a mile south or southeast from Metcalf VABM (Vertical Angle Benchmark, U.S. Geological Survey Morgan Hill quad) while one lies southwest of Metcalf VABM (#54). Two occurrences (#30 and 31) are located on County-owned parkland. Occurrence #30 was recorded in Calero County Park, near the south arm of Calero Reservoir while occurrence #31 was documented in Almaden Quicksilver County Park. Occurrence #32 was noted on private land about 1.5 miles south from the town of Evergreen, east of San José.

Natural History

Habitat Requirements

Fragrant fritillary occurs in grasslands, woodland, and coastal scrub up to 1,345 feet (California Natural Diversity Database 2006; California Native Plant Society 2006) and in vernal pool areas (California Natural Diversity Database 2006; Sawyer and Keeler-Wolf 1995). The species typically occurs on serpentine soils, although occurrences on heavy clay soils and other soil types have also been reported (California Natural Diversity Database 2006). Serpentine grasslands in the study area are the most likely habitat for this species (Table 1). Some species commonly associated with fragrant fritillary are purple needlegrass (*Stipa* [*Nassella*] *pulchra*), blue dicks (*Dichelostemma capitatum*), soap plant (*Chlorogalum pomeridianum*), sun cups (*Taraxia* [*Camissonia*] *ovata*), purple clarkia (*Clarkia purpurea*), and coyote brush (*Baccharis pilularis*) (Corellia and Chandik 1995; California Natural Diversity Database 2006).

Table 1. Habitat Associations for Fragrant Fritillary

Land Cover Type	Habitat Designation	Habitat Parameters	Percent Suitable	Rationale
Serpentine Bunchgrass Grassland	Primary	Often on serpentine grasslands between 10 and 1,345feet in elevation.	Unknown	California Natural Diversity Database 2006
California Annual Grassland; Northern Coastal Scrub/Diablan sage scrub; Valley Oak Woodland; Mixed Oak Woodland; Blue Oak Woodland; Coast live Oak Woodland; Seasonal Wetlands	Secondary	Various soil types though most often clay, including serpentine, between 10 and 1,345 feet elevation	Unknown	California Natural Diversity Database 2006

Population Ecology

The population ecology of fragrant fritillary is largely unknown. The blooming period of this species is very early in the season (Table 2).

Table 2. Key Seasonal Periods for Fragrant Fritillary

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination										✓	✓	✓
Flowering		✓	✓	✓								
Fruiting			✓	✓	✓							
Seed Dispersal						✓	✓	✓				

Population Status and Trends

Global: Declining (NatureServe 2006)
State: Declining (NatureServe 2006)
Within Study Area: Unknown

Nine documented occurrences of fragrant fritillary are believed to be extirpated in the state as a whole (California Natural Diversity Database 2006). Two populations are reported as stable and two as decreasing, but population trends for the other occurrences are unknown (California Natural Diversity Database 2006). For 21 occurrences, the habitat in which fragrant fritillary occurs is rated good to excellent, suggesting that the populations are likely to be stable. Habitat quality is rated as fair for 10 occurrences and unknown for 18 occurrences. The population sizes of fragrant fritillary in the study area are unknown. Population sizes reported for the species in Solano County on the Jepson Prairie Preserve range from 20 to 100 plants (LSA 2005).

Threats

Some common threats to fragrant fritillary are loss of habitat to urban development and agriculture (Corelli and Chandik 1995), competition from invasive exotic species, and grazing (California Natural Diversity Database 2006). In Santa Clara County, additional threats are from recreation and feral pigs (California Natural Diversity Database 2006).

Data Characterization

Very little information is available for fragrant fritillary. 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 2006). Specific observations on habitat and plant associates, threats, and other factors are present in the California Natural Diversity Data Base (California Natural Diversity Database 2006).

Existing Conservation Actions in the Study Area

No conservation actions have been implemented or are planned in the study area that target fragrant fritillary. A recovery plan for the serpentine soil species of the San Francisco Bay Area was compiled in 1998 in which can be found specific management efforts being carried out in the Bay Area. Fragrant fritillary is included as a frequent associate of some of these species (U.S. Fish and Wildlife Service 1998).

Modeled Habitat Distribution in Study Area

Model Description

Model Assumptions

1. Primary habitat is defined as serpentine bunchgrass grassland between 0 and 1,500 feet elevation on slopes with all degrees of steepness.

2. Secondary habitat is defined as annual grassland, northern coastal scrub/Diablan sage scrub, and all oak woodland land cover types on slopes with all degrees of steepness between 0 and 1,500 feet elevation.

Both types of suitable habitat apply in the following ecoregion subsections: Fremont-Livermore Hills and Valleys, Leeward Hills, Santa Cruz Mountains, Western Diablo Range, and Diablo Range.

Rationale

Fragrant fritillary occurs primarily on serpentine soils in grasslands (California Natural Diversity Database 2006). The species also occurs on non-serpentine soils in grasslands, oak woodland, and coastal scrub up to 1,345 feet (California Natural Diversity Database 2006; California Native Plant Society 2006).

Model Results

Figure 2 shows the modeled potential habitat for fragrant fritillary within the study area. Suitable habitat is found in the foothills on the east and west sides of the valley floor. Most of the modeled habitat is secondary habitat for this species. All eight known occurrences in the study area are located on modeled habitat.

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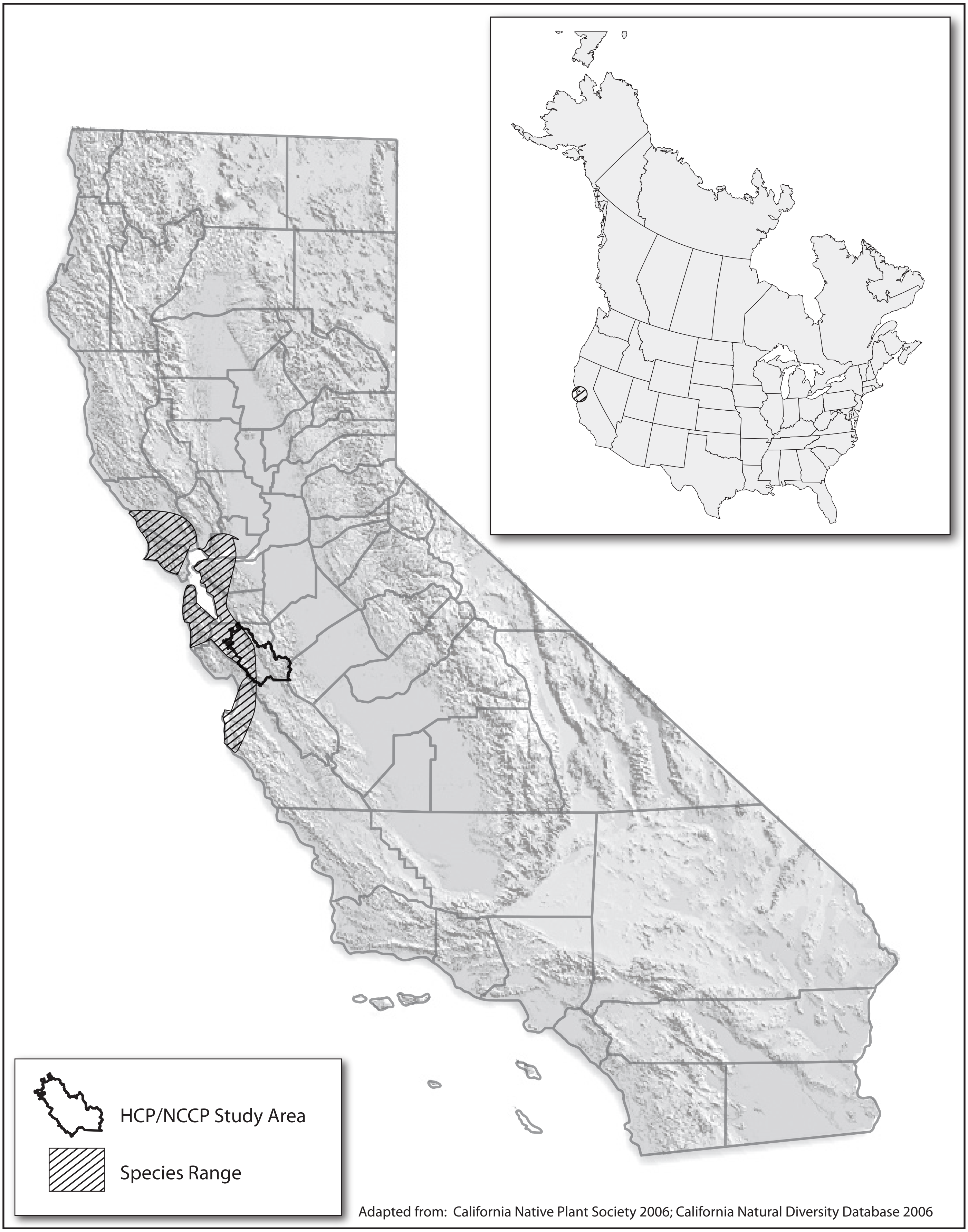

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Figure 1
Fragrant Fritillary (*Fritillaria liliacea*) Distribution in California

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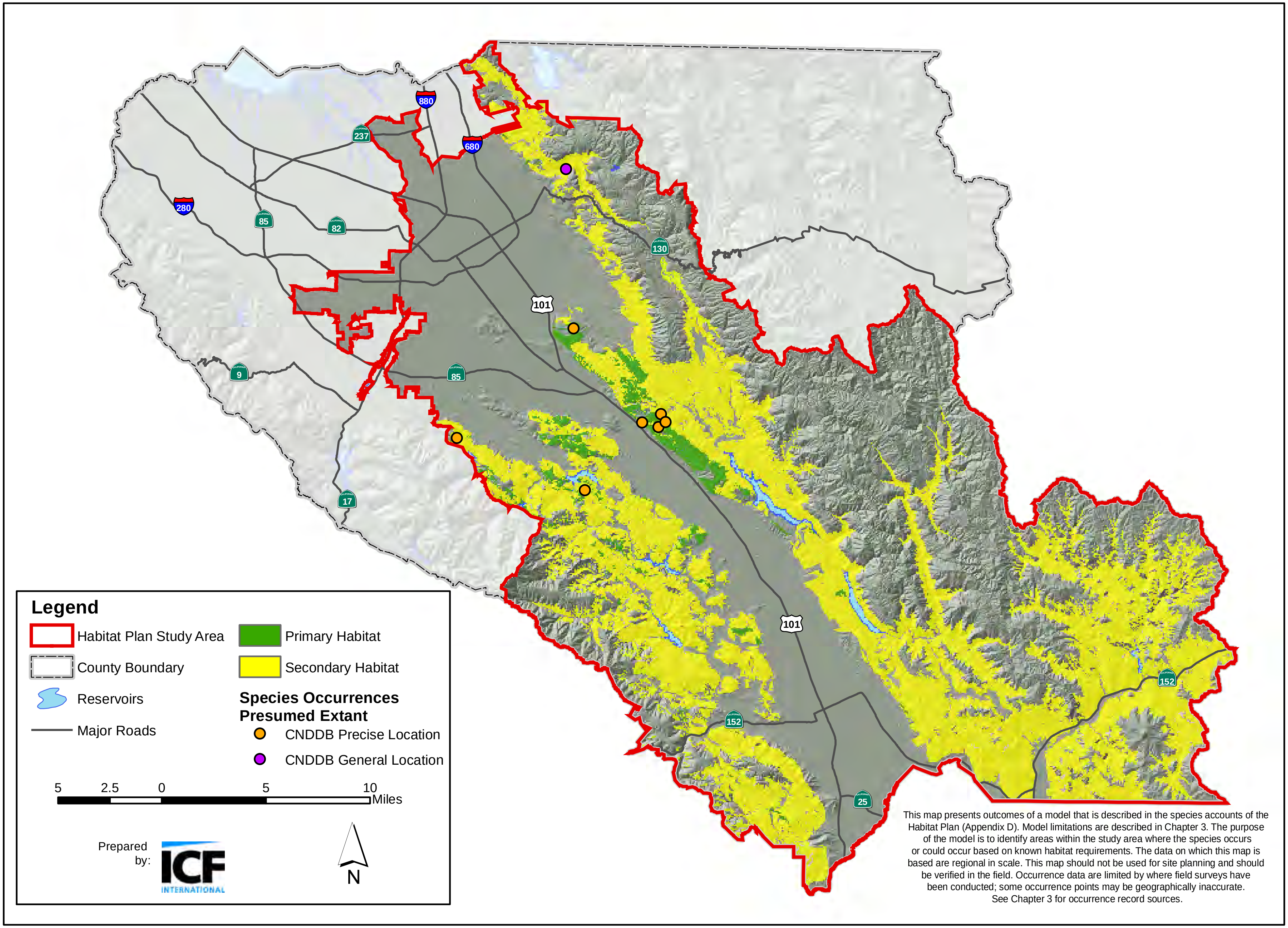

Figure 2
Fragrant Fritillary Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Loma Prieta Hoita (*Hoita strobilina*)

Legal Status

State: California Native Plant Society List 1B.1[1]
Federal: None
Critical Habitat: N/A
Recovery Planning: N/A

Taxonomy

Loma Prieta hoita was originally described in 1838 as *Psoralea strobilina,* based on collections made in California during the expedition led by Captain Frederick Beechey to the Pacific and Bering Strait from 1825 to 1828 (Hooker and Arnott 1838: 332). Rydberg (1919: 11) later transferred the species to *Hoita*. Rydberg's recognition of the genus *Hoita* was not generally accepted until recently (Grimes 1990). Loma Prieta hoita is in the legume family (Fabaceae).

Description

Descriptions of the species' physical characteristics can be found in Rydberg (1919: 11), Abrams (1944: 554, Figure 2753), Munz (1959: 852), and Grimes (1993: 610). Loma Prieta hoita is herbaceous plant up to three feet tall with three leaflets per leaf and dense terminal clusters of purple flowers. This species is distinguished from other species of Hoita by the length and structure of the calyx lobes and flower petals.

Distribution

General

Loma Prieta hoita is endemic to California, where it occurs primarily in the Santa Cruz Mountains of Santa Clara and Santa Cruz Counties (Figure 1). The species also occurs in the Diablo Range in Santa Clara, Alameda, and Contra Costa Counties. There are 26 known occurrences of Loma Prieta hoita (California Natural Diversity Database 2006).

[1] 1B means rare, threatened, or endangered in California and elsewhere; .1 means seriously endangered in California.

Occurrences within the Study Area

Historical

Two historic occurrences (California Natural Diversity Database Occurrences #2 and 3) were recorded from near Gilroy (California Natural Diversity Database 2006).

Extant

Fourteen occurrences of Loma Prieta hoita have been reported from the study area (California Natural Diversity Database 2010). Three occurrences are located in Almaden Quicksilver County Park (California Natural Diversity Database Occurrence #5, #23, and #24). An occurrence consisting of three colonies was reported from Santa Teresa County Park (California Natural Diversity Database Occurrence #6). Two occurrences were reported from the hills east of Coyote Creek, one on private land and one on land of unknown ownership (California Natural Diversity Database Occurrence #10 and #11 respectively). Three occurrences were reported from Rancho Cañada del Oro Open Space Preserve (California Natural Diversity Database Occurrence #13, #25, and #26). One occurrence was reported in the vicinity of Chesbro Reservoir (California Natural Diversity Database Occurrence #16). One occurrence was reported from along Javelina Loop Trail in Calero County Park (California Natural Diversity Database Occurrence #22). Three new occurrences were added from field data collected by Tom Cochrane and John Folkowski at Santa Clara County Parks (2010): One occurrence within Rancho San Vicente and two just east of Almaden Quicksilver Park boundaries.

Two additional occurrences are outside the study area east of Highway 17, including one reported in 2004 at Sierra Azul Open Space Preserve (California Natural Diversity Database Occurrence #12). In addition, collections made on Loma Prieta Peak and at the head of Uvas Creek on lands of unknown ownership (California Natural Diversity Database Occurrence #4) may be within the study area. Figure 2 shows the locations of these occurrences.

Natural History

Habitat Requirements

Loma Prieta hoita generally occurs as an understory element of coast live oak forest and woodland, generally in riparian woodland or on shaded slopes, between 100 and 2,000 feet elevation. Coast live oak (*Quercus agrifolia*) is the dominant canopy tree, associated with California bay (*Umbellularia californica*), valley oak (*Quercus lobata*), or white alder (*Alnus rhombifolia*). The understory is often shrubby, composed of poison oak (*Toxicodendron diversilobum*), toyon (*Heteromeles arbutifolia*), big-berry manzanita (*Arctostaphylos glauca*), bush monkeyflower (*Mimulus aurantiacus*), and coffeeberry (*Frangula* [*Rhamnus*] spp.). Although the California Natural Diversity Database reports that the species sometimes occurs in chaparral or on serpentine (California Natural Diversity Database 2006), other sources note that this species primarily occurs on and is a strong indicator species for serpentine soils (Safford et al. 2005, California Native Plant Society 2012). Within the study area it seems to occur primarily on serpentine and secondarily on non-serpentine (J. Hillman pers. comm.). It also often occurs in the riparian zone. Generalized habitat requirements are shown in Table 1.

Table 1. Habitat Associations for Loma Prieta Hoita

Land Cover Type	Habitat Designation	Habitat Parameters	Percent Suitable	Rationale
Coast Live Oak Forest and Woodland; Mixed Oak Woodland	Primary	Primarily on serpentine soils on shaded slopes or along streams, between 100 and 2,000 feet elevation	Unknown	California Natural Diversity Database 2006; J. Hillman pers. comm.
Northern Mixed Chaparral/Chamise Chaparral	Secondary	All soil types, including serpentine between 100 and 2,000 feet elevation	Unknown, but possibly low	California Natural Diversity Database 2006

Population Ecology

Populations generally consist of one to several stands composed of about a hundred plants, sometimes with up to a thousand plants in a stand (California Natural Diversity Database 2006). Key seasonal periods for the species are shown in Table 2.

Table 2. Key Seasonal Periods for Loma Prieta Hoita

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination	✓	✓	✓							✓	✓	✓
Flowering					(✓)	✓	✓	✓	✓	(✓)		
Fruiting							✓	✓	✓	✓	✓	
Seed Dispersal	✓						✓	✓	✓	✓	✓	✓

Notes: Months in parentheses are uncommon periods.

Population Status and Trends

Global: *Unknown* (California Natural Diversity Database 2006)
State: *Unknown* (California Natural Diversity Database 2006)
Within Study Area: *Unknown* (California Natural Diversity Database 2006)

All but one occurrence of Loma Prieta hoita are presumed to be extant (California Natural Diversity Database 2006). One of the occurrences near Gilroy (California Natural Diversity Database occurrence #2) has possibly been extirpated.

Threats

Few population threats are known for Loma Prieta hoita. Populations at roadsides or in power line rights-of-way are subject to vegetation clearing. At least one population is reported to be subject to cattle grazing and trampling and feral pig rooting. Wild pigs commonly root under oak canopies in the study area, severely disturbing the soil and uprooting most herbaceous plants. At least one population may be threatened by development.

Data Characterization

Only 8 occurrences provide sufficient information to characterize the species' general habitat requirements. Very little data is available on the species' population biology, and no data is available on the management needs of the species. More information is also needed on threats to this species in the study area.

Existing Conservation Actions in the Study Area

There are no known conservation actions in the study area focused on Loma Prieta hoita.

Modeled Species Distribution in Study Area

Model Description

Model Assumptions

1. Primary habitat is defined as mixed oak woodland and coast live oak forest and woodland between 100 and 2,000 feet in elevation on slopes with all degrees of steepness and in all soil types but primarily on serpentine soils.

2. Secondary habitat is defined as northern mixed chaparral/chamise chaparral and mixed serpentine chaparral between 0 and 2,000 feet in elevation on slopes with all degrees of steepness. Northern mixed chaparral applies in all soil types.

Potential ecoregion subsections include the Fremont-Livermore Hills and Valleys, Leeward Hills, Santa Cruz Mountains, Western Diablo Range, and the Diablo Range (i.e., all ecoregions except the Santa Clara Valley).

Rationale

Loma Prieta hoita occurs as an understory element of oak woodland between 100 and 2,000 feet elevation, on shaded slopes or in riparian areas. The species associated with Loma Prieta hoita correspond with the coast live oak woodland and mixed oak woodland land cover types. Secondary habitat appears to be mixed northern chaparral and mixed serpentine chaparral.

Model Results

Figure 2 shows the modeled potential habitat for Loma Prieta hoita within the study area. The potential habitat is spread throughout the study area, with the exception of the valley floor. The known occurrences of this species within the study area fall within the modeled habitat.

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Tom Cochrane. CNPS Volunteer. Email correspondence to Rebecca Sloan, August 1, 2010.

John Folkowski. GIS Analyst. Santa Clara County Parks and Recreation. Email correspondence to David Zippin, July 21, 2010.

Janell Hillman. Botanist, Santa Clara Valley Water District. Email correspondence to David Zippin, October 18, 2006.

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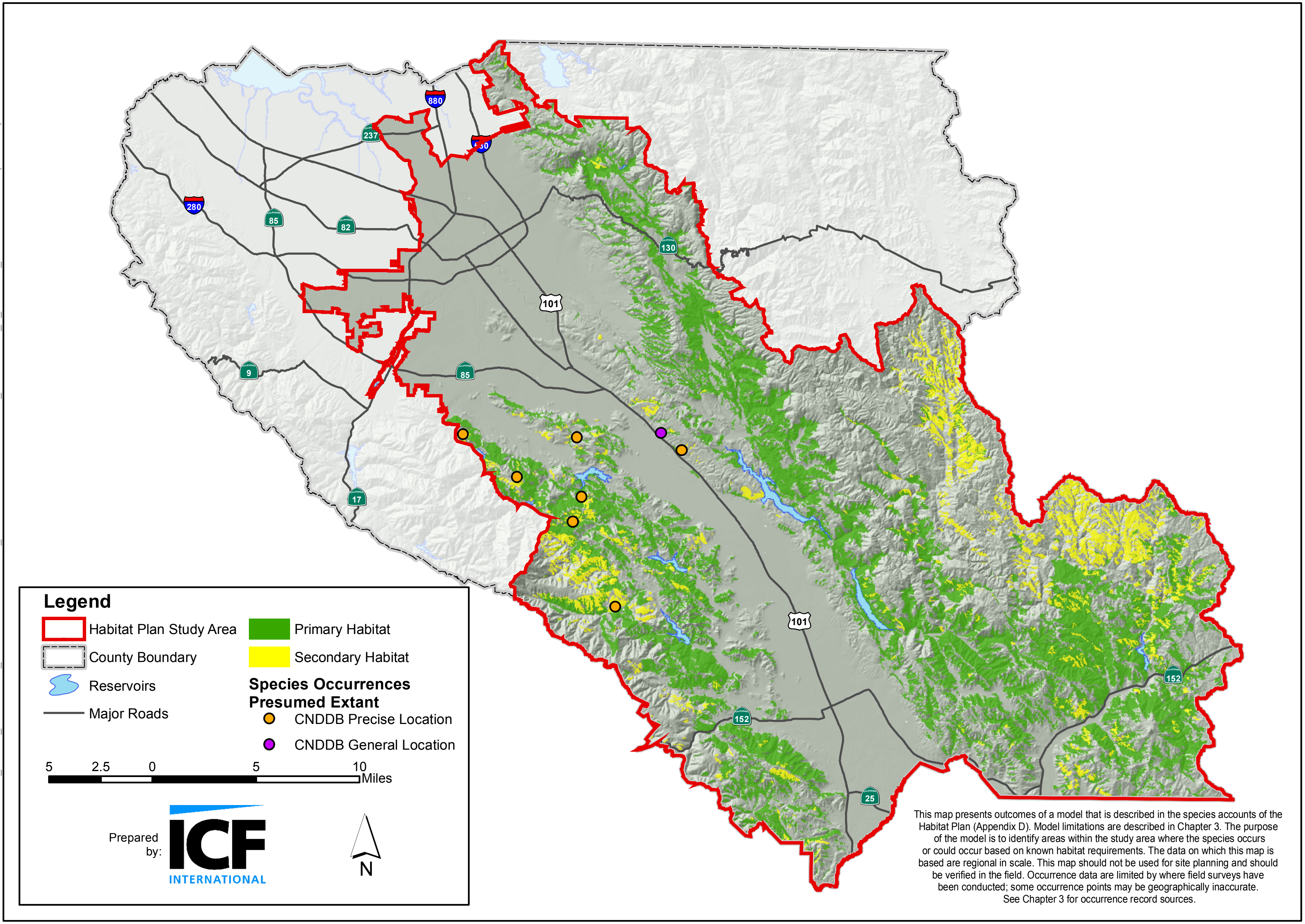
Figure 1
Loma Prieta Hoita (*Hoita strobilina*)
Distribution in California



This map presents outcomes of a model that is described in the species accounts of the Habitat Plan (Appendix D). Model limitations are described in Chapter 3. The purpose of the model is to identify areas within the study area where the species occurs or could occur based on known habitat requirements. The data on which this map is based are regional in scale. This map should not be used for site planning and should be verified in the field. Occurrence data are limited by where field surveys have been conducted; some occurrence points may be geographically inaccurate. See Chapter 3 for occurrence record sources.

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Figure 2

Loma Prieta Hoita Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Smooth Lessingia (*Lessingia micradenia* var. *glabrata*)


© David Tharp

Legal Status

State: California Native Plant Society List 1B.2[1]
Federal: None
Critical Habitat: N/A
Recovery Planning: U.S. Fish and Wildlife Service (1998)

Taxonomy

Smooth lessingia was originally described by D.D. Keck, based on a collection from the Santa Cruz Mountains between Los Gatos and Almaden, in Santa Clara County (Keck 1958: 105). It was originally described as *Lessingia ramulosa* var. *glabrata*. Keck (1958: 105) characterized var. *glabrata* as "exactly like *L. ramulosa* var. *micradenia*" except that var. *glabrata* lacked glandular hairs. Ferris (1958: 101) subsequently raised var. *micradenia* to species rank and transferred var. *glabrata* to *L. micradenia*, recombining the name as *Lessingia micradenia* var. *glabrata*. Smooth lessingia is in the sunflower family (Asteraceae).

Description

Descriptions of the species' physical characteristics can be found in Keck (1958: 105), Munz (1959: 1223), Abrams and Ferris (1960: 379), and Lane (1993: 306). Smooth lessingia is an annual herb that grows up to 60 cm tall. It has deciduous basal leaves less than 6 centimeters (cm) long, and linear leaves along the stem up to only 2 cm long. Smooth lessingia is distinguished from the related Tamalpais lessingia (*Lessingia micradenia* var. *micradenia*) by its three to five flowers per flower head.

[1] 1B means rare, threatened, or endangered in California and elsewhere; .2 means fairly endangered in California.

Distribution

General

Smooth lessingia is endemic to Santa Clara County on the eastern slopes of the Santa Cruz Mountains and the hills adjacent to the Santa Clara Valley (Figure 1). There are 39 known occurrences of smooth lessingia (California Natural Diversity Database 2008), all within the study area.

Occurrences within the Study Area

Historical

Four historical occurrences of smooth lessingia are known from the study area (California Natural Diversity Database 2006). These include occurrences reported from 1.5 miles southwest of San Martin in 1926 (California Natural Diversity Database Occurrence #1), from the eastern slope of Loma Prieta in 1893 (California Natural Diversity Database Occurrence #2), from north of Morgan Hill near Pigeon Point in 1937 (California Natural Diversity Database Occurrence #5), and from near Almaden in 1941 (California Natural Diversity Database Occurrence #9).

Extant

There are thirty-nine extant occurrences of smooth lessingia within the study area, twenty-six of which are known form the California Natural Diversity Database (2008). The remaining occurrences were reported from the Santa Clara Valley Water District or Santa Clara County Parks and Recreation. Most of the smooth lessingia occurrences are located west of Highway 101 with the exception of several occurrences that occur directly adjacent to Highway 101 to the east. Occurrences occur primarily on private land although there are several occurrences in Santa Teresa County Park and one occurrence each in Calero and Mt. Madonna County Parks.

Natural History

Habitat Requirements

Smooth lessingia occurs on serpentine outcrops and in rocky soils in serpentine bunchgrass grassland. It appears to prefer areas with low vegetation cover, sometimes occurring on roadcuts or at roadsides. The occurrences range in elevation from 400 to 1,600 feet (Table 1).

Species associated with smooth lessingia include bigberry manzanita *(Arctostaphylos glauca)*, common yarrow *(Achillea millefolium)*, dwarf plantain

(Plantago erecta), golden yarrow *(Eriophyllum confertiflorum),* gypsum springbeauty *(Claytonia gypsophiloides),* hayfield tarweed *(Hemizonia congesta),* junegrass *(Koeleria macrantha),* miner's lettuce *(Claytonia perfoliata),* purple needlegrass (*Stipa* [*Nassella*] *pulchra),* serpentine linanthus *(Linanthus ambiguus),* serpentine sunflower *(Helianthus bolanderi),* streambank springbeauty *(Claytonia parviflora),* and yellow star thistle *(Centaurea solstitialis)* (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006).

Table 1. Habitat Associations for Smooth Lessingia

Land Cover Type	Habitat Designation	Habitat Parameters	Percent Suitable	Rationale
Serpentine Bunchgrass Grassland	Primary	In areas with low vegetation cover, at 400 to 1,600 feet elevation	Unknown, but probably high	California Natural Diversity Database 2006
Serpentine Rock Outcrop	Primary	at 400 to 1,600 feet elevation	Unknown, but probably high	California Natural Diversity Database 2006

Population Ecology

The ecology and demography of smooth lessingia is unknown and remains unstudied. Population size appears to vary considerably between occurrence sites. Four populations had fewer than 200 individuals, whereas three other populations were reported to contain tens of thousands of plants (California Natural Diversity Database 2006). Estimates of population density at two sites were 10-20 plants per square meter and 40–60 plants per square meter (California Natural Diversity Database 2006). Table 2 shows key seasonal periods for the species.

Table 2. Key Seasonal Periods for Smooth Lessingia

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination	✓	✓	✓	✓								✓
Flowering							✓	✓	✓	(✓)	(✓)	
Fruiting								✓	✓	✓	✓	✓
Seed Dispersal	✓								✓	✓	✓	✓

Note: Periods in parentheses are atypical.

Population Status and Trends

Global: *Unknown* (California Natural Diversity Database 2006)
State: *Unknown* (California Natural Diversity Database 2006)
Within Study Area: *Unknown* (California Natural Diversity Database 2006)

All documented occurrences of smooth lessingia are presumed to be extant (California Natural Diversity Database 2006).

Threats

Reported threats to populations of smooth lessingia in the study area include cattle grazing, foot traffic (trampling), competition from invasive exotic plants, and road and trail maintenance (California Natural Diversity Database 2006).

Data Characterization

Only 8 occurrences provide substantial information on the habitat in which the species has been found, but the available information is not likely to adequately characterize the species' habitat requirements. Very little data is available on the species' population biology, and no data is available on the management needs of the species. More information is also needed on threats to this species in the study area.

Existing Conservation Actions in the Study Area

There are no conservation actions in the study area that are focused on the conservation of smooth lessingia.

Modeled Habitat Distribution in Study Area

Model Description

Model Assumptions

Suitable habitat for smooth lessingia is defined as serpentine bunchgrass grassland and serpentine rock outcrops between 0 and 2,000 feet in elevation on slopes with all degrees of steepness. Potential ecoregions include the Fremont-Livermore Hills and Valleys, Santa Clara Valley, Leeward Hills, Santa Cruz Mountains, Western Diablo Range, and Diablo Range.

Rationale

Smooth lessingia is restricted to serpentine rock outcrops, serpentine roadcuts, and sparsely-vegetated serpentine grassland below 2,000 feet (California Natural Diversity Database 2006).

Model Results

Modeled potential habitat for smooth lessingia is shown in Figure 2. The habitat is concentrated in the hills east of the Santa Clara Valley floor and north of Anderson Reservoir, and in scattered areas dominated by serpentinite-derived soils in the foothills of the Santa Cruz Mountains to the west of the valley floor. All of the known occurrences are mapped in Figure 2, and are found on modeled habitat (note that in some cases the modeled habitat is smaller than the size of the symbols in Figure 2).

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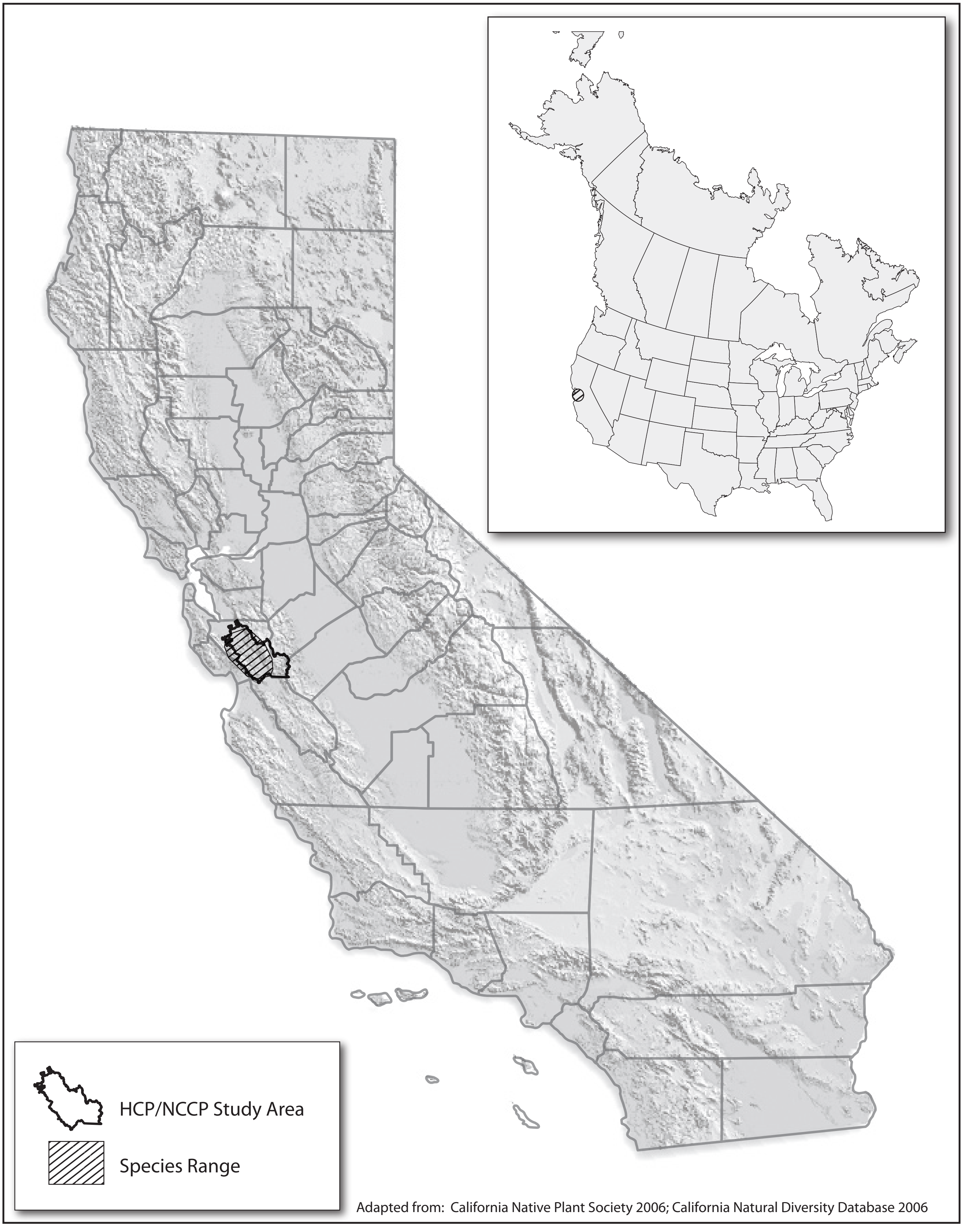

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Figure 1
Smooth Lessinga (*Lessingia micradenia* var. *glabrata*) Distribution in California

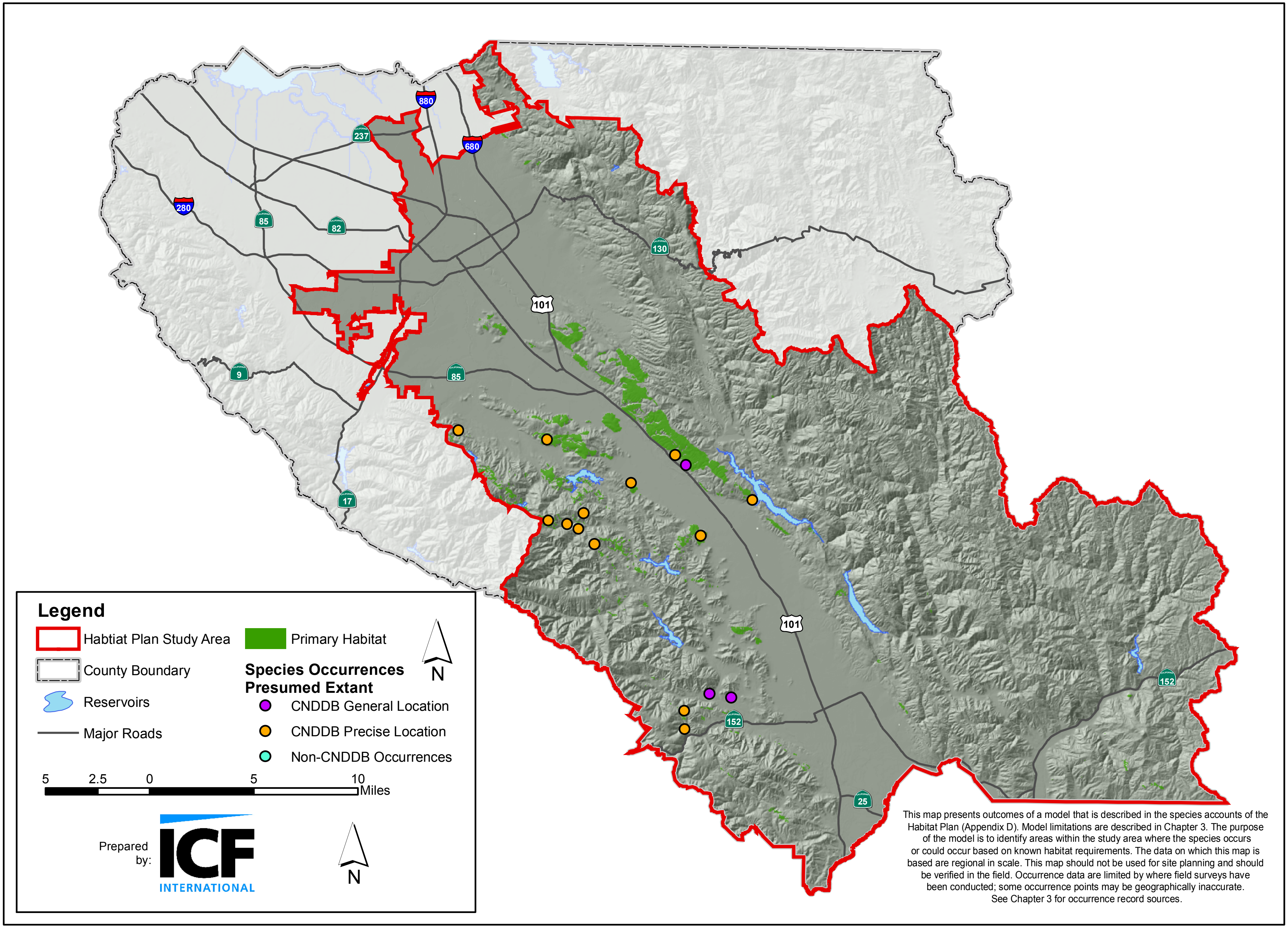

Figure 2
Smooth Lessingia Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

© R. Bittman and CNPS

Metcalf Canyon Jewelflower (*Streptanthus albidus* ssp. *albidus*)

Legal Status

State: California Native Plant Society 1B.1[1]
Federal: Endangered (U.S. Fish and Wildlife Service 1995)
Critical Habitat: None
Recovery Planning: *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998)

Taxonomy

Metcalf Canyon jewelflower (*Streptanthus albidus* ssp. *albidus)* was first described by Edward Greene in 1887 (Greene 1887). It was grouped into the subgenus *Euclisia* and changed status with the subgenus. *Euclisia* became its own genus (Greene 1904) until Jepson (1925) moved it back to subgenus status. Jepson (1925) considered Metcalf Canyon jewelflower to be a supspecies of *S. glandulosus.* Kruckberg (1958) determined that *S. albidus* ssp. *albidus* was so distinct both morphologically and based on geologic restrictions that he recognized this species as separate from *S. glandulosus* and divided it into *S. albidus* ssp. *albidus* and *S. albidus* ssp. *peramoenus* (most beautiful jewelflower, another taxa covered by this Plan). These divisions are still recognized as accurate (Integrated Taxonomic Information System 2001; U.S. Fish and Wildlife Service 1998). Metcalf Canyon jewelflower is in the Brassicaceae, or mustard family. The only *Streptanthus* species likely to grow in the same area as Metcalf Canyon jewelflower is its close relative, most beautiful jewelflower, which is distinguished by its dark purple sepals.

Description

Descriptions of the species' physical characteristics can be found in Buck et al. (1993), Corelli and Chandik (1995), and U.S. Fish and Wildlife Service (1998). Metcalf Canyon jewelflower is a wiry annual herb up to three feet tall possessing small flowers along the stem with white petals with purple veins. It has bristly hairs at the base and glaucous stems and leaves (U.S. Fish and Wildlife Service 1998).

[1] 1B means rare, threatened, or endangered in California and elsewhere; 0.1 means seriously endangered in California.

Distribution

General

The range for Metcalf Canyon jewelflower is highly restricted and lies completely within Santa Clara County, extending approximately 20 miles from San José south to Anderson Lake (Figure 1; U.S. Fish and Wildlife Service 1998; California Native Plant Society 2006). Its current range is thought to be the same as its historic range (U.S. Fish and Wildlife Service 1998).

Occurrences within the Study Area

Historical

There are four historic reports of Metcalf Canyon jewelflower (California Natural Diversity Database 2006). One occurrence (California Natural Diversity Database occurrence #6) from 1895 may actually be a different species of *Streptanthus*. The second historic occurrence (#5) documented in 1937 has likely been extirpated because it is located in an area now covered by Anderson Lake. A third occurrence (#11) first documented in 1980 at Tulare Hill and updated again in 1995, was extirpated when the plants were covered by fill during construction of a housing development. A fourth occurrence was documented in Gilroy along Llagas Avenue in 1957 and has not been reported since (#16). There is some taxonomic uncertainty about this occurrence (U.S. Fish and Wildlife Service 1998).

Extant

Eleven occurrences of Metcalf Canyon jewelflower in Santa Clara County are presumed extant (California Natural Diversity Database 2006), 10 of which are within the study area. Most of the occurrences are on the east side of Santa Clara Valley along U.S. 101 (Figure 2).

There are four occurrences on the west side of U.S. 101: CNDDB occurrence numbers 6, 17, 19, and 21. CNDDB occurrence 6 is located near Lexington Reservoir, is on Santa Clara County Parks land, and is outside the study area. Occurrence 17 is located on private land in San Jose and is assumed extant by the CNDDB. Occurrence 19 is on Communication Hill in San Jose and is adjacent to an active quarry. This occurrence is expected to be impacted by activities not covered by this Plan. Occurrence 21 is a non-specific reference from 1992 and is located on private property.

The remaining seven occurrences are found on the eastern side of U.S. 101. CNDDB occurrence numbers 18 and 20 are located on Type I open space. Occurrence number 15 is located near the Silver Creek Valley Country Club golf course. Occurrence numbers 8 and 4 are located in the Coyote Ridge area and are the two occurrences most likely to be impacted by SCVWD activities on the

Coyote Canal. Occurrence number 8 is located on Type 3 open space and occurrence 4 is located on private property. Occurrences 2 and 12 are also located on private property in the Coyote Ridge area.

Natural History

Habitat Requirements

Metcalf Canyon jewelflower is a serpentine endemic that can be found between 200 and 1,200 feet in elevation. It grows in serpentine grasslands and on serpentine outcrops and road cuts that have little soil development and are surrounded by grasslands (California Natural Diversity Database 2005; U.S. Fish and Wildlife Service 1998; Table 1). Commonly associated species are California sage (*Artemisia californica*), California poppy (*Eschscholzia californica*), foothill deer vetch (*Acmispon* [*Lotus*] *humistratus*), wild oats (*Avena fatua)* and a variety of other rare plants such as most beautiful jewelflower (*Streptanthus albidus* ssp. *peramonenus*), and Santa Clara Valley dudleya (*Dudleya abramsii* ssp. *setchellii*) (U.S. Fish and Wildlife Service 1998).

Table 1. Habitat Associations for Metcalf Canyon Jewelflower

Land Cover Type	Habitat Designation	Habitat Parameters	Percent Suitable	Rationale
Serpentine Bunchgrass Grassland	Primary habitat	Rocky outcrops and roadcuts with little soil development; 200–1,200 feet	High	U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006; California Native Plant Society 2006
Serpentine Rock Outcrop/Barrens	Primary habitat	200–1,200 feet	High	U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006; California Native Plant Society 2006

Population Ecology

Very little is known about its life history stages and reproductive biology (U.S. Fish and Wildlife Service 1998). Metcalf Canyon jewelflower is closely related to most beautiful jewelflower (McCarten 1992 in U.S. Fish and Wildlife Service 1998). Based on chloroplast DNA studies, there is evidence that Metcalf Canyon jewelflower has recently evolved (neoendemic) (Mayer and Soltis 1994 in U.S. Fish and Wildlife Service 1998). Furthermore, studies have shown that there are genetic differences among the various populations of Metcalf Canyon jewelflower, which suggests that all populations are important to monitor and protect (Mayer et al. 1994 in U.S. Fish and Wildlife Service 1998). Key seasonal periods for this species are shown in Table 2.

Herbivory has been recorded on other species of *Streptanthus* in central Texas by white-tailed deer and insects such as pierid butterfly caterpillars. These herbivores can have substantial negative effects on plant growth, survival, reproduction, and population dynamics (Zippin 1997).

Table 2. Key Seasonal Periods for Metcalf Canyon Jewelflower

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination	✓	✓	✓							✓	✓	✓
Flowering				✓	✓	✓	✓					
Fruiting						✓	✓	✓	✓			
Seed Dispersal						✓	✓	✓	✓	✓	✓	✓

Population Status and Trends

Global: Declining (NatureServe 2006)
State: Declining (NatureServe 2006)
Study Area: Unknown

Nine populations have been documented as having a total of 20,000 to 25,000 plants (McCarten 1992 in U.S. Fish and Wildlife Service 1998). The current status of these populations is unknown. Road construction through serpentine areas may create habitat for this species by exposing serpentine rock that can be colonized by Metcalf canyon jewelflower.

Threats

Urban development and cattle grazing pose the greatest threats to Metcalf Canyon jewelflower (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006). Urban development has already eliminated at least one known population and planned developments have threatened others. Even if no direct impacts on these plants are anticipated, construction activities, human disturbance, and habitat fragmentation can all have a negative impact (U.S. Fish and Wildlife Service 1998). Cattle may trample and eat plants, leading to a decline in the overall population as well as to a decline in the soil seed bank if plants are eliminated prior to setting seed (U.S. Fish and Wildlife Service 1998). Plants found on steep roadcuts or large rock outcrops are likely inaccessible to cattle. Garbage dumping and off-road motorcycles are additional threats (U.S. Fish and Wildlife Service 1998). One site located next to an active quarry could be impacted by quarry-related activities (U.S. Fish and Wildlife Service 1998, California Natural Diversity Database 2006). At another site, expansion of a landfill poses a threat (California Natural Diversity Database 2006). Road maintenance and construction could also impact populations which occur on or near roadcuts and those found along roads (U.S. Fish and Wildlife Service 1998).

Data Characterization

Very little information about the reproductive biology or demography of Metcalf Canyon jewelflower is available (U.S. Fish and Wildlife Service 1998).

Existing Conservation Actions in the Study Area

There are no known conservation actions in the study that are focused on Metcalf Canyon jewelflower. However, conservation actions directed at other serpentine species may benefit Metcalf Canyon jewelflower. For example, recent acquisition of mitigation land on Coyote Ridge by the Santa Clara Valley Transportation Authority is protecting suitable habitat for Metcalf Canyon jewelflower. Livestock grazing along Coyote Ridge designed to maintain and improve habitat for the food and nectar plants of Bay checkerspot butterfly (see the account for Bay checkerspot butterfly for more information) may indirectly benefit Metcalf canyon jewelflower by reducing the density and biomass of exotic grasses and herbs that may compete with the jewelflower.

The U.S. Fish and Wildlife Service suggests that surveys should be conducted at the Tulare Hill site to see if appropriate habitat still exists for potential repopulation efforts (U.S. Fish and Wildlife Service 1998).

Modeled Habitat Distribution in Study Area

Model Description

Model Assumptions

Suitable habitat for Metcalf Canyon jewelflower is defined as serpentine bunchgrass grassland and serpentine rock outcrops between 0 and 1,200 feet in elevation on slopes with all degrees of steepness. Potential ecoregion subsections include the Fremont-Livermore Hills and Valleys, Leeward Hills, Western Diablo Range, and Diablo Range.

Rationale

Metcalf Canyon jewelflower is restricted to serpentine rock outcrops and sparsely-vegetated serpentine grassland below 1,200 feet (U.S. Fish and Wildlife Service 1995, 1998).

Model Results

Figure 2 shows the modeled potential habitat for Metcalf Canyon jewelflower. The habitat is primarily located in the hills east of the Santa Clara Valley floor and north of Anderson Reservoir, and in scattered areas dominated by serpentinite-derived soils in the foothills of the Santa Cruz Mountains to the west of the valley floor. All of the known occurrences are found on modeled habitat (see Figure 2; note that in some cases the modeled habitat is smaller than the size of the symbols on the map).

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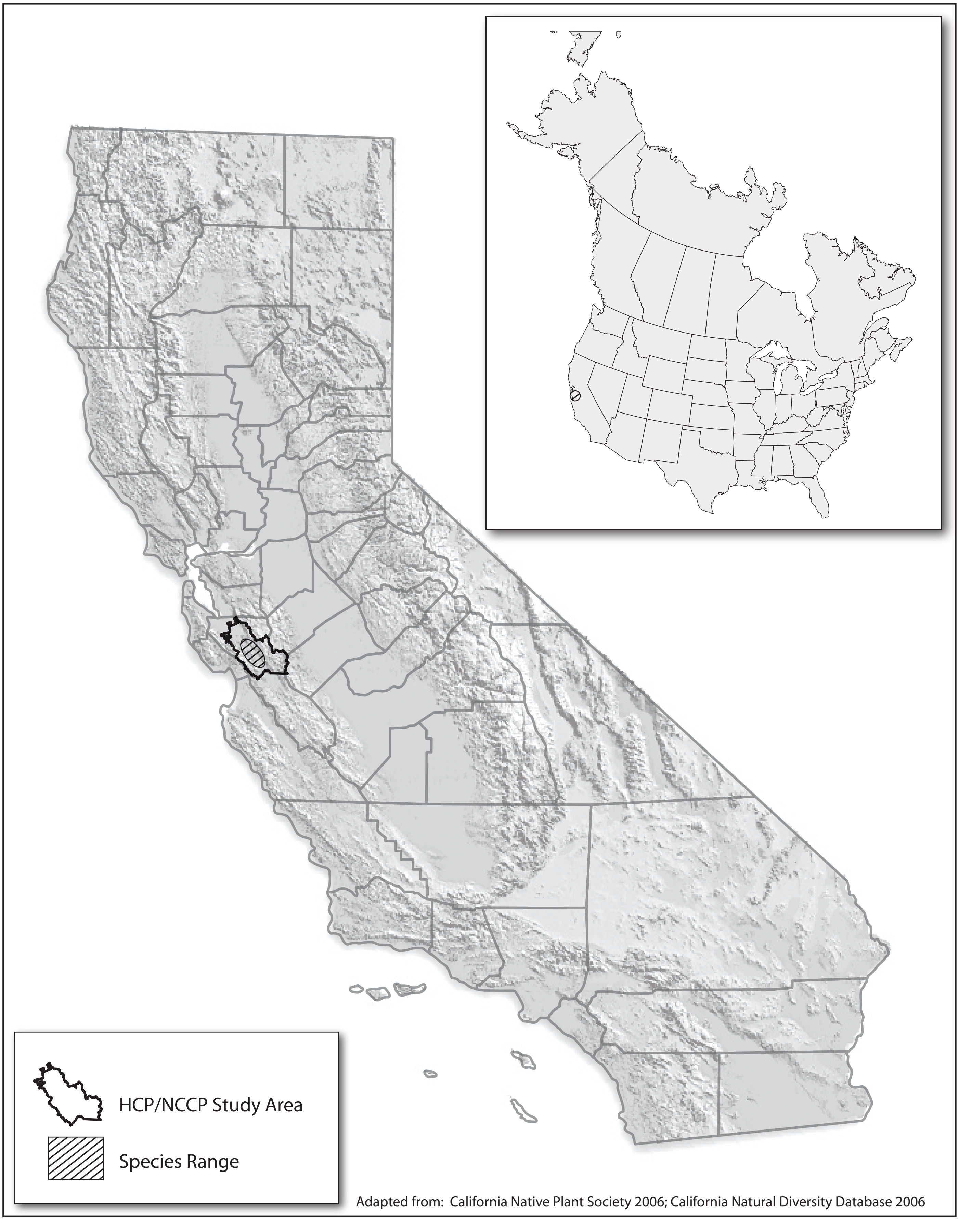

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Figure 1
Metcalf Canyon Jewelflower (*Streptanthus albidus* ssp. *albidus*) Distribution in California

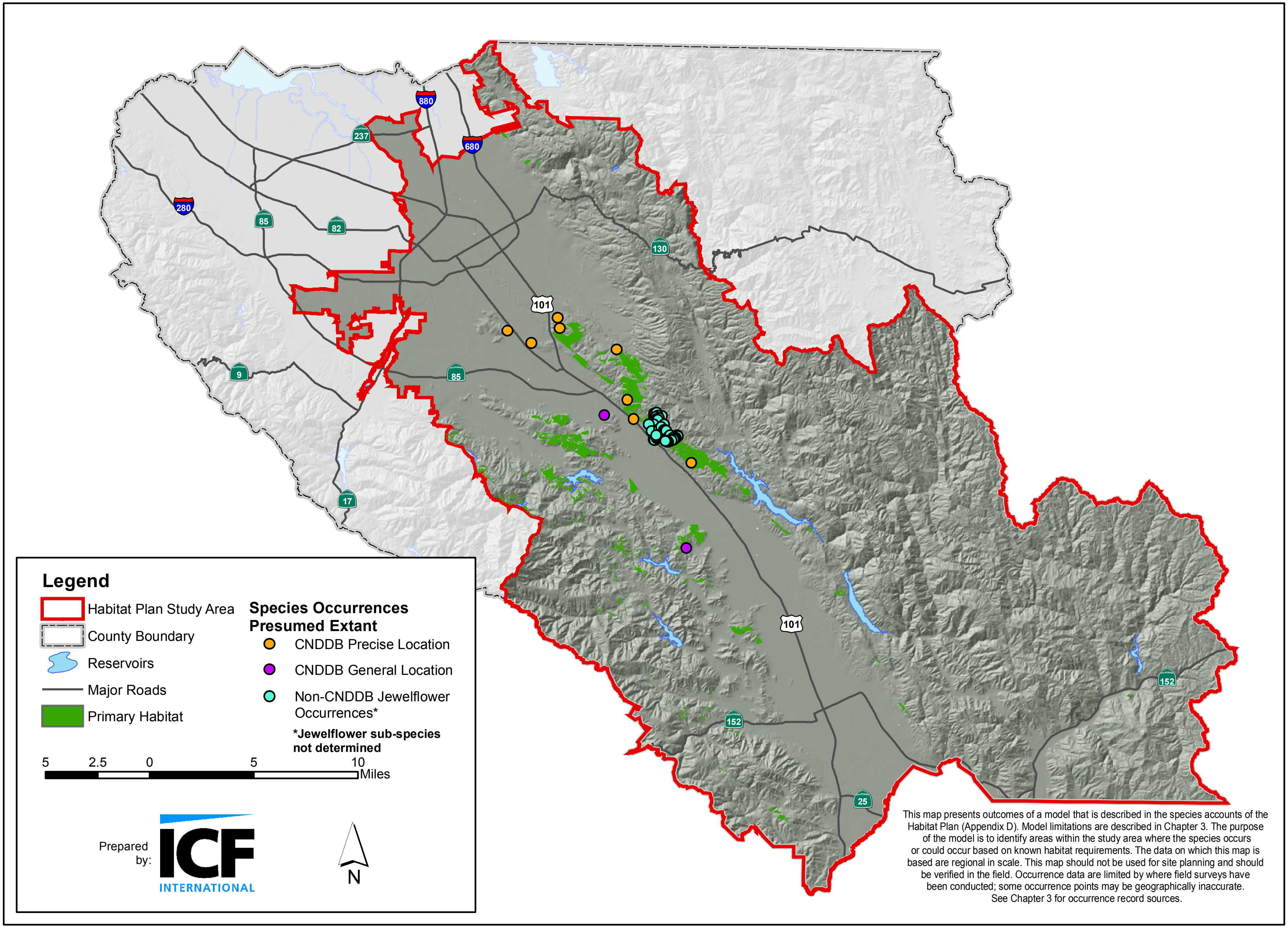

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Figure 2

Metcalf Canyon Jewelflower Modeled Habitat Distribution - Santa Clara Valley Habitat Plan

Most Beautiful Jewelflower (*Streptanthus albidus* ssp. *peramoenus*)

© Benjamin C. Hammett,
California Academy of Sciences

Legal Status

State: California Native Plant Society List 1B.2[1]
Federal: Special Concern
Critical Habitat: None
Recovery Planning: *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998)

Taxonomy

Most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*) was first described by Edward Greene in 1887 as *Streptanthus peramoenus* (Greene 1887). It was grouped into the subgenus *Euclisia* and changed status with the subgenus. *Euclisia* became its own genus (Greene 1904) until Jepson (1925) moved it back to subgenus status. Jepson (1925) considered most beautiful jewelflower to be a part of *S. glandulosus.* Kruckberg (1958) determined that *S. albidus* was distinct both morphologically and based on geologic restrictions that he recognized this species as separate from *S. glandulosus* and divided it into *S. albidus* ssp. *albidus* (Metcalf Canyon jewelflower, another taxa covered by this Plan) and *S. albidus* ssp. *peramoenus*.

The taxonomic status of this species is currently under debate. Recent genetic studies raise the possibility that the species concept for most beautiful jewelflower may be broadened by including additional populations of plants currently assigned to other *Streptanthus* species (Mayer et al. 1994; Mayer and Soltis 1999). However, the U.S. Fish and Wildlife Service concluded that current research affirms the uniqueness of this taxon (1998). Therefore, its regulatory status is unlikely to be affected by ongoing taxonomic research. Most beautiful jewelflower is in the mustard family (Brassicaceae).

Description

Descriptions of the species' physical characteristics can be found in Kruckeberg (1958) and Buck et al. (1993). The species is an annual herb up to 32 inches tall with fleshy and glaucous stems and leaves. The flowers have lilac-lavender

[1] 1B means rare, threatened, or endangered in California and elsewhere; .2 means fairly endangered in California.

sepals and purplish petals. The subspecies is distinguished from the closely-related Metcalf Canyon jewelflower by its lilac-lavender sepals. (Metcalf Canyon jewelflower has greenish-white sepals which are tinged with purple at their base.)

Distribution

General

Most beautiful jewelflower is endemic to the northern South Coast Ranges of Contra Costa, Alameda, and Santa Clara Counties (Figure 1) (California Native Plant Society 2006; California Natural Diversity Database 2008). If other species of *Streptanthus* were to be incorporated into the same taxon as most beautiful jewelflower, its range would be expanded to include Mount Hamilton and portions of the Mount Hamilton range, as discussed below.

Occurrences within the Study Area

There are 39 occurrences of the most beautiful jewelflower in the study area, 35 of which are listed with the California Natural Diversity Database (2012). The other occurrences are known to occur on Santa Clara County Parks and on or adjacent to Santa Clara Valley Water District lands. All occurrences are believed to be extant. Most are of high precision and may be accurately located. Two other occurrences are known that are not recorded in the California Natural Diversity Database; two populations of the dark-flowered form that occur on Mount Hamilton (Mayer et al. 1994; not mapped). Other collections of *Streptanthus glandulosus* from the Mount Hamilton Range (CalFlora 2006) may also represent the dark-flowered form of most beautiful jewelflower.

Occurrences of the species are located in the vicinity of Anderson Lake, Kirby Canyon, and Metcalf Canyon east of Highway 101. West of Highway 101, occurrences are documented in the New Almaden Historic Landmark District, in the vicinity of Coyote Peak and Santa Teresa County Park, in the vicinity of Calero Reservoir County Park and Laurel Hill, in the vicinity of Chesbro Reservoir, and south of Morgan Hill and north of the Carlyle Hills. These occurrences fall on both Santa Clara County land, principally in County parks, and on private land. Two of the occurrences on private land are owned by IBM (California Natural Diversity Database 2006). According to the U.S. Fish and Wildlife Service, IBM intends to preserve these occurrences (U.S. Fish and Wildlife Service 1998).

Natural History

Habitat Requirements

Most beautiful jewelflower is almost entirely restricted to serpentinite outcrops or soils derived from serpentinite (Table 1). Serpentine soils are deficient in calcium, but serpentine-endemic jewelflower populations are capable of growing under low levels of calcium (Kruckeberg 1954). Most beautiful jewelflower is generally found in grasslands dominated by native perennial grasses or in open grasslands dominated by nonnative annual grasses with relatively low cover. It is also found on rock outcrops or grassy openings in serpentine chaparral or where serpentine grassland or chaparral habitats transition to oak woodland and it can occur on serpentine roadcuts and road surfaces. It has been found at elevations ranging from 360 to 3280 feet.

Species commonly associated with most beautiful jewelflower include native species such as bigberry manzanita (*Arctostaphylos glauca*), buck brush (*Ceanothus cuneatus*), California poppy (*Eschscholzia californica*), dwarf plantain (*Plantago erecta*), purple needlegrass (*Stipa* [*Nasella*] *pulchra*), as well as non-natives including foxtail chess (*Bromus madritensis* ssp. *rubens*), pampas grass (*Cortaderia jubata*), slender wild oat (*Avena barbata*), soft chess (*Bromus hordeaceus*), and wild oat (*Avena fatua*) (California Natural Diversity Database 2006).

At least one population of the dark-flowered form of most beautiful jewelflower occurs on non-serpentine habitat at Henry Coe State Park (Mayer et al. 1994). A population found in Arroyo Hondo in Alameda County occurs in non-serpentine habitat, where it occurs on rock outcrops in coastal sage scrub dominated by California sagebrush (*Artemisia californica*), bush monkeyflower (*Mimulus aurantiacus*), and golden-yarrow (*Eriophyllum confertiflorum*). Bristly jewelflower (*Streptanthus glandulosus*), to which most beautiful jewelflower is closely related, also has serpentine-tolerant and serpentine-intolerant populations (Kruckeberg 1951).

Table 1. Habitat Associations for Most Beautiful Jewelflower

Land Cover Type	Habitat Designation	Habitat Parameters	Habitat Suitability	Rationale
Serpentine bunchgrass grassland	Primary	Shallow soils or where non-native species have low relative cover; 360 to 3280 feet	Moderate	Kruckeberg 1954
Serpentine rock outcrop/barrens	Primary	Includes roadcuts; 360 to 3280 feet	High	Competition from non-natives in serpentine grassland frequently restricts this species to shallow soils near serpentine rock outcrops (Green 2004)
Mixed serpentine chaparral	Primary	Grassy openings; 360 to 3280 feet		Kruckeberg 1954; California Natural Diversity Database 2006
Rock outcrop	Secondary	360 to 3280 feet	Low to Moderate	Non-serpentine populations of the species may be found here (Mayer et al. 1994; California Natural Diversity Database 2006)

Population Ecology

Population sizes of most beautiful jewelflower vary from less than fifty to tens of thousands (California Natural Diversity Database 2006). Most beautiful jewelflower appears to be insect pollinated. Kruckeberg (1957) reported that members of the *Streptanthus glandulosus* complex, including most beautiful jewelflower, were incapable of self-pollination, and he had observed bees, butterflies, and beetles visiting the flowers. Bees have been observed to the primary floral visitors in other outcrossing *Streptanthus* species (Dieringer 1991; Preston 1994), although flies and butterflies also visit *Streptanthus* flowers (Moldenke 1976). *Streptanthus* flowers appear to be self-fertile, but a combination of spatial and temporal separation of the stamens and receptive stigmas prevents self-pollination (Preston 1991).

No information on herbivory of most beautiful jewelflower is available; however, other jewelflower species are eaten by herbivorous insects (e.g., Zippin 1997). The larvae of pierid butterflies commonly eat jewelflower leaves, flowers, and developing fruit (Shapiro 1981a, 1981b, 1984; Karban and Courtney 1987; Zippin 1997). The flowers are also eaten by sap beetles and flea beetles (Shapiro 1981a; Karban and Courtney 1987; Preston 1991; Zippin 1997). Some species of serpentine-endemic jewelflowers appear to have “egg-mimics” on the leaves, which inhibit some pierid species from laying eggs there (Shapiro 1981a). Key seasonal periods for the species are shown in Table 2.

Table 2. Key Seasonal Periods for Most Beautiful Jewelflower

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Germination	✓	✓	✓							✓	✓	✓
Flowering			✓	✓	✓	✓						
Fruiting					✓	✓	✓					
Seed Dispersal					✓	✓	✓	✓	✓	✓	✓	✓

Population Status and Trends

Global: Declining (NatureServe 2006)
State: Declining (NatureServe 2006)
Study Area: Unknown

Population trends for most beautiful jewelflower are unknown in the study area. There are no known populations in the study area that have been extirpated. Road construction through serpentine areas may create habitat for this species by exposing serpentine rock that can be colonized by most beautiful jewelflower (S. Weiss pers. comm.). However, the small number of populations known, and the known threats to these populations, suggest that protection and management of populations is necessary to ensure the species' long-term survival (U.S. Fish and Wildlife Service 1998).

Threats

Potential threats to most beautiful jewelflower include cattle grazing, competition from invasive exotic species (notably yellow star thistle [*Centaurea solstitialis*]), and habitat loss from residential development and road construction (California Natural Diversity Database 2006; California Native Plant Society 2006). Non-native species invasion of serpentine grassland threatens occurrences in the study area (Green 2004). Grazing threatens some populations in the study area west of Highway 101 (U.S. Fish and Wildlife Service 1998). Additional threats in the study area include rooting by feral pigs and disturbance from landfill operations.

Data Characterization

A species profile for most beautiful jewelflower is provided in the *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (U.S. Fish and Wildlife Service 1998). The main sources of general information on most beautiful jewelflower are *The Jepson Manual* (Buck et al.1993) and the California Native Plant Society (2001). Specific information on the systematics of most beautiful jewelflower is found in Mayer et al. (1994) and in Mayer and Soltis (1999). Specific observations on habitat and plant associates, threats, and other factors are provided in the recovery plan and in the California Natural Diversity Database (2006). There are relatively many occurrence records for this species, and all are presumed extant and with excellent or good geographic accuracy. Very little information about the reproductive biology or demography of most beautiful jewelflower is available (U.S. Fish and Wildlife Service 1998), but the species' ecology can be inferred from study of other *Streptanthus* species.

Existing Conservation Actions in the Study Area

There are no known conservation actions in the study that are focused on most beautiful jewelflower. However, conservation actions directed at other serpentine species may benefit the species. For example, recent acquisition of mitigation land on Coyote Ridge by the Santa Clara Valley Transportation Authority is protecting suitable habitat for most beautiful jewelflower. Livestock grazing along Coyote Ridge designed to maintain and improve habitat for the food and nectar plants of Bay checkerspot butterfly (see the account for Bay checkerspot butterfly for more information) may indirectly benefit most beautiful jewelflower by reducing the density and biomass of exotic grasses and herbs that may compete with the jewelflower. Acquisition by the Santa Clara Valley Open Space Authority south of Calero Reservoir is also protecting several occurrences of this species (Cañada de Oro Open Space Preserve). Long-term plans by the Santa Clara County Parks and Recreation Department to reintroduce livestock grazing in Santa Teresa County Park may also benefit most beautiful jewelflower by reducing competition with exotic grasses and herbs.

Modeled Habitat Distribution in Study Area

Model Description

Model Assumptions

1. Primary habitat is defined as serpentine bunchgrass grassland, serpentine rock outcrops/barren, and mixed serpentine chaparral between 0 and 3,500 feet elevation on slopes with all degrees of steepness.

2. Secondary habitat is defined as non-serpentine rock outcrops between 0 and 3,500 feet elevation on slopes with all degrees of steepness.

Potential ecoregion subsections for both habitat types are the Fremont-Livermore Hills and Valleys, Santa Clara Valley, Leeward Hills, Santa Cruz Mountains, Western Diablo Range, and Diablo Range.

Rationale

Most beautiful jewelflower is almost entirely restricted to serpentinite outcrops or soils derived from serpentinite (Kruckeberg 1954). The species is found within serpentine grasslands and serpentine chaparral, primarily in grassy openings or at the boundary with oak woodlands (U.S. Fish and Wildlife Service 1998; California Natural Diversity Database 2006). Most beautiful jewelflower is less commonly found in non-serpentine soils on rock outcrops (Mayer et al. 1994; California Natural Diversity Database 2006).

Model Results

Modeled potential habitat for most beautiful jewelflower is shown in Figure 2. The habitat is concentrated in the hills east of the Santa Clara Valley floor and north of Anderson Reservoir, and in scattered areas dominated by serpentinite-derived soils in the foothills of the Santa Cruz Mountains to the west of the valley floor. Most of the secondary habitat is located in areas that are smaller than the minimum mapping unit of the land cover mapping, so very little of it shows on the habitat model. However, all of the known occurrences are found on modeled habitat (see Figure 2, note that in some cases the modeled habitat is smaller than the size of the symbols on the map).

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Figure 1
Most Beautiful Jewelflower (*Streptanthus albidus* ssp. *peramoenus*) Distribution in California

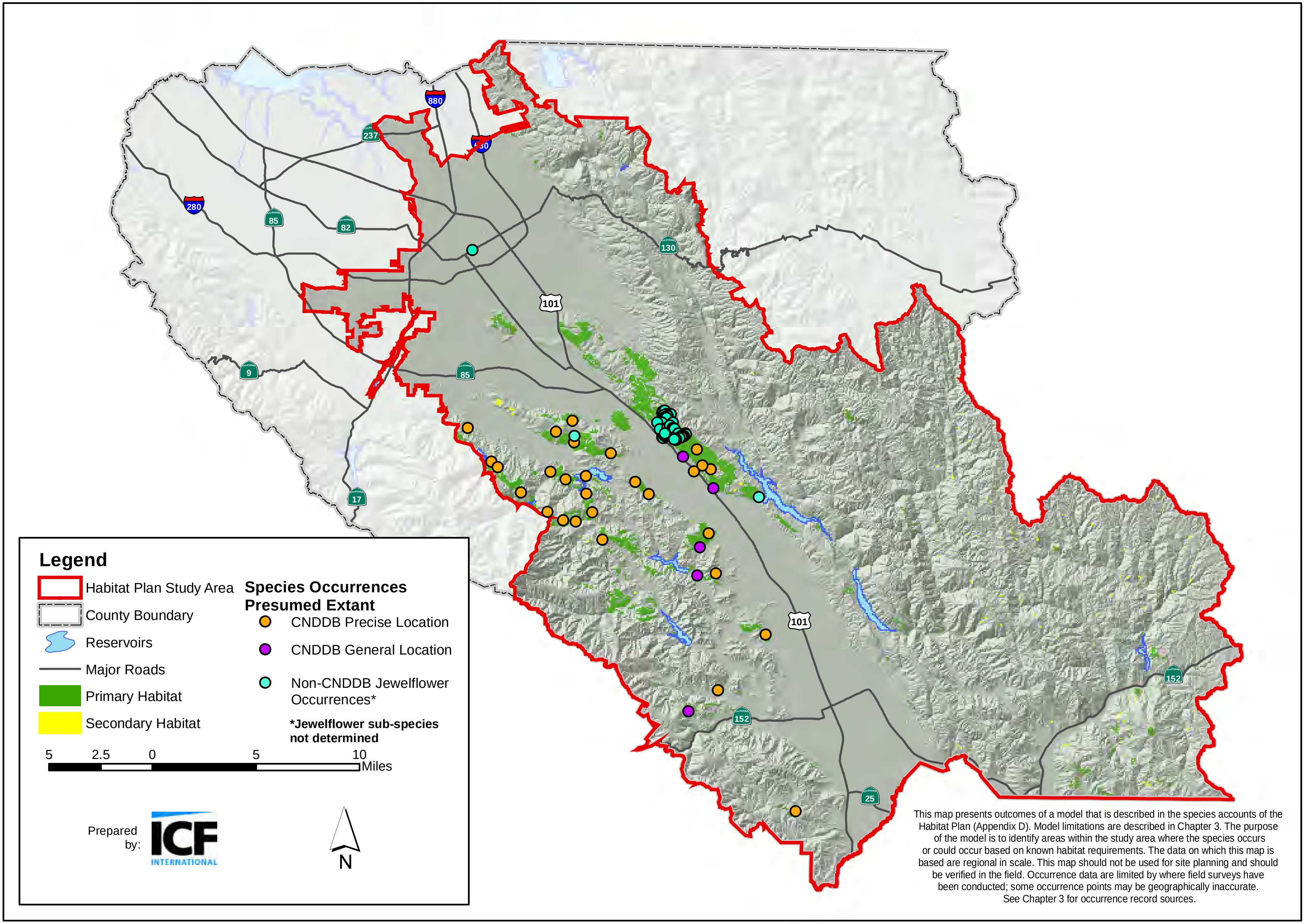

Figure 2
Most Beautiful Jewelflower Modeled Habitat Distribution - Santa Clara Valley Habitat Plan