Alameda Whipsnake
(*Masticophis lateralis euryxanthus*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

September 2011

5-YEAR REVIEW

Alameda whipsnake (*Masticophis lateralis euryxanthus*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, be changed in status from threatened to endangered, or that the status remain unchanged. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

The Alameda whipsnake is a slender, fast-moving, semi-arboreal, diurnal snake with a broad head, large eyes, and slender neck; characteristics typical of snake species that predate on lizards. This species is commonly associated with small to large patches of chaparral or coastal scrub vegetation, interspersed with other native vegetation types and rock lands throughout Contra Costa County, most of Alameda County, and portions of northern Santa Clara and western San Joaquin counties. Chaparral and coastal scrub vegetation serve as the center of home ranges, provide for concealment from predators, and foraging opportunities. However, verified observations have been made up to 6.4 kilometers (4 miles) from coastal scrub and chaparral habitat.

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO), following the Region 8 guidance issued in March 2008. We used information from the Draft Recovery Plan for Chaparral and Scrub Community Species East of San Francisco Bay (Service 2002), survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database (CNDDB) maintained by the California Department of Fish and Game (CDFG). Personal communications with experts, published literature, biological assessments, and government agency reports were the primary sources of information used to update the species' status and threats. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Federal Register (FR) Notice Citation Announcing Initiation of This Review:

A notice announcing the initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on March 25, 2009 (Federal Register 74:12878-12883). We did not receive any comments from the public specific to the Alameda whipsnake.

Listing History:

Original Listing

FR Notice: Federal Register 62:64306-64320
Date of Final Listing Rule: December 5, 1997
Entity Listed: *Masticophis lateralis euryxanthus*, a reptile subspecies
Classification: Threatened

State Listing

Masticophis lateralis euryxanthus was listed as threatened by the State of California on June 27, 1971.

Associated Rulemakings:

On March 8, 2000, a proposed determination of critical habitat for the Alameda whipsnake was issued, fulfilling an out-of-court settlement agreement (Service 2000*a*). A final determination was subsequently issued on October 3, 2000 (Service 2000*b*). On May 9, 2003, a U. S. District Court Judge vacated and remanded the October 3, 2000, final rule designating critical habitat. On October 2, 2006, critical habitat for the Alameda whipsnake was designated (Service 2006; Figure 1).

Review History:

No 5-year reviews have previously been conducted for this species since its listing in 1997.

Recovery Priority Number at Start of 5-Year Review:

The recovery priority number for the Alameda whipsnake is 9C according to the Service's 2010 Recovery Data Call for the Sacramento Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates this taxon is a subspecies, faces a medium degree of threat, has a high potential for recovery, and there is, or may be, some degree of conflict between recovery efforts and economic development.

Recovery Plan or Outline:

Name of Plan or Outline: Draft Recovery Plan for Chaparral and Scrub Community Species East of San Francisco Bay, California

Date Issued: December 2002

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy:

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife.

II.A.1. Is the species under review listed as a DPS?
____ *Yes*
__X_ ***No***

II.A.2. Is there relevant new information for this species regarding the application of the DPS policy?
____ *Yes*
__X_ ***No***

Information on the Species and its Status:

Life History

Adult Alameda whipsnakes have a bimodal seasonal activity pattern, with peaks during the spring mating season and a smaller peak during late summer and early fall (Swaim 1994). They generally retreat into winter hibernacula (the location chosen for hibernation) in November and emerge in March; however, short, above-ground activity such as basking in the immediate vicinity of the hibernaculum may occur during this time (Swaim 1994). Courtship and mating occur from late March through mid-June. During this time, males have been found to move throughout their home range and females have been found to remain at or near their hibernacula until mating is complete. One female was observed copulating with more than one male during a mating season, but the extent to which females mate with multiple males (polyandry) is unknown (Swaim 1994). Suspected egg-laying sites for two females in the Berkeley Hills in Alameda County were located in patches of grassland, within 3 to 6 meters (10 to 20 feet) of coastal scrub, and were also found within areas of low density scattered scrub intermixed with grassland. Three individuals monitored for nearly an entire activity season appeared to maintain stable home ranges (Swaim 1994). Movements of these individuals were multi-directional and individuals returned to specific areas and retreat sites after long intervals of non-use. Alameda whipsnakes have been found to have one or more core area (areas of concentrated use) within their home range, with large areas of the home range receiving little use.

Sperm is stored by the male over winter in the epididymides and vas deferens (Goldberg 1975). Copulation commences soon after emergence from winter hibernacula (Swaim 1994). Females begin yolk deposition in mid-April (Goldberg 1975), and intervals of 47, 50, and 55 days have been recorded between dates of first known mating and first egg laid (Hammerson 1978). Average clutch size was found to be 7.21 (range 6 to 11, $n = 19$), with a significant correlation between body size and clutch size (Goldberg 1975). Incubation lasts about 3 months and young appear in late summer and fall. Hatchlings have been observed or captured above ground from August through November (Hammerson 1978, Swaim 1994). Prey items have been detected in the stomachs of captured hatchlings during this period, indicating feeding may occur prior to winter hibernation (Swaim 1994). California whipsnakes (*Masticophis lateralis*) reach maturity in 2 to 3 years, with adults growing to nearly 1.5 meters (5 feet). Based on a study of captive California whipsnakes, they may live for 8 years (Jennings 1994).

Feeding and Prey

The Alameda whipsnake is a slender, fast-moving, diurnal snake with a broad head, large eyes, and slender neck. When hunting, it commonly moves with its head held high and occasionally moves it from side to side. Prey is seized with great speed, pinioned under loops of the body, and engulfed without constriction. The Alameda whipsnake is semi-arboreal and can escape into or hunt within shrubs or trees. They also seek shelter in rock piles or outcrops in small mammal burrows (Stebbins 1985, Swaim 1994) and in cracks that form in the ground as it dries (Swaim 1994). In a study of the thermal responses of Alameda whipsnakes held in captivity in an outdoor enclosure in Hayward, California, Hammerson (1979) found that these snakes maintained a relatively high active body temperature during the day, 33.0 to 34.1 degrees Celsius (91.4 to 93.4 degrees Fahrenheit) (mean value, $n = 4$), compared to most other snake species. Shine (1980) hypothesized that the morphological and behavioral characteristics of diurnal and terrestrial activity, slender body form, long-tail, large eyes, high body temperature, and oviparity (egg laying) are adaptations that facilitate the pursuit and capture of fast-moving diurnal prey, usually lizards.

Lizards, especially the western fence lizard (*Sceloporus occidentalis*), appear to be important prey items (Stebbins 1985, Swaim 1994, H. Greene personnel communication 1998), although other prey items including frogs, snakes, small birds, small mammals, and insects have been reported to be eaten by California whipsnakes (Stebbins 1985). The western fence lizard is often semi-terrestrial, occupying rocks, fallen trees or limbs, or man-made sites such as woodpiles, rock walls, houses, and wooden fence posts, but it is also semi-arboreal in many parts of its range. Western skinks (*Eumeces skiltonianus*) and alligator lizards (*Elgaria spps.*), other lizard species in the range of the Alameda whipsnake, exhibited defense techniques that allowed for escape from whipsnake in experimental enclosures (Swaim 1994).

In a dietary study of captive hatchling Alameda whipsnakes, hatchlings consistently consumed lizard prey, the only other items consumed during the study were a single Pacific treefrog (*Pseudacris regilla*) and a single slender salamander (*Batrachoseps attenuatus*); all other trials with amphibians, sharp-tailed snakes, newborn mice, and insects presented as potential prey resulted in various non-feeding responses (Swaim 1994). Stomach contents of field-captured Alameda whipsnakes were exclusively lizards and included western fence lizards and western skink (Swaim 1994). Stomach contents of museum specimens were almost exclusively lizards (H. Greene personnel communication 1998). However, despite widespread abundance of western fence lizards (abundant at 21 of 22 study sites), their occurrence alone did appear to account for the presence of Alameda whipsnakes (Swaim 1994). Several of the sites where Alameda whipsnakes were not captured had the highest abundance of western fence lizards during the study. Although considered a lizard specialist, an Alameda whipsnake was observed consuming a lesser goldfinch (*Carduelis psaltria*) 5 meters (16.4 feet) above the ground in a *Quercus agrifolia* (coast live oak) at Mount Diablo State Park (Shafer and Hein 2005).

Habitat and Community Associations

Alameda whipsnakes are typically associated with small to large patches of chaparral or coastal scrub vegetation, interspersed with other native vegetation types and rock lands (areas containing large percentage of rocks, rocky features, and/or rock-bearing soil types). Based on a radio telemetry study of five Alameda whipsnakes (3 males and 2 females) at Tilden Regional Park near the City of Berkeley and a single male at Moller Ranch near the City of Pleasanton, Swaim (1994) found home ranges were centered around coastal scrub vegetation; however, Alameda whipsnakes were also observed using adjacent vegetation types, including grassland, oak savanna, and oak-bay woodland up to 150 meters (500 feet) from coastal scrub and chaparral. In that study, male home ranges varied from 1.9 to 8.7 hectares (4.7 to 21.5 acres, $n = 4$), and showed a high degree of spatial overlap and female home ranges ($n = 2$) averaged 3.4 hectares (8.4 acres). Swaim (1994) documented use of all slope aspects and brush community canopy closures by Alameda whipsnakes. However, Swaim (1994) found core areas (areas of concentrated use) to be on south- , southwest- , southeast-, east- or northeast-facing slopes at both Tilden Regional Park and Moller Ranch. Alameda whipsnakes usually had more than one core area, separated by more northerly aspects. Northerly aspects were used on a regular basis to move between core areas (Swaim 1994). The near exclusive use of southerly aspects for everything except movement at Tilden Regional Park is likely accentuated by its relatively cool and fog influenced climate, compared to sites outside the fog belt and farther away from the San Francisco Bay. At Moller Ranch, which is relatively warmer than Tilden Regional Park, the radio-marked Alameda whipsnake used level ground and east-facing slopes (Swaim 1994). Selection for southerly and easterly aspects is likely related not only to consistently warmer temperatures; it is also related to the availability of morning sun which promotes emergence earlier in the day and maximizes the activity period for foraging, mate finding and digestion. Eleven of 12 study sites without Alameda whipsnake captures contained mostly closed canopy *Baccharis pilularis* (coyote brush); however, 11 of the 12 study sites without Alameda whipsnake captures also lacked rock outcrops (Swaim 1994).

Chaparral and coastal scrub vegetation serve as the center of home ranges, provide for concealment from predators, and foraging opportunities. Core areas have been found to center around patches of coastal scrub or chaparral as small 0.2 hectare (0.5 acre) embedded within a mosaic of other dominant vegetation types. Although Swaim (1994) found this species remained within approximately 150 meters (500 feet) of coastal scrub and chaparral vegetation, many verified and measurable observations have been made beyond 150 meters from these vegetation types (Swaim 2003). Alvarez et al. (2005) compiled free-ranging Alameda whipsnake occurrence records and reported that 37 of 119 records were greater than 100 meters (330 feet) from and in a variety of vegetation types other than chaparral or coastal scrub, including annual grassland (n = 17), mixed evergreen forest (n = 1), oak savannah (n = 1), oak woodland (n = 12), and riparian (n = 6). Alvarez et al. (2005) also found that 27 of the 37 occurrence records were greater than 200 meters (660 feet) from the nearest patch of coastal scrub or chaparral, with the farthest being 7.3 kilometers (4.5 miles).

Often times found embedded within coastal scrub and chaparral core areas and in adjacent vegetation types used by Alameda whipsnakes are rock outcrops or talus. Small rodent burrows are important retreats, and brush piles and deep soil crevices can also serve as important habitat features (Swaim 1994). These habitat features are essential for normal behaviors such as breeding, reproduction, and foraging, because they provide refuge from predators, egg-laying sites, thermal cover, shelter, winter hibernacula, and increased numbers of foraging opportunities (Swaim 1994).

Historic Distribution and Phenotype

Riemer (1954) described the Alameda whipsnake subspecies based on eight morphological differences (all color characters) observed between six California whipsnake specimens collected near the City of Berkeley, the City of Alamo, Somersville (Black Diamond Mines Regional Preserve), and near Mount Diablo in Alameda and Contra Costa counties, California and specimens collected throughout the rest of the range of the species, with possible intergrades (snakes exhibiting phenotypic characteristics of both subspecies) in southern Alameda County. None of the eight morphological differences used by Reimer (1954) to describe the Alameda whipsnake are diagnostic; that is, each of the eight morphological characters used to describe Alameda whipsnake as a subspecies have been observed in chaparral whipsnake specimens far removed from the San Francisco East Bay. In addition, interpreting some of the eight characters is ambiguous; for instance, distinguishing characteristic number three in Reimer (1954) states, "A light stripe between nostril and eye usually not interrupted by dark vertical lines along the margins of the loreal," characteristic number four states, "The lack, usually, of a dark line across the rostral, representing a connection between the supralabial stripes," and characteristic number seven, "A sooty black dorsal color. Melanistic individuals are, however, not uncommon throughout the range of the species." However, throughout much of Alameda and Contra Costa counties Alameda whipsnake specimens exhibit five or more of the eight characters, particularly within the East Bay Hills (K. Swaim personnel communication 2011). There are no definitive geographic boundaries to the south that separate the Alameda whipsnake phenotype from the chaparral whipsnake phenotype. Rather, there appears to be a transition zone in southern and eastern Alameda, northern Santa Clara, and southwestern San Joaquin counties; whereby each of the eight phenotypic characteristics have been found to occur less frequently in specimens as one moves away from the East Bay Hills. Based on field and photographic analysis of numerous museum and living California whipsnake specimens collected or observed throughout the range of the species, Swaim Biological, Inc. is developing maps that depict the geographic distribution of each of the eight phenotypic characters, a description of the observed variation in each of the eight characters, and evidence of characters changing over time in individual snakes (K. Swaim personnel communication 2011).

Genetics

In a study using short tandem repeat loci (STRs) to examine population dynamics of the Alameda whipsnake and mitochondrial DNA (mtDNA) to examine the phylogeny of the California whipsnake, Richmond et al. (2011) found no evidence the Alameda whipsnake phenotype forms an exclusive mtDNA genetic group. However, Richmond et al. (2011) did find strong support for five distinct California whipsnake mtDNA clades (a monophyletic group composed of a single ancestor and all its descendants): (1) southern Baja, from mid-peninsula near San Ignacio south to the Isthmus of La Paz in Baja California Sur, Mexico; (2) northern Baja, from the Peninsular Range of northern Baja California, Mexico to extreme southern San Diego County, California; (3) southern California, from southern San Diego County to the south side of the Salinas Valley in Monterey County; (4) northern California, from the foothills of the Sierra Nevada Mountains in Tulare County, to the northern rim of the Sacramento Valley near Redding, California, along the western side of the Sacramento Valley in the southern Klamath Mountains and northern Coast Range to the San Francisco Bay in Napa County, California; and (5) central California, from northern Contra Costa County to the northern side of the Salinas Valley into Pinnacles National Monument in Monterey and San Benito Counties (Figure 2).

According to Richmond et al. (2011), populations of the California whipsnake dispersed northward along the major montane corridors, through the Transverse Ranges, northward into the southern Coast Ranges to the west and the Sierra Nevada Mountains to the east. Dispersal northward along the southern Coast Ranges was stopped short of Monterey Bay by the San Joaquin Embayment. This embayment served as the main drainage from the San Joaquin Valley to the Pacific Ocean approximately 2.5 million years ago, before the formation of the San Francisco Bay. Similar to the California whipsnake, the signature of this barrier is evident in the phylogeography of other reptilian and amphibian taxa (Richmond and Reeder 2002, Shaffer et al. 2004, Feldman and Spicer 2006). The northern California clade is the sister taxon to a monophyletic central California lineage; evidence that suggests the California whipsnake dispersed into the present day East San Francisco Bay Area from the north, at a time when the San Francisco Bay did not constitute a significant water barrier. The central California clade contains occurrences that are phenotypically recognized as both the Alameda whipsnake and California whipsnake.

Richmond et al. (2011) note that divergence estimates between the central and northern California whipsnake clades exceeds those between currently recognized *Masticophis* species in southern Baja California, Mexico, and many of the clade boundaries recovered within the California whipsnake correspond to phylogeographic breaks in other sympatric taxa. Under a phylogenetic species concept (Cracraft 1983), it would be possible to recognize each of the five clades as separate species. However, Richmond et al. (2011) do not subscribe to the phylogenetic species concept, citing the traditional definition of subspecies, those of Darwin (1896) and Mayr (1940), and suggest that molecular data can be used to validate or refute subspecies taxonomy as an indicator of evolutionary lineages, but cannot be used to identify classical subspecies (a geographically defined aggregate of local populations which differ taxonomically from other subdivisions of the species (Mayr 1940)). O'Brien and Mayr (1991) proposed guidelines for the use of the subspecies concept by conservation biologists and policy makers. Their proposed guidelines suggest that subspecies be defined based on Mayr (1940) and the evidence for subspecies designation, under the biological species concept (Mayr 1940), should come from the concordant distribution of multiple, independent, and genetically based traits. The mtDNA phylogenetic results in Richmond et al. (2011) provide evidence that the evolutionary history of the Alameda whipsnake is not distinct from other California whipsnakes throughout the central California clade. However, mtDNA haplotypes should not be used as a single line of evidence for recognizing taxa and additional genetic data, including nuclear DNA and genetic markers associated with phenotype, should be considered.

Due to limited sampling in San Benito, Monterey, and Fresno counties, the precise southern boundary separating the southern California clade from the central California clade is not known at this time. Similarly, due to a lack of sampling in San Mateo or Santa Cruz counties or Santa Clara County west of the Coyote Valley, it is not known which clade of the California whipsnake occurs in the Santa Cruz Mountains and the San Francisco Peninsula. Richmond et al. (2011) note the central and southern California clades come fairly close to contacting each other in San Benito and Monterey counties, but they did not detect any overlap in the distribution of haplotypes belonging to these clades. In addition, they did not detect any areas where the two clades coexist; however, this could be a result of the relatively small sample size from this area. There are no apparent geographic barriers or gaps in chaparral and coastal scrub vegetation that would preclude dispersal and gene flow between the two clades. Increased mtDNA sampling and nuclear DNA analysis in the Coast Range in Monterey, San Benito, Merced, Santa Cruz, San Mateo, and Fresno counties is needed to determine if geographic boundaries separating the clades exist, if there are any areas where the two clades coexist, and if breeding between the two clades occurs.

Richmond et al. (2011) also analyzed the population dynamics of the Alameda whipsnake using nuclear DNA in the San Francisco East Bay. Analysis revealed substantial genetic partitioning corresponding to Critical Habitat Units, with few individuals showing evidence of mixed ancestry. There was clear genetic structuring among the 12 sites sampled. Significant differences in allelic richness, gene diversity, and levels of inbreeding among the populations were not detected. Little evidence for clinal transitions in allele frequencies was detected, despite a strong overall pattern of genetic isolation by distance. Inferred migration was detected out of Critical Habitat Unit 3 and into Critical Habitat Unit 1 to the north and Critical Habitat Unit 5 to the south. Little migration between Critical Habitat Unit 4 and 5 was detected, suggesting the lack of chaparral and coastal scrub vegetation and the historic presence of vast wetlands in the Tri-Valley or the presence of Interstate Highway 580 are significant dispersal barriers. Richmond et al. (2011) found no evidence of recent reductions in effective population size at any of the sampling sites in the San Francisco East Bay. However, there is often a time lag between the onset of an anthropogenic disturbance and the genetic effects of the disturbance.

Current Distribution

Our current understanding of the Alameda whipsnake range suggests it is slightly larger than the ranges depicted by Reimer (1954) and Jennings (1983). The range of the Alameda whipsnake and phenotypic-intergrade specimens includes mosaics of chaparral, coastal scrub, and adjacent vegetation types throughout Contra Costa County, most of Alameda County, and small portions of northern Santa Clara and western San Joaquin counties. This range can be subdivided into five populations that correspond to relatively contiguous mosaics of chaparral and coastal scrub, grassland, oak woodland/savanna, and riparian vegetation types that are fragmented by urban development, transportation corridors, and a lack of coastal scrub and chaparral vegetation within the Tri-Valley. In addition to the Mount Diablo Area and northern Hamilton Range (for our purposes, the Hamilton Range refers to the portion of the Diablo Range south of Tri-Valley, north of Pacheco Pass, west of San Joaquin Valley, and east of Coyote Valley and San Francisco Bay) populations, three of the five populations are located within the East Bay Hills (for our purposes, the East Bay Hills refers to the area south of the Carquinez Strait, north of Sunol Valley, east of the San Francisco Bay, and west of Interstate Highway 680). The East Bay Hills are divided into thirds by two major east-west highways; California State Route 24 separates the northern from the central population and Interstate 580 separates the southern from the central population. Based on this, the draft recovery plan (Service 2002) established draft recovery units (units 1 thru 5) to correspond to each of the five populations. In addition, two draft recovery units (units 6 and 7) were established to correspond to corridors that best provide habitat linkage between the five populations (Figure 3).

Abundance

Little population abundance data exists for the Alameda whipsnake. However, Alameda whipsnakes have been found to be locally abundant and the dominant snake species when habitat quality is high (Swaim 2002). Almost all trapping studies targeting this species have been designed to determine presence or absence for regulatory purposes and assessing impacts to potential habitat. As such, monitoring is most often habitat based; assuming snake abundance is positively correlated with the amount of coastal scrub or chaparral vegetation and rock lands present. We are not aware of any studies that have quantified Alameda whipsnake densities relative to habitat quality or quantity.

Changes in Taxonomic Classification or Nomenclature

The Service is not aware of any changes in the taxonomic classification or nomenclature of *Masticophis lateralis euryxanthus* since its listing.

Species-specific Research and/or Grant-supported Activities

In addition to the genetic study described under ***Genetics***, the following species-specific research and/or grant-supported activity was conducted:

Prescribed Fire Study

The Alameda whipsnake was the focus of a regional study, proposed by the SFWO, to investigate effects of prescribed burns in chaparral and coastal scrub vegetation on Alameda whipsnake abundance. Study sites included the U. S. Department of Energy's, Lawrence Livermore National Laboratory Site 300 (Site 300) in San Joaquin County, Tilden Regional Park in the Berkeley Hills, and Mallory Ridge in eastern Contra Costa County. The study was initiated in the spring of 2002 with live trapping efforts to collect baseline data on the Alameda whipsnake and its habitat prior to treatment. Attempts to burn at Mallory Ridge were not successful due to wet conditions during the planned burn. The prescribed fire at Tilden Regional Park was not implemented according to the study design (an area without pretreatment data was burned) and the prescribed fire escaped. In the spring of 2003, a portion of the studied habitat was burned at Site 300 via prescribed fire. However, in addition to low Alameda whipsnake sample sizes, a wildfire in the summer of 2005 burned the entire study area at Site 300, including the control areas, making it impossible to statistically compare pre- and post-treatment effects.

Five-Factor Analysis:

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

At the time of listing and when the Draft Recovery Plan was issued, we cited urban development and associated impacts due to increased human population as a threat to the Alameda whipsnake. California population growth projections indicate the human population in California is expected to increase by more than 25 million by 2050 (State of California 2007). Because chaparral and coastal scrub vegetation often occur on slopes and because slopes are often more expensive to develop, parcels with chaparral and coastal scrub vegetation are typically developed after level parcels. Thus, the threat of urban expansion into chaparral and coastal scrub vegetation is often associated with pre-existing cities that have completely or nearly completely developed all level parcels. The expansion of urban areas into surrounding rural areas often begins with the construction of larger estate homes and ranchettes, which often convert large blocks of chaparral and coastal scrub habitat to grassland and other vegetation types. At this time, much of the level lands in the San Francisco East Bay have been developed, particularly those in the East Bay Hills, and urban development remains one of the greatest threats to the species.

Often interrelated to urban development and an expanding human population in California is the need to increase the water supply that supports urban development. Water supply improvement projects, such as the construction of dams and reservoirs for the purpose of increased water storage capacity, tend to result in large-scale losses of wildlife habitat. Water demand in California currently exceeds water supply. Thus, as urban areas expand and threaten the Alameda whipsnake, so too do water supply improvement projects, including the construction or expansion of dams and reservoirs on lands owned by local water districts.

Urban Development and Habitat Fragmentation

East Bay Hills: The East Bay Hills include Alameda whipsnake draft recovery units 1, 2, 3, 6, and 7 and Critical Habitat Units 1, 2, 3, and 6. In addition to the fragmentation caused by transportation corridors, the East Bay Hills have experienced substantial losses of coastal scrub and chaparral vegetation from urban development that expanded into these vegetation types from lower elevation valleys and coastal cities. In effect, the East Bay Hills are virtually surrounded by urban development and major transportation corridors. The historic loss of habitat from encroaching urban development pressures surrounding the East Bay Hills and the highly fragmented state of these areas were the primary threats leading to the listing of the Alameda whipsnake. Development pressure along much of the western-flank of the East Bay Hills has been reduced through the establishment of East Bay Regional Park District parks, East Bay Municipal Utility District (EBMUD) watersheds, and other public lands. Urban development pressure is often greatest along major transportation routes (i.e., California State Routes 24 and 4 and Interstate Highway 580). However, much of the private lands within the East Bay Hills that are not associated with transportation corridors remain vulnerable to large estate home and ranchette development.

Over two thirds of draft recovery unit 1 is currently not susceptible to urban development due to ownership by EBRPD, EBMUD, Muir Heritage Land Trust, University of California, Berkeley, City of Pinole, and U. S. National Park Service. These lands are relatively contiguous and provide expansive mosaics of chaparral and coastal scrub vegetation, grasslands, oak woodlands, and oak savannah. However, the northeastern quarter of this unit, adjacent to the City of Martinez, and numerous undeveloped parcels along the northwestern and southeastern border remain unprotected and will likely experience some degree of urban development in the foreseeable future if not preserved.

Draft recovery unit 6, designated to provide a habitat linkage between draft recovery units 1 and 2, currently provides an approximately 0.4 mile (0.6 kilometer) wide corridor over State Route 24 at the Caldecott Tunnel. However, a moderate amount of development has occurred on the western side of the unit, near the narrowest portion of corridor. Approximately half of the corridor remains in private ownership and is vulnerable to development. An Alameda whipsnake was observed approximately 150 meters (500 feet) from the narrowest portion of the corridor in 2007 and seven additional occurrences have been recorded in draft recovery unit 6 (CNDDB 2011), suggesting the corridor actively facilitates gene flow between draft recovery units 1 and 2. Aside from draft recovery unit 6, no other habitat linkages exist between draft recovery units 1 and 2. Loss of connectivity between the northern and southern portions of draft recovery unit 6 represents a substantial threat to the species in the East Bay Hills.

A little over one-third of draft recovery unit 2 and almost the entirety of the western border of this unit are in public ownership. However, significant development pressure continues from the north, southwest, and east. Although the amount and extent of coastal scrub and chaparral habitat is lowest in the southwestern portion of the unit, there are important patches that may act as "stepping stones" between draft recovery units 2 and 3. The northern portion of the unit contains large blocks of high quality Alameda whipsnake habitat, but is highly fragmented from urbanization and the long-term ability of the Alameda whipsnake to occupy these fragments is questionable. For example, despite thorough trapping efforts, no Alameda whipsnakes were captured at Lafayette Reservoir Recreational Area, a 927 acre parcel owned by EBMUD with approximately 202 acres of coastal scrub vegetation almost entirely surrounded by urban development (Swaim 2000). Separating the southern border of draft recovery unit 2 and the northern border of draft recovery unit 3 is Interstate Highway 580. Few, if any, highway crossings exist along Interstate Highway 580 and development pressures associated with cities along this major transportation corridor are high. Therefore, it is likely significant development will occur along the southern boundary of this unit, if not protected, which will further decrease the already restricted dispersal potential between draft recovery units 2 and 3.

Approximately one third of draft recovery unit 3 is owned by EBRPD. However, very few of these EBRPD-owned parcels are contiguous or located adjacent to urban development; therefore; they provide little protection from the development pressures associated with adjacent urban areas and transportation corridors. Large scale development along Niles Canyon Road, the southern boundary of this unit, is unlikely at this time, due to the steepness of the hillsides and associated costs of development. However, small scale rural residential development is threat within this area.

Draft recovery unit 7 was designated to provide habitat linkage between draft recovery units 3 and 5, across Interstate Highway 680. More than three quarters of this unit is in public ownership; San Francisco Public Utilities Commission is the largest landowner and EBRPD owns several parcels in the western portion of the unit. Coastal scrub and chaparral vegetation is primarily concentrated along the northern border of the unit; just south of Niles Canyon Road. Habitat fragmentation in draft recovery unit 7 is greatest around Sunol Valley. Sunol Valley has been fragmented by Interstate Highway 680, the development of a golf course, a quarry, a commercial nursery, and urban development. Despite the development and corresponding fragmentation in Sunol Valley, the Alameda Creek riparian corridor, which runs under Niles Canyon Road, through Sunol Valley, and under Interstate Highway 680, is arguably the shortest link between patches of coastal scrub and chaparral vegetation in draft recovery units 3 and 5 and most likely to facilitate successful dispersal between the two units. Further development in this area represents a substantial threat to gene flow between the populations in the East Bay Hills and populations in the northern Hamilton Range.

Mount Diablo Area: Mount Diablo and the surrounding mountains and hills are located east of Interstate Highway 680, north of Interstate Highway 580 and the Tri-Valley, south of State Route 4, and west of the San Joaquin Valley in Contra Costa County. This area includes draft recovery unit 4 and Critical Habitat Unit 4. Draft recovery unit 4 contains one of the most isolated populations of Alameda whipsnakes. Little to no habitat connectivity occurs between the Mount Diablo Area population and any other population; Interstate Highway 680 and associated urban development constitute barriers to dispersal between the Mount Diablo Area and the East Bay Hills and Interstate Highway 580 and the expansive grasslands of the Tri-Valley constitute barriers to dispersal between the Mount Diablo Area and the northern Hamilton Range. At this time, approximately half of draft recovery unit 4 is in public ownership, primarily through ownership by California Department of Park and Recreation (CDPR), EBRPD, Contra Costa Water District, Save Mount Diablo, and the cities of Walnut Creek and Concord.

More than two-thirds of draft recovery unit 4 is within the East Contra Costa Habitat Conservation Plan (ECCHCP). Within the ECCHCP permit area, which includes a portion of draft recovery unit 4, between 8,670 and 11,853 acres of development and an additional 1,126 acres from rural infrastructure projects will be permitted. To address these impacts, approximately 23,800 to 30,300 acres of land will be preserved. Under the ECCHCP, an estimated 1,690 to 1,817 acres of core and perimeter Alameda whipsnake habitat and 10,564 to 12,166 acres of upland movement habitat will be preserved, almost entirely within draft recovery unit 4. Although urban development of Alameda whipsnake habitat is likely to occur within this unit, nearly all of the highest quality habitat and areas that provide for the greatest connectivity within the ECCHCP have been targeted for land acquisition and management.

Areas not under public ownership or within the bounds of the ECCHCP primarily occur along the southern and the eastern boundary of draft recovery unit 4. The southwestern portion of this draft recovery unit, along the southeastern edge of the Black Hills, contains the largest unprotected and contiguous blocks of Alameda whipsnake core habitat. This area is susceptible to urban development pressure, which is most likely to occur from development associated with the communities of Blackhawk and Tassajara to the west. However, development is likely to occur in the grasslands at the base of the Black Hills, prior to the development of coastal scrub and chaparral vegetation on steeper slopes. The western portion of the unit contains fragments of unprotected parcels within a matrix of City of Walnut Creek designated open space areas, EBRPD properties, and CDPR land. Development between public lands in the eastern portion of the unit, that result in fragmentation and isolation of large patches of coastal scrub or chaparral, would significantly reduce the habitat quality of the adjacent publically owned parcels. Due to the ECCHCP and the large amount of contiguous public ownership within draft recovery unit 4, this population has the greatest potential for recovery at this time.

Northern Hamilton Range: Within the northern Hamilton Range, Alameda whipsnakes and phenotypic intergrades can be found throughout most of Alameda County and small portions of northern Santa Clara and western San Joaquin counties. Within this area is Alameda whipsnake draft recovery unit 5, the largest of all the draft recovery units, and Critical Habitat Units 5a and 5b. Approximately one quarter of draft recovery unit 5 is within public ownership; San Francisco Public Utilities Commission, EBRPD, City of Fremont, Santa Clara County, and CDPR are the largest public land owners within the unit. Current development pressure within and adjacent to this unit is primarily associated with the Cities of Pleasanton and Livermore along the northwestern border and the Cities of Fremont and Milpitas along the western border.

All portions of draft recovery unit 5 that occur within Alameda County, approximately 75 percent of the unit, are within the Eastern Alameda County Conservation Strategy (EACCS). The EACCS is a voluntary program that provides a baseline inventory of biological resources and conservation priorities to be used by local agencies and regulatory agencies during project-level planning and environmental permitting. The EACCS includes the Alameda whipsnake and aims to protect over 75 percent of the coastal scrub and chaparral within the EACCS.

Water Development Projects

Prior to listing, numerous water storage reservoirs were constructed throughout the range of the Alameda whipsnake (i.e., San Pablo, Briones, Lake Chabot, and Upper San Leandro reservoirs). These reservoirs resulted in the inundation and large scale losses and fragmentation of Alameda whipsnake habitat. In the late 1980s, EBMUD proposed to construct a dam and reservoir in Buckhorn Canyon, south of the City of Moraga in the East Bay Hills. Due to public outcry, the dam was never constructed. However, in EBMUD's Water Supply Management Program 2040 (EBMUD 2009), the option of building a dam and reservoir along 7 miles of Buckhorn Canyon for the purpose of increasing water supply in the San Francisco East Bay was considered. Although this option was eliminated early on due to numerous environmental concerns by stakeholders, including the loss of Alameda whipsnake habitat, the option to inundate Buckhorn Canyon or other areas occupied by the Alameda whipsnake could become less controversial and a viable solution to meet water demand for local water districts if a lack of water supply threatened the economic livelihood and welfare of the public.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

At the time of listing (Service 1997), we indicated the Alameda whipsnake did not appear to be particularly popular among reptile collectors, but that Federal listing could raise the value of this snake within reptilian trade markets and increase the threat of unauthorized collection above current levels. Sullivan (2000) identified the collection of snakes for the pet trade as a possible explanation for decreases snake populations, including the California whipsnake, over a 20 year period along Corral Hollow Road in Alameda and San Joaquin Counties. In that study, Sullivan (2000) notes that often there were 2 to 4 collectors on warm nights in May during both the 1970s and 1990s; collectors permanently removed virtually every living snake they encountered. It is likely collection for the pet trade occurs most often on isolated roadways, the effects of which would be greatest to small and isolated Alameda whipsnake populations. The collection of Alameda whipsnakes for the pet trade remains a minor threat.

FACTOR C: Disease or Predation

At the time of listing (Service 1997), the Service determined that the potential impact of disease on the Alameda whipsnake was unknown, but that a number of native and exotic mammals and birds were likely to be predators of the Alameda whipsnake including the California kingsnake (*Lampropeltis getula californiae*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), opossum (*Didelphis virginianus*), coyote (*Canis latrans*), gray fox (*Vulpes cinereoargenteus*), and hawk (*Buteo* species). Urbanization can lead to increased numbers and access to habitat by native predators, leading to increased levels of predation on native fauna (Goodrich and Buskirk 1995). In situations where Alameda whipsnake habitat has become fragmented, isolated, and otherwise degraded by human activities, increased predatory pressure may become excessive, especially where alien species, such as rats (*Rattus* species), feral pigs (*Sus scrofa*), and feral and domestic cats (*Felis domestica*) and dogs (*Canis familiaris*) are introduced. These additional threats become particularly acute where urban development immediately abuts Alameda whipsnake habitat. At this time, predation by native or non-native mammals and birds has not been documented; thus, predation represents a minor threat to the species.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing (Service 1997), regulatory mechanisms thought to have some potential to protect the Alameda whipsnake included: listing under the California Endangered Species Act (CESA) in 1979, the California Environmental Quality Act (CEQA), and the Native Plant Protection Act (NPPA). In addition to state of California regulatory mechanisms, the Alameda whipsnake is protected by the National Environmental Protection Act (NEPA) and the Act. Inadequacy of existing regulatory mechanisms is not considered a threat at this time. The following is a summary of the regulatory mechanisms protecting the Alameda whipsnake.

State Protections in California

The State's authority to conserve rare wildlife and plants is comprised of four major pieces of legislation: CESA, the NPPA, CEQA, and the Natural Community Conservation Planning Act.

CESA and NPPA: CESA (California Fish and Game Code, section 2080 *et seq*.) prohibits the unauthorized take of State-listed threatened or endangered species. The NPPA (Division 2, Chapter 10, section 1908) prohibits the unauthorized take of State-listed threatened or endangered plant species. CESA requires State agencies to consult with the CDFG on activities that may affect a State-listed species and mitigate for any adverse impacts to the species or its habitat. Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. The Alameda whipsnake was listed as threatened by the State of California on June 27, 1971.

CEQA: CEQA requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

Federal Protections

NEPA: NEPA (42 U.S.C. 4371 *et seq*.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

Endangered Species Act of 1973, as amended: The Act is the primary Federal law providing protection for this species. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize adverse affects to listed species associated with a project. In addition to section 7(a)(2) of the Act, incidental take of listed animal species can be authorized for activities carried out by non-Federal agencies through section 10(a)(1)(B) of the Act. Section 10(a)(1)(B) requires non-Federal applicants to submit a conservation plan specifying the impact which will likely result from the take and what steps the applicant will take to minimize and mitigate such impacts.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Wildfire Fuel Reduction Treatments

Large catastrophic wildfires in brush-covered regions of California are often driven by high winds, and under these conditions fire suppression techniques are typically ineffective (Countryman 1974). Although fuel structure is an important determining factor in fire behavior, the role of structure diminishes markedly under foëhn winds. These winds, sometimes referred to as “Diablo Winds” in the San Francisco East Bay, are created when a high pressure weather system is located over the Great Basin of the inland western states, accompanied by an offshore low pressure system. The high pressure system imports chilled air from the far north, with extremely low moisture content. The interaction of the two pressure systems and their counter-rotational forces creates a wind flow from northeast to southwest, while the pressure differential forces the dry air from high altitudes down to ground level. The result is a strong wind of exceptionally dry air, blowing through the mountain passes and spilling over the coastal hills toward the Pacific Ocean. Increased pressure also heats the air mass (adiabatic compression), which often results in drastically increased air temperatures at sea level, with less than 10 percent relative humidity and wind velocities of 35 to 70 miles per hour. Under these conditions, fires readily burn through all age classes of fuels, and thus, rotational burning programs that attempt to modify vast expanses of chaparral and coastal scrub through age class modification are not likely to be effective in stopping these catastrophic fires, without extensive ecological impacts (Keeley et al. 1999). Based on an analysis of data collected on more than 500 chaparral inventory plots in 14 California counties, from Marin County in the north to San Diego County in the south by Fried el al. (2004), it appeared that nearly all chaparral older than 10 years had moved out of the low-hazard category and would likely burn readily in a wildfire.

Mediterranean-climate shrublands of California are one of the most fire hazardous landscapes in North America. For example, the Tunnel Fire of 1991 started in the Wildland Urban Interface (WUI) of the Oakland/Berkeley Hills under severe fire hazard conditions. The Tunnel Fire burned 1600 acres of coastal scrub, maritime chaparral, and other vegetation types; killed 25 people, destroyed 3,354 homes and 456 apartments, and resulted in an estimated $1.5 billion in damages. Of primary concern to the municipalities and land management agencies in the WUI is reducing wildfire hazard to protect property and human lives. One of the only effective means of reducing this threat is to reduce the amount and/or structure of fire carrying fuels.

The use of prescribed fire in the WUI is not considered a viable option by many land managers at this time due to the risk of fire escape and the legal liability in such an event. In effect, mechanical fuel reduction treatments are one of the only management tools capable of reducing wildfire hazard in the WUI. In addition to a possible shift in native species composition, recent studies have found that mechanical fuel reduction treatments can result in shifting the ecological balance from native fire-stimulated species to invasive non-native annuals (Eliason and Allen 1997, Keeley 2006, Keeley et al. 2008, Potts and Stephens 2009). Keeley and Keeley (1989) concluded that in nature a substantial proportion of the seed pool of some chaparral species is unlikely to germinate in the absence of fire and that dormancy mechanisms minimize seed germination during periods of low survival probability. However, they also note that a portion of the seed pool is potentially capable of germinating in the absence of fire. Chaparral and scrub management should focus on ecosystem function and site specific goals. Mechanical fuel treatments that alter stand structure will likely have significant ecological impacts, some of which will not be known for many years.

EBRPD's Wildfire Hazard Reduction and Resource Management Plan: EBRPD developed a Wildfire Hazard Reduction and Resource Management Plan (LSA Associates, Inc. 2009) (WHRRMP) to reduce fuel loads within the WUI of the Oakland/Berkeley Hills. According to the WHRRMP, more than 500 acres of core Alameda whipsnake habitat will be mechanically treated to reduce fuel loads. Coastal scrub and chaparral will be converted to other vegetation types in more than 25 of the treatment areas. In fuel treatment areas where coastal scrub and chaparral are not converted to other vegetation types, the WHRRMP calls for creating clumps of scrub and chaparral through mosaic or "patch regeneration" thinning to break up large expanses of brush and slow rapid fire spread. Patches would be small enough to provide horizontal separation between groups to allow proper maintenance and to help slow the spread of fire. Each shrub or group of plants would measure no wider than two times its height, or less than 120 square feet (or 6 feet x 20 feet). The effects of creating clumps of coastal scrub and chaparral vegetation to the Alameda whipsnake are not known at this time. Loss of Alameda whipsnake core habitat from wildfire fuel reduction treatments represents a moderate threat to the species.

<u>Fire Frequency</u>

At the time the Alameda whipsnake was listed (Service 1997) and the Draft Recovery Plan was issued (Service 2002), we defined fire suppression as both a direct and indirect threat to the Alameda whipsnake. We determined the natural fire return interval for the San Francisco East Bay was 10 to 30 years and that fire suppression exacerbated the effects of wildfires by allowing a buildup of fuels, creating the conditions for hotter fires that may directly kill Alameda whipsnakes that do not find retreat in burrows or rock crevices. We further determined the effects of fire suppression indirectly threaten the Alameda whipsnake by allowing plants to establish a closed canopy that will tend to create relatively cool conditions that are less suitable to the Alameda whipsnake, which maintains a relatively high active body temperature. There has been considerable debate about the effects of decades of fire suppression on California shrublands (Moritz 2003). One side of the debate believes fire suppression in California shrublands has increased fuel loads and lead to fewer, but larger wildlfires. This theory is supported by studies contrasting shrubland fire regimes north and south of the U.S.-Mexican border (Minnich 1983, 1995, 2001), arguing that the pattern of small fires south of the boarder is a model of what fire regimes were like north of the boarder prior to fire suppression policy. Based on this assumption, proponents of this theory suggested that shrubland-WUI management should de-emphasize fire suppression and reestablish an age mosaic of shrublands to return the landscape to a condition in which fire size is constrained by discontinuities in fuels due to smaller, more frequent fires.

In contrast, others have found that relatively large stand-replacing crown fires are a natural part of these ecosystems and that urban expansion into these ecosystems has increased the rate of fire incidence through human ignition sources, resulting in more frequent and destructive fires. This theory is supported by research that has shown that extremely large stand replacing crown fires predate fire suppression policy (Keeley and Fotheringham 2001, Keeley and Zedler 2009); much more area has burned by wildfires in recent decades than before active fire suppression (Moritz 1997, Conrad and Weise 1998, Keeley et al. 1999); wildfire hazard is relatively independent of stand age (Moritz 1999); and when wildfires occur under severe fire conditions they burn through all age classes of chaparral and coastal scrub (Keeley 2002).

Chaparral should not be considered a fire-adapted vegetation type, but rather one adapted to a particular fire regime (Parker 1988). Because California shrublands burn in stand-replacing fires, it is difficult to reconstruct precise fire histories using dendroecological methods (Keeley and Fotheringham 2001). Determining the natural fire regime is also complicated because humans have set fires in the region for hundreds to thousands of years (Keeley and Fotheringham 2003). Although the natural fire regime has proven difficult to determine, extremely short intervals between fire events can threaten the persistence of some shrub species or irreversibly convert chaparral to other vegetation types such as coastal scrub or non-native annual grasslands (Zedler et al. 1983). Due to the smaller stature, faster growth rate, and lighter wind-dispersed seeds, coastal scrub species are more invasive (i.e., *Baccharis pilularis*) than chaparral species. Under repeated or severe disturbance coastal scrub species are capable of dominating chaparral sites. If disturbance is too frequent, coastal scrub sites are often replaced by annual grassland species; though, with decreased disturbance coastal scrub species do return (Westman 1976).

Based on a study of 12 chaparral sites, from Marin County to San Diego County, California, Keeley (1992) found century old chaparral stands dominated by vigorous shrub populations with little evidence of a decline in species diversity or successional replacement by other vegetation types; the richest community in the study was 118 years of age. Keeley (1992) found many chaparral stands between 56 and 118 years of age to be relatively healthy and diverse. Similar to the observations by Keeley (1992), Bradbury (1978) documented a stand of coastal scrub that had remained unchanged in the absence of domestic livestock grazing and fire for 100 years bordering a stand of chaparral. However, Van Dyke and Holl (2001) were concerned that stands of maritime chaparral more than 70 year of age in Monterey County, California were succeeding to *Quercus agrifolia* and *Heteromeles arbutifolia* (toyon) in the absence of fire.

Human-ignited fires account for most of the acreage burned in California wildlands and these fires differ greatly from lightning-ignited fires in their temporal and spatial distribution (Keeley 1982). Lightning-ignited fire frequency in the California coastal ranges is one of the lowest in California (Greenlee and Langenheim 1990) and in North America (Keeley 2004). In the absence of human ignition sources, lighting is the only predictable source of fire ignition in the coast range east of San Francisco Bay. The frequency of lightning-ignited fires increases with distance from the coast and with elevation. In a study of relative frequency of human-caused and lightning-caused fires in the coast range east of San Francisco, Keeley (2005) found that most years were without any lightning-ignited fires: in Contra Costa County 86 percent of the years had no lightning-ignited fires and in Alameda County the figure was 74 percent.

Ecological studies in the California coastal ranges have failed to uncover any clear soil or climate factors explaining grassland distribution patterns (Keeley 2004). During the latter half of the 20^{th} century, grasslands in many of the protected areas of the coast range east of San Francisco have decreased due to colonization by shrubs (i.e., *Baccharis pilularis*) and succession to oak woodland as a result of a change in the fire regime and reduced grazing (Russell and McBride 2003; Keeley 2005). Because grasslands of the San Francisco East Bay do not appear to be under strong edaphic (soil) control, rather their distribution appears to be disturbance dependant, and lightning-ignited fires are rare; Keeley (2004, 2005) hypothesized that prior to Native American dispersal into the area and repeated burning by Native Americans, shrublands dominated and grasslands were of limited extent. Following the cessation of Native American burning, these grasslands were maintained by the overstocking of range lands with cattle and sheep by European settlers. Gannet (1900, as cited in Fried et al. 2004) reported that the grazing of cattle, sheep, and goats numbering in the tens of thousands, and fires set by herdsmen to open up grazing areas, removed vegetation over vast areas in southern Oregon and California between 1850 and 1899. Due to the unknown frequencies, sizes, timing, and locations of shrubland fires set by Native Americans and early European settlers, the amount of chaparral converted to grassland and coastal scrub and the amount of coastal scrub converted to grassland will likely never be known.

Based on the above analysis of fire frequency in California shrubland ecosystems and the effects of fire suppression on stand structure and fire behavior, we no longer believe fire suppression significantly exacerbates the effects of wildfires in chaparral and coastal scrub vegetation types. Based on this, it does not appear that prescribed fire can be effectively used to maintain open canopied stands of chaparral or coastal scrub. However, because periodic wildfire is considered necessary to maintain a full suite of native chaparral and scrub plant species and because many of these species depend on fire cues (heat, smoke, and/or charate) for germination (Potts and Stephens 2009), fire suppression remains a threat to the Alameda whipsnake. Although the natural fire return interval is not known at this time, research suggest it is likely much greater than 10 to 30 years in the San Francisco East Bay. Since listing the species, Alameda whipsnakes have been observed using and achieving relatively high population densities in chaparral and coastal scrub vegetation irrespective of canopy cover, particularly on warmer sites outside of the fog belt in the Los Vaqueros Reservoir Watershed (Swaim 2005); thus, the threat of closed canopied stands represent a greater threat on cooler sites. In addition, because chaparral and coastal scrub can be converted to other vegetation types by increasing fire frequency, too frequent of a fire return interval also represents a threat to the species.

Non-native Invasive Species

Chaparral and coastal scrub ecosystems are comprised of plant species that are most often shade intolerant. Non-native trees, specifically *Eucalyptus globules* (blue gum), *Pinus radiata* (Monterey pine), and *Cupressus macrocarpa* (Monterey cypress), were planted by the millions between 1880 and 1920 in the East Bay Hills to replace harvested *Sequoia sempervirens* (coast redwood) and for potential future lumber profits that were never realized. Shrub-form non-native invasive species, such as *Genista monspessulana* (French broom), are also capable of colonizing disturbed coastal scrub and chaparral in Alameda and Contra Costa Counties. The ability of non-native trees and shrubs to colonize chaparral, coastal scrub, and grassland ecosystems has led to inhibited growth of native plants, vegetation type conversion, changes in microclimates and soil chemistry, increased sediment mobilization, increased fuel loads, and an overall reduction in habitat quality and quantity of core habitat and peripheral dispersal and foraging habitat. For example, radiotelemetry data indicate that Alameda whipsnakes tend to avoid dense stands of Eucalyptus species (Swaim 1994). Non-native invasive plant species represent a substantial threat to the habitat of the Alameda whipsnake.

Succession

When the Alameda whipsnake was listed, succession of coastal scrub or chaparral to other native vegetation types was not cited as threat to the species. Succession of core Alameda whipsnake habitat, from coastal scrub and chaparral to other native vegetation types, is occurring. It is hypothesized this succession is due to the removal of disturbance regimes. This threat is greatest on more mesic sites where fire and grazing have been removed, particularly on sites within the fog belt in the East Bay Hills. However, the rate of succession and the possibility of a net loss in coastal scrub or chaparral that has or is likely to occur are unknown at this time. Mosaics of grassland, oak woodland, coastal scrub, and chaparral, in some locations, have been reported to correlate with geological substrate (Cole 1980) and soil characteristics (Harrison et al. 1971). However, Callaway and Davis (1993) found each of these vegetation types represented abundantly on most soil depths, slope aspects, and all geological substrates. Cyclical changes between chaparral, oak woodland, grassland, and coastal scrub do occur. The interactions between variables responsible for vegetation type conversion and the rate of conversion are complex and site specific. Callaway and Davis (1993) found that transition rate and direction varied with substrate and topographic position, indicating fire, grazing, and the physical environment interacted to determine direction and rate of transition. They also found that grazing may slow the rates at which community types may replace each other, but, unlike fire, grazing does not appear to alter the direction of succession. Scheidlinger and Zedler (1980) also documented relatively high transition rates for grassland conversion to shrubland, shrubland conversion to oak woodland, and oak woodland to grassland. Variation in transition on different substrates suggests that only portions of the vegetation on the landscape may be dynamic, with some patches in certain combinations of environment and disturbance that change rapidly, and other patches that remain static as edaphic or topographic climax communities. As a generalization, in the absence of disturbance and on sites with environmental factors that allow for transition from one vegetation type to another, grasslands tend to transition to coastal scrub, coastal scrub to chaparral or oak woodland, chaparral to oak woodland, and oak woodland to grassland (Callaway and Davis 1993). Although stands of coastal scrub and chaparral are succeeding to other vegetation types, it is also true that grasslands are succeeding to coastal scrub in the San Francisco East Bay. The effect of succession represents a moderate threat to the Alameda whipsnake and warrants further research.

Grazing

At the time of listing we determined excessive livestock grazing or in appropriate grazing regimes represented a threat to the species. Because Alameda whipsnakes forage in grasslands between stands of scrub, livestock grazing that significantly reduces or eliminates plant cover in these grasslands could lead to an increased loss of Alameda whipsnakes and their prey to predation (Service 1997). However, we also indicated that livestock grazing, if appropriately managed, could benefit the Alameda whipsnake. At this time, incompatible grazing practices, such as overgrazing or bulldozing and burning to prepare lands for grazing, that results in significant and long-term losses of scrub vegetation or a loss of hiding cover represent a moderate threat to the species. Overgrazing may also negatively affect Alameda whipsnakes by damaging the rodent burrows these snakes use for cover. Grazing animals can also act as vectors for non-native invasive plant species and increase the invasive abilities of non-native plants through the removal of native vegetation and ground disturbance. However, through appropriate timing and stocking levels, grazing can be used to target and control some non-native invasive plant species.

Roads, Off-highway Vehicles, and Trails

Loss and fragmentation of habitat as a result of road and trail construction were cited as threats at the time the Alameda whipsnake was listed (Service 1997). Roads can impede gene flow and dispersal. Networks of roads and trails fragment habitat, reduce patch size, and increase the ratio of edge to interior habitat. Road variables that potentially affect wildlife, both directly and indirectly, include size, substrate, age, accessibility, and density (Andrews et al. 2008). The potential environmental effects of roads on wildlife include pollutants, noise, light, increased spread of invasive species, and human access (Andrews et al. 2008). In addition, snakes are particularly vulnerable to motor vehicle mortality associated with roads due to their propensity to thermoregulate on road surfaces and intentional killing by humans when observed on road surfaces. Road placement within the surrounding landscape is possibly the most important factor determining the severity of road impacts because it influences road-kill locations and the rate of mortality.

Although the presence of hiking and biking trails do not result in motor vehicle associated mortality of Alameda whipsnakes, heavily trafficked and high density hiking and bicycling trails can result in harassment or harm by causing snakes to flee and hide when humans are present, thus reducing the overall quality and quantity of habitat. Alameda whipsnakes can also be killed or injured from collisions with cyclists.

In addition to the general effects of roads on the Alameda whipsnake, Off-Highway Vehicles (OHV) continually damage and destroy large patches of habitat and generate high levels of noise that can cause animals to change their behavior (Beauchamp et al. 1998) or result in hearing damage (Brattstrom and Bondello 1983). An approximately 5,000 acre OHV park, Carnegie State Vehicular Recreation Area, is located in eastern Alameda and western San Joaquin counties, within draft recovery unit 5. Alameda whipsnakes are known to inhabit this OHV park. Although this area is no longer susceptible to urban development, Alameda whipsnakes are likely killed, injured, harmed, and harassed as a result of OHV activities at the site. The continual effects of OHV activities could act as a sink and thus represent a threat to the Alameda whipsnake.

Climate Change

Global climate change increases the frequency of extreme weather events, such as heat waves, droughts, and storms (IPCC 2007). Extreme events, in turn, may cause mass mortality of individuals and significantly contribute to determining which species will remain or occur in natural habitats. As the global climate warms, terrestrial habitats are moving northward and upward, but in the future, range contractions are more likely than simple northward or upslope shifts. Since climate change threatens to disrupt annual weather patterns, it may result in a loss of habitats and/or prey. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat.

III. RECOVERY CRITERIA

The draft recovery plan for *Masticophis lateralis euryxanthus* (Draft Recovery Plan for Chaparral and Scrub Community Species East of San Francisco Bay, California) was issued in November 2002 (Service 2002). A final recovery plan has not been issued.

IV. SYNTHESIS

The loss and fragmentation of habitat, as a result of urban development and transportation corridors, were considered to be substantial threats to the Alameda whipsnake when it was listed and remain threats today. Large portions of several of the draft recovery units, such as draft recovery units 1 and 4, have been protected or are part of an HCP. Although we cited a lack of fire as a threat to the species, understanding of how fire affects the Alameda whipsnake and its habitat is incomplete. Nevertheless, because periodic wildfire is often considered necessary to maintain a full suite of native chaparral and coastal scrub plant species and because too frequent of fire can convert chaparral and coastal scrub to other vegetation types, an altered fire regime remains a threat to the species. Non-native invasive plant species were not cited specifically as a threat at the time of listing; however, it is clear the loss of habitat to non-native invasive tree and shrub species represent one of the primary threats to the Alameda whipsnake today. For these reasons, we believe the Alameda whipsnake continues to meet the definition of threatened.

Current genetic data suggest the evolutionary history of the Alameda whipsnake phenotype may not be distinct from other California whipsnakes throughout the central California clade. However, mtDNA haplotypes should not be used as a single line of evidence for recognizing taxa and additional forms of genetic data (i.e., nuclear DNA) should be considered.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
__X__ No Change

New Recovery Priority Number and Brief Rationale: No change. There does not appear to be an overall decline or increase in Alameda whipsnake populations or threats since the time of listing.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Promote the eradication of *Eucalyptus globules*, *Pinus radiata*, and *Cupressus macrocarpa*, *Genista monspessulana*, and other non-native invasive species in the San Francisco East Bay.
2. Focus land protection efforts on undeveloped parcels in the WUI to reduce urban sprawl into chaparral and coastal scrub vegetation and to reduce the need for fuel reduction treatments within Alameda whipsnake habitat.
3. Conduct a genetic study, using nuclear DNA, to determine the genetic basis for the phenotype and to determine if there is a geographic boundary separating the Central and the Southern California clades, if individuals from each of these clades coexist, and if gene exchange between the two clades occurs.

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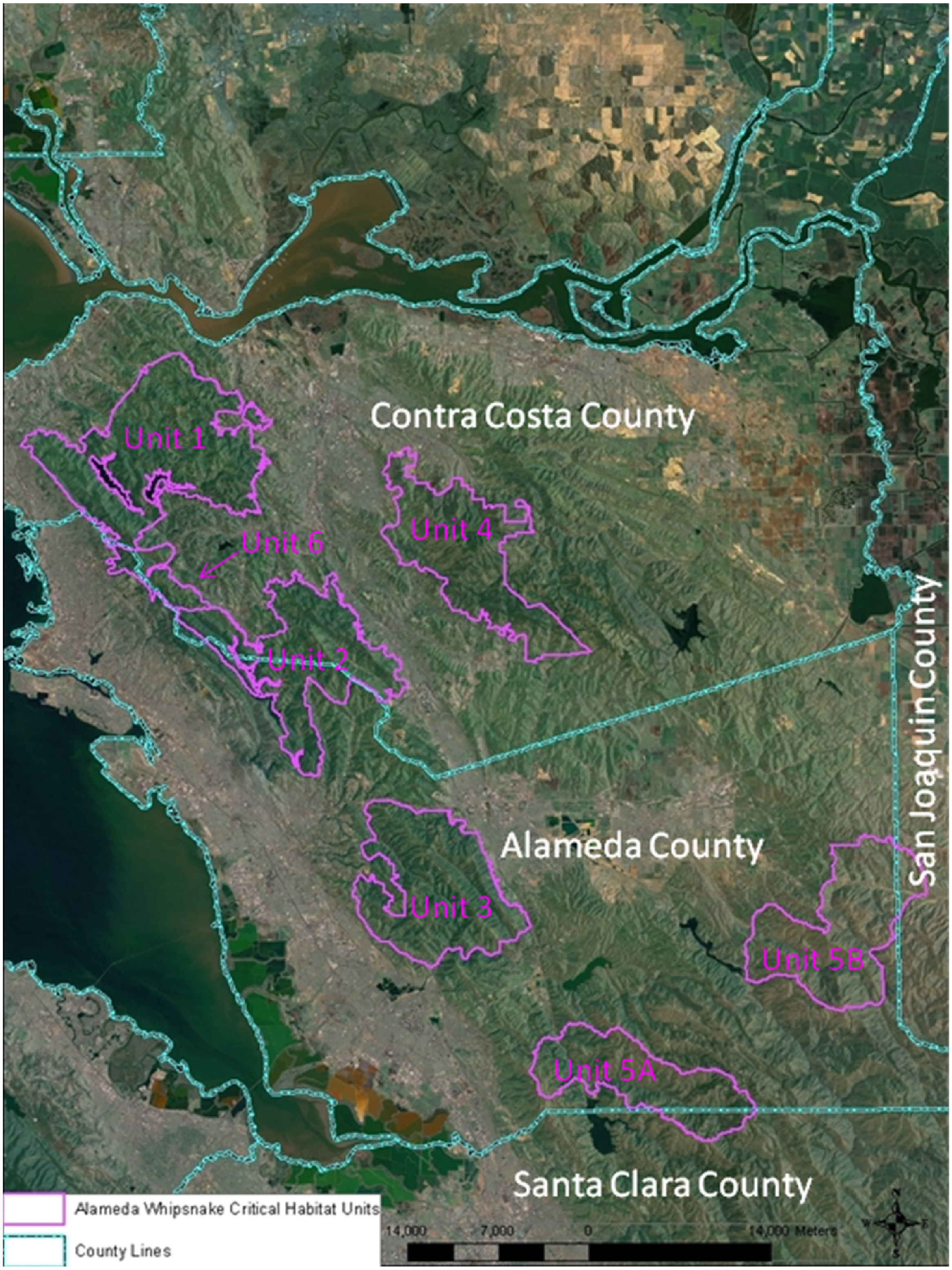

Figure 1. Alameda Whipsnake Critical Habitat Units (Service 2006).

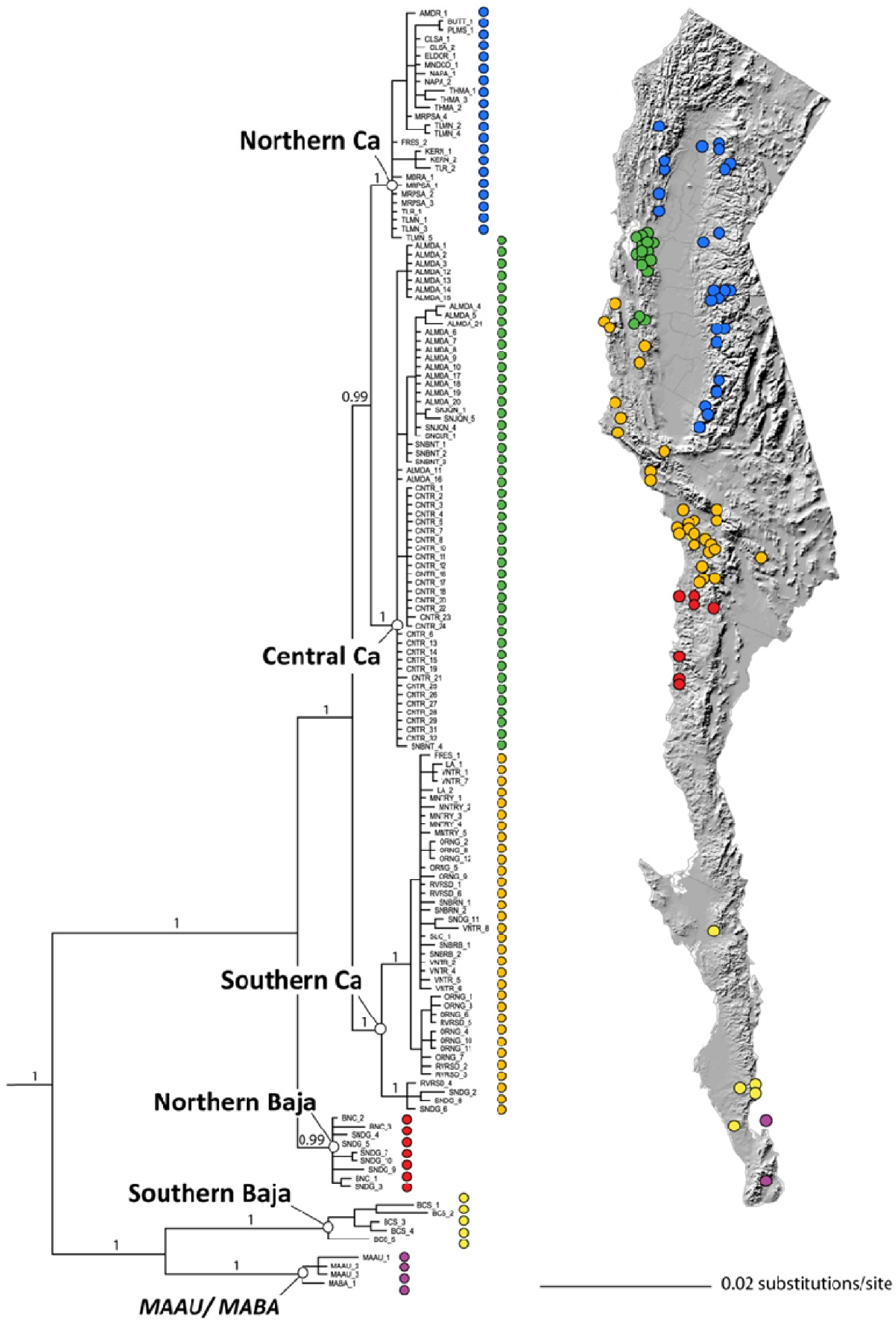

Figure 2. Bayesian estimate of the phylogenetic tree for *Masticophis lateralis* based on mtDNA sequence data. Colors highlight major mitochondrial lineages within the species. Numbers above tree branches indicate posterior probabilities for inferred relationships. MAAU = *Masticophis aurigulus*; MABA = *Masticophis barbouri*. Figure adapted from Richmond et al. 2011.

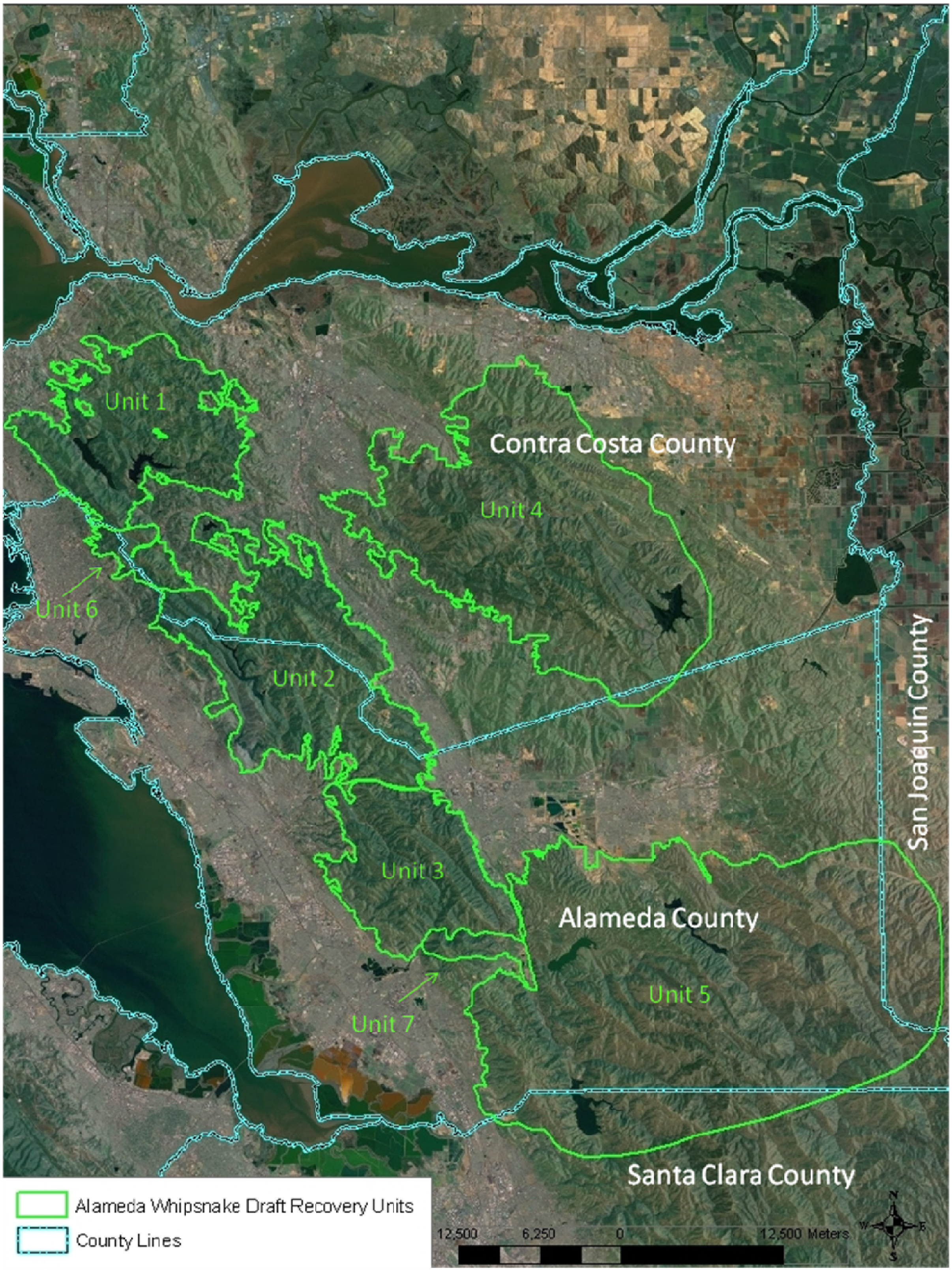

Figure 3. Alameda Whipsnake Draft Recovery Units (Service 2002).

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Alameda whipsnake (*Masticophis lateralis euryxanthus*)

Current Classification: Threatened

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change needed

Review Conducted By: **Ben Solvesky, Sacramento Fish and Wildlife Office**

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve [signature] Date 8 Sept 2011