U.S. Fish & Wildlife Service

Draft Recovery Plan for the Santa Barbara County Distinct Population Segment of the California Tiger Salamander (*Ambystoma californiense*)

Ambystoma californiense (California tiger salamander). Photograph by Alice Abela. Used with permission.

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2015

Region 8

U.S. Fish and Wildlife Service

Ventura, California

Approved: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Regional Director, Pacific Southwest Region, Region 8,
U.S. Fish and Wildlife Service

Date: XXXXXXXXXXXXXXXXXXXX

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An electronic copy of this draft recovery plan will be made available at:

http://www.fws.gov/endangered/species/recovery-plans.html

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Executive Summary

Current Species Status

The Santa Barbara County Distinct Population Segment (DPS) of the California tiger salamander (*Ambystoma californiense*), was listed as endangered throughout its entire range in 2000 under the Endangered Species Act of 1973, as amended. The DPS is endemic to the northern portion of Santa Barbara County, California, and currently consists of six distinct metapopulations. The recovery priority number for the Santa Barbara County California tiger salamander is 3C, indicating a high potential for recovery and a high degree of threat in conflict with development.

Habitat Requirements and Threats

The California tiger salamander requires a combination of pond habitat for breeding and upland (underground) habitat for the rest of its life cycle. The species depends on a series of interconnected breeding and upland habitats as a metapopulation, making it particularly sensitive to changes in the amount, configuration, and quality of these habitats. The loss and destruction of habitat represent the primary threat to the species. Within the range of the Santa Barbara County DPS of the California tiger salamander, significant portions of its habitat have been altered or destroyed. Additional threats to the species include hybridization with non-native tiger salamanders, predation and competition by non-native species, vehicle-strike mortality, and lack of regulatory compliance. Other potential threats include contaminants, disease, and climate change. A majority of the known California tiger salamander occurrences in Santa Barbara County currently occur on private lands, requiring continual coordination with multiple private and local government entities for management.

Recovery Strategy

The strategy to recover the Santa Barbara County DPS of the California tiger salamander focuses on alleviating the threat of habitat loss and fragmentation in order to increase population resiliency (ensure a large enough population to withstand stochastic events) and redundancy (a sufficient number of populations to ensure the species can withstand catastrophic events). Recovery of this species can be achieved by addressing the conservation of remaining aquatic and upland habitat that provides essential connectivity, reduces fragmentation, and sufficiently buffers against encroaching development. Appropriate management of these areas would also reduce mortality by addressing non-habitat related threats. Research and monitoring should be undertaken to determine the extent of other threats and reduce them to the extent possible, including those from non-native and hybrid tiger salamanders, other non-native species, and vehicle-strike mortality.

Recovery Goal and Objectives

The goal of this draft recovery plan is to reduce the threats to the Santa Barbara County DPS of the California tiger salamander to ensure its long-term viability in the wild, and allow for its removal from the list of threatened and endangered species. The interim goal is to recover the population to the point that it can be downlisted from endangered to threatened status. The recovery objectives of the plan are:

1. Protect and manage sufficient habitat within the metapopulation areas to support long-term viability of the Santa Barbara County DPS of the California tiger salamander.

2. Reduce or remove other threats to the Santa Barbara County DPS of the California tiger salamander.

Recovery Criteria

Downlisting may be warranted when the recovery criteria below have been met in a sufficient number of metapopulation areas such that the Santa Barbara County DPS of the California tiger salamander exhibits increased resiliency and redundancy to prevent endangerment in the foreseeable future.

Delisting may be warranted when the following recovery criteria have been met in a sufficient number of metapopulation areas to support long-term viability of the Santa Barbara County DPS of the California tiger salamander:

1. At least four functional breeding ponds are in fully preserved status per metapopulation area.
2. A minimum of 623 acres (252 hectares) of functional upland habitat around each preserved pond is in fully preserved status.
3. Adjacent to the fully preserved ponds and fully preserved upland habitat, a minimum of 1,628 acres (659 hectares) of additional contiguous, functional upland habitat is present, which is at least 50 percent unfragmented and partially preserved.
4. Effective population size (N_e) in the metapopulation is, on average, increasing for 10 years.
5. Management is implemented to maintain the preserved ponds free of non-native predators and competitors (e.g., bullfrogs and fish).
6. Risk of introduction and spread of non-native genotypes is reduced to a level that does not inhibit normal recruitment and protects genetic diversity within and among metapopulations.
7. The effects of vehicle-strike mortality have been minimized to a level that does not threaten viability and protects connectivity within metapopulations, including providing means for effective migration and dispersal in a roadway-impacted landscape.

Actions Needed

The actions identified below are those that we believe are necessary to bring about the recovery of the Santa Barbara County DPS of the California tiger salamander.

1. Protect and manage habitat.
2. Restore and maintain habitat and reduce road mortality/barriers to dispersal.
3. Reduce and remove threats from non-native species.
4. Prevent and reduce the potential for the transmission of disease.
5. Conduct research on threats.
6. Undertake activities in support of developing and implementing management and monitoring plans.
7. Conduct public education and outreach programs.

Estimated Date and Cost of Recovery

Date of recovery: If recovery actions are implemented promptly and are effective, recovery criteria could be met by approximately 2045.

Cost of recovery: $46,806,000

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I. Background

A. Overview

All California tiger salamanders (*Ambystoma californiense*) are federally listed; however, they are listed as three unique entities, or Distinct Population Segments (DPSs): the Sonoma County DPS of California tiger salamander, the Santa Barbara County DPS of California tiger salamander, and Central DPS of California tiger salamander. When listing a population as a DPS under the Endangered Species Act of 1973 (USFWS 1973), as amended (Act), three elements are considered: (1) the discreteness of the population segment in relation to the remainder of the species to which it belongs; (2) the significance of the population segment to the species to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing (USFWS and National Marine Fisheries Service 1996).

We, the U.S. Fish and Wildlife Service (USFWS), emergency listed the Santa Barbara County DPS of the California tiger salamander as endangered on January 19, 2000 (USFWS 2000a) under the Act. The final listing rule for the species was subsequently published on September 21, 2000 (USFWS 2000b). On May 23, 2003, a proposed rule was published in the Federal Register to list the Central California DPS as threatened and reclassify the Santa Barbara and Sonoma County DPSs from endangered to threatened, as well as a proposed rule pursuant to section 4(d) of the Act to exempt routine ranching activities from the Act's prohibitions (USFWS 2003). On August 4, 2004, we published the final listing rule that listed the California tiger salamander as a single threatened species range wide rather than three separate DPSs (USFWS 2004a). This rule was subsequently vacated by a judicial decision on August 19, 2005, and the Santa Barbara County DPS was reinstated and returned to endangered status. As a result, the listed entity for this recovery plan is the endangered Santa Barbara County DPS, as determined by the September 21, 2000 listing rule (USFWS 2000b). In 2004, critical habitat for the Santa Barbara County DPS of the California tiger salamander was designated, consisting of six units totaling 7,491 acres (USFWS 2004b). The California tiger salamander is listed as a single entity by the State of California throughout its range as a threatened species (California Code of Regulations, 2010).

A 5-year review for the Santa Barbara County DPS of the California tiger salamander was finalized on November 13, 2009 (USFWS 2009), and the DPS was re-assigned a recovery priority number of 3C (from 5C), indicating that the DPS has a high potential for recovery, a high degree of threat, and is in conflict with construction or development (USFWS 1983).

The following discussion summarizes characteristics of California tiger salamander biology, distribution, habitat requirements, population status, and threats that are most relevant to Santa Barbara County California tiger salamander recovery. Additional information is available in USFWS (2000a, b, 2003, 2009), Trenham (2000, 2001), Trenham et al. (2001), Shaffer et al. (2004), Trenham and Shaffer (2005), Wang et al. (2009), Searcy and Shaffer (2011), Searcy et al. (2013), and associated literature.

B. Species Description and Taxonomy

The California tiger salamander is a member of the group of mole salamanders (Family Ambystomatidae). It is a large, stocky, terrestrial salamander with a broad, rounded snout; adult total lengths can range from 6 to 8.6 inches (15 to 22 centimeters) (Storer 1925). Adult coloration generally consists of random white or yellowish markings against a black body, and larval coloration is variable, but usually pale (Stebbins 2003).

The California tiger salamander was described as *Ambystoma californiense* by Gray (1853) from specimens collected in Monterey County (Grinnell and Camp 1917), and the species was recognized as distinct by Storer (1925) and Bishop (1943), and was confirmed with genetic data (Shaffer and McKnight 1996, Irschick and Shaffer 1997). Recent genetic studies also show that there has been little, if any, gene flow between the Santa Barbara County DPS and other populations for a substantial period of time (Shaffer et al. 2004, 2013).

C. Distribution

All occurrences of California tiger salamanders in Santa Barbara County are within the Santa Maria Basin Geomorphic Province, which occurs between the interface of the westernmost extent of the east-west trending Transverse Ranges (i.e., the Santa Ynez Mountains) and the southernmost extent of the north-south trending Coast Ranges (i.e., the San Luis Range and San Rafael Mountains). The Santa Barbara County DPS of the California tiger salamander is restricted to Santa Barbara County in southern California. This population constitutes the southernmost range of the species and is the only one west of the outer Coast Ranges (USFWS 2000b). At the time of publication of the emergency listing rule in January 2000, the Santa Barbara County DPS of the California tiger salamander was known from 14 ponds in Santa Barbara County. The emergency and final listing rules acknowledged that other potential breeding ponds or pond complexes may exist, but could not be surveyed at that time because access was restricted.

The Santa Barbara County California tiger salamander is found in six metapopulation areas: (1) West Santa Maria/Orcutt, (2) East Santa Maria, (3) West Los Alamos, (4) East Los Alamos, (5) Purisima Hills, and (6) Santa Rita Valley (Figure 1) (USFWS 2009). For the purposes of this recovery plan, a "metapopulation" is defined as a set of local populations or breeding sites within an area, where typically dispersal from one local population or breeding site to other areas containing suitable habitat is possible, but not routine. The "metapopulation areas" displayed on the maps in this plan (Figure 1; see Appendix D for maps of individual metapopulations) encompass both existing, occupied, and potentially occupied, suitable habitat for each metapopulation for regional conservation planning purposes. Critical habitat for the Santa Barbara DPS of the California tiger salamander has been designated within portions of each of the six metapopulations (USFWS 2004b). Each of the six metapopulation areas for the Santa Barbara County California tiger salamander contain breeding ponds for the species and are described in detail in USFWS (2009) and summarized in Figure 1 and Table 1.

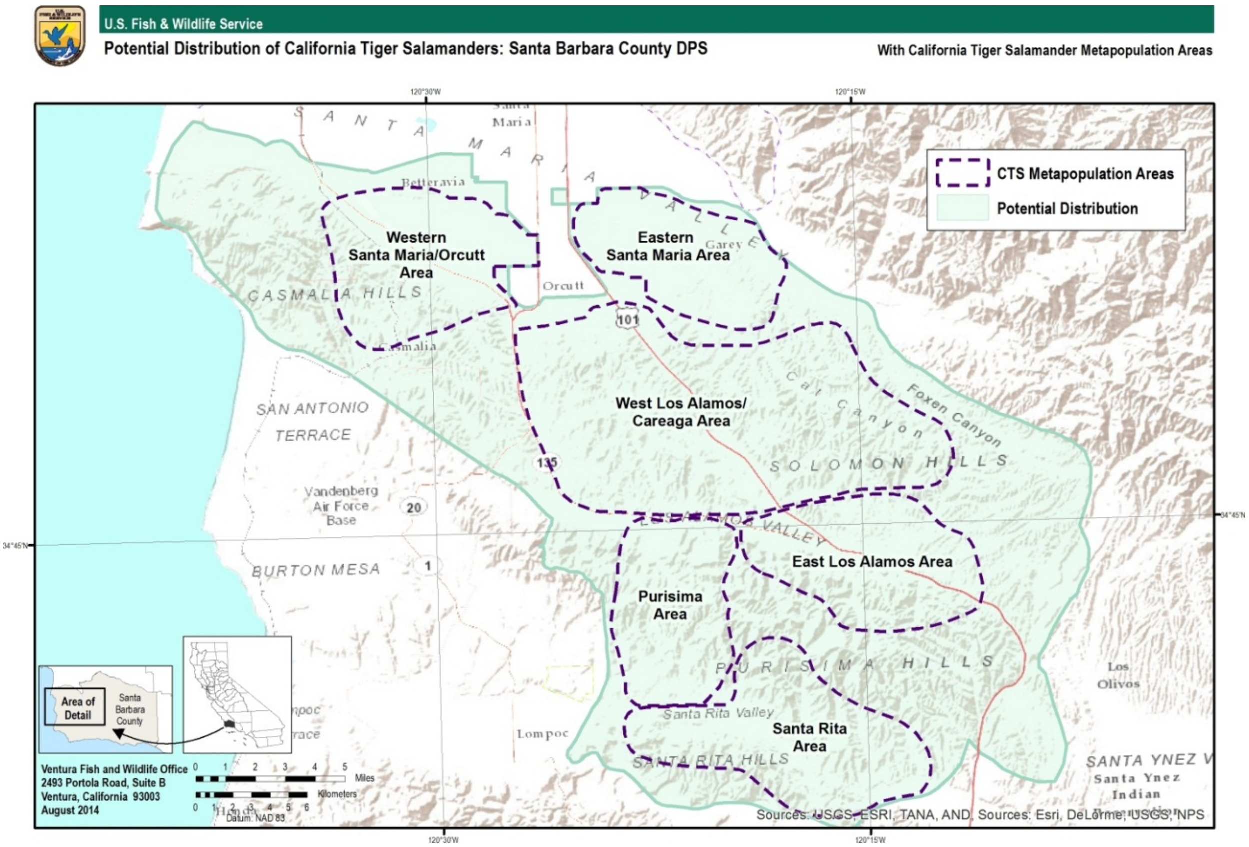

Figure 1. Distribution of California Tiger Salamanders: Santa Barbara Population.

Metapopulation Areas encompass the general area of current occurrences and associated habitat and outline the general areas where recovery actions will be focused. Potential Distribution includes the general area of suitable habitat within the range of the species that is currently occupied or has the potential to become occupied.

Currently, there are approximately 60 known extant tiger salamander breeding ponds in Santa Barbara County (USFWS 2009) distributed across the six metapopulations (Table 1). Since listing, USFWS and the California Department of Fish and Wildlife (CDFW), formerly the California Department of Fish and Game (CDFG), developed guidance for protocol survey efforts (USFWS and CDFG 2003), and this guidance aided in the detection of additional breeding ponds discovered post-listing. Several of the additional ponds were discovered as a result of surveys conducted as a part of proposed development or land conversion projects.

Table 1. Metapopulations of the Santa Barbara County DPS of the California tiger salamander.

Metapopulation	Designated Critical Habitat Unit & Acreage of Designated Critical Habitat	Known extant breeding ponds within metapopulations
West Santa Maria/Orcutt	Unit 1 (W. Santa Maria/Orcutt) 4,135 ac (acres) (1,673 ha (hectares))	15
East Santa Maria	Unit 2 (Eastern Santa Maria)/ 2,909 ac (1,177 ha)	4 (an additional 2 destroyed in 2012)
West Los Alamos	Unit 3 (West Los Alamos/Careaga) / 1,451 ac (587 ha)	12
East Los Alamos	Unit 4 (Eastern Los Alamos) / 90 ac (36 ha)	4
Purisima Hills	Unit 5 (Purisima Hills) / 1,957 ac (792 ha)	19 (8 of which are permanently protected)
Santa Rita Valley	Unit 6 (Santa Rita Valley) / 638 ac (258 ha)	6

D. Abundance and Population Trends

We do not have data on the population size or trends of the Santa Barbara County DPS of the California tiger salamander due to its cryptic life history strategy. However, recent advances in molecular techniques have allowed researchers to measure the effective population size (N_e) (number of breeding individuals, in a breeding season; (Wright 1969)) of California tiger salamander populations (Wang et al. 2011). Effective population size measurements can be used to estimate size of the population and trends over time. Recent research on the Central DPS of the California tiger salamander shows N_e is positively related to the area of individual vernal pools; however, no relationship was found with stock ponds (Wang et al. 2011, Shaffer et al. 2013). This suggests that larger vernal pools are more valuable for the conservation of the species than smaller ones. Although small mammal burrows provide important habitat for California tiger salamander during the terrestrial part of their life cycle, the density of adults in a population has been observed to decrease as burrow densities increase, suggesting that the species is sensitive to other factors than burrow density (Searcy et al. 2013).

California tiger salamander breeding populations can fluctuate substantially due to random, natural processes. At one study site monitored for seven years in Monterey County (Central DPS of the California tiger salamander), the number of breeding adults visiting a site ranged from 57 to 244 individuals (Trenham et al. 2000). Similar work also conducted in Monterey County showed a comparable pattern of variation, suggesting that such fluctuations are typical (Loredo and Van Vuren 1996). Further complicating estimating population size is that salamanders move between ponds (Trenham et al. 2001), or even forego breeding for 2 to 8 years, resulting in negative aquatic surveys despite the presence of the species in adjacent uplands (Trenham et al. 2000, Alvarez et al. 2013)

E. Habitat Characteristics

Historically, the Santa Barbara County DPS of the California tiger salamander inhabited low-elevation (generally under 1,500 feet (475 meters)) seasonal ponds and associated grassland, oak savannah, and coastal scrub plant communities of the Santa Maria, Los Alamos, and Santa Rita Valleys in the northwestern area of Santa Barbara County (Shaffer et al. 1993, Sweet 1993). Seasonal ponds, such as vernal pools (seasonal, shallow wetlands that alternate between dry and wet periods) and sag ponds (ponds located in depressions formed at a strike-slip fault), are typically used by California tiger salamanders for breeding. California tiger salamanders are rarely found in streams or rivers. Natural breeding ponds inundate for variable periods from winter to spring, but may be completely dry for most of the summer and fall. Bedrock or hard clay layers, which help the area retain water, typically lie beneath these pools. These pools range in size from small pools to shallow lakes; preferred ponds have depths ranging between approximately 15.75 to 31.5 inches (40 to 80 centimeters) (Cook et al. 2005).

The area occupied by the Santa Barbara County DPS of the California tiger salamander has several unique soil formations, including dune fields (e.g., Orcutt Terrace Dune Sheet), folded and faulted ridges (e.g., Casmalia, Purisima, and Santa Rita Hills), and adjacent valleys (e.g., Los Alamos and Santa Rita Valleys) (Hunt 1993, Ferren and Hecht 2003). The complex, geologically active landscape of the area provides the vernal pools and seasonal ponds required by California tiger salamanders for breeding.

Climatic changes associated with each season cause dramatic changes in the size and period of inundation of seasonal ponds. These wetlands collect water during winter and spring rains, changing in volume in response to varying weather patterns. During a single season, they may fill and dry several times, and in years of drought, some pools/ponds may not fill at all. Changes in climate can alter the amount of water and the length of time that pools are inundated (Pyke 2005), potentially resulting in long-term loss and degradation of complexes of long-lasting pools that are important breeding habitat (Pyke and Marty 2005).

Several man-made ponds or modified natural ponds have created various types of artificial aquatic habitat in which California tiger salamanders breed in Santa Barbara County, mostly in foothill and upland terrain (Sweet, pers. comm. 2009). Often these ponds are created for the purposes of providing water for cattle when a berm is created in a natural drainage corridor, forming a pond behind it. The availability of these created aquatic habitat, along with the loss of natural vernal and seasonal pools and sag ponds, has caused California tiger salamanders to extensively shift to using these manmade or modified ephemeral and permanent ponds (e.g., livestock ponds) in the foothills. Whether or not this has affected patterns of upland habitat use is unknown (Sweet, pers. comm. 2009).

Small mammal burrows, primarily those of the California ground squirrel (*Spermophilus beecheyi*) and Botta's pocket gopher (*Thommomys bottae*) (Loredo et al. 1996, Trenham and Shaffer 2005), provide important habitat for California tiger salamanders during the terrestrial part of their life cycle (Trenham et al. 2000). While in the uplands, California tiger salamanders may prefer drier microhabitats to more mesic (moist) areas, as indicated by a 2-year study of the species at Jepson Prairie in Solano County, California (Central DPS) (Searcy et al. 2013). Less vegetation may facilitate the movement of California tiger salamanders from upland areas to breeding ponds (USFWS 2003). In one study (Central DPS), radio-tracked adults favored grasslands with scattered large oaks over more densely wooded areas (Trenham 2001). A landscape genetic study in Monterey County, California (Central DPS) found that movement through grassland was twice as costly to the species (in terms of gene flow) as movement through chaparral, and that oak woodlands are the most costly for the species to traverse (Wang et al. 2009).

F. Life History and Ecology

Life cycle

Like other members of family Ambystomatidae, California tiger salamanders spend the majority of their lives underground in small mammal burrows. California tiger salamanders may also use landscape features such as leaf litter or desiccation cracks in the soil for upland refugia. Such refugia provide protection from the sun and wind associated with a dry California climate, which can otherwise desiccate (dry out) and kill amphibians in upland terrain.

Little is known about the fossorial (i.e., underground) behavior of California tiger salamanders as they are difficult to observe while underground, though most evidence suggests that California tiger salamanders remain active. Because California tiger salamanders arrive at breeding ponds in good condition and are heavier when entering a pond than when leaving, researchers infer that California tiger salamanders are feeding while underground. Trenham (2001) recorded underground movements within burrow systems, and other researchers have used fiber optic or infrared scopes to observe active California tiger salamanders while underground (Semonsen 1998).

Winter rain events trigger California tiger salamanders to emerge from refugia and seek breeding ponds (Storer 1925). After mating, females attach their eggs to submerged twigs, grass stems, vegetation, or debris (Storer 1925; Twitty 1941). California tiger salamander eggs hatch into larvae within 10 to 28 days, (Petranka 1998; Hansen and Tremper 1993), with observed differences likely related to water temperatures. Requiring a relatively short period to complete development of the aquatic larvae as compared to other salamanders, California tiger salamanders may breed successfully in pools or ponds that are inundated with water for little more than 2 months. The developmental period can be prolonged in colder weather, commonly in excess of 4 months, after which they emerge as terrestrial metamorphic salamanders, between approximately May and August (Trenham et al. 2000).

Lifetime reproductive success of California tiger salamanders is typically low because they require an extended amount of time before they reach sexual maturity (4 to 5 years) (Trenham et al. 2000). Less than 50 percent of first-time breeding California tiger salamanders typically survive to breed more than once (Trenham et al. 2000). Metamorphs also have low survivorship—in some populations, less than 5 percent survive to breed (Trenham 1998). Thus, isolated metapopulations can decline substantially from unusual, randomly occurring, natural events (e.g., disease, drought) as well as from human-caused factors that reduce breeding success and individual survival.

Metapopulation structure and dynamics

The California tiger salamander has a metapopulation structure. A metapopulation is a set of local populations or breeding sites within an area, where typically dispersal from one local population or breeding site to other areas containing suitable habitat is possible, but not routine. California tiger salamanders appear to have high site-fidelity, returning to their natal pond as adults and commonly returning to the same terrestrial habitat areas after breeding (Orloff 2007, 2011; Trenham 2001). Wang et al. (2009) studied genetic distinctness across 16 Central DPS California tiger salamander breeding sites (Fort Ord, Monterey County), and confirmed genetic differences at almost every site. More work is needed to determine the genetic distinctness across metapopulations in the Santa Barbara County DPS of the California tiger salamander; however, the metapopulation structure of the DPS suggests that there would be similar genetic differences.

Migration and dispersal

Migration is defined as movements, primarily by resident adults, toward and away from aquatic breeding sites (Semlitsch 2008). For the adult residents using a breeding pond, migrations are reoccurring events (often, but not always annually), round-trip, and intrapopulational (within populations). *Dispersal* is defined as unidirectional movements that are interpopulational (between different populations) in scale, are ultimately greater in distance than for migrating adults, and may occur only once in a lifetime (Semlitsch 2008). For dispersing juveniles, movement occurs from natal sites to future breeding sites that are not the pond of birth and not part of the local population. For dispersing adults, movement occurs out of the local population and/or between metapopulations. A local population can be either one pond or clusters of ponds in close proximity occupied by one breeding group.

California tiger salamanders can undertake long-distance migrations, and can disperse long distances as well. They have been recorded traveling the second-longest distance among salamanders, which is also the longest of any salamander in the family Ambystomatidae (reviewed in Searcy et al. 2013). California tiger salamanders move more readily among breeding ponds than other members of the family, a characteristic found consistently among different study sites (Trenham et al. 2001, Wang et al. 2011).

Many studies have recorded migration and dispersal distances by adult and juvenile California tiger salamanders, both through radio-tracking (Loredo et al. 1996, Trenham 2001) and upland drift fence capture (Trenham and Shaffer 2005, Orloff 2007, Orloff 2011). None of these studies were conducted within the range of the Santa Barbara County DPS of the California tiger salamander but are considered to be the best available scientific information on the species. Movement of California tiger salamanders is reviewed in USFWS (2009) and Searcy et al. (2013). In general, adults may migrate up to 1.2 miles (6,336 feet; 2 kilometers) from upland habitats to aquatic breeding sites (USFWS 2000a). Trenham et al. (2001) observed a substantial number of California tiger salamanders moving between ponds separated by up to 2,200 feet (670 meters). Trenham and Shaffer (2005) used capture data and models to calculate that 95 percent of migrating salamanders remain within 2,034 feet (620 meters) of a breeding pond. Orloff (2011) found that a considerable number of adult and juvenile California tiger salamanders moved more than 2,625 feet (800 meters) from their breeding pond, and some more than 1.4 miles (7,392 feet; 2.2 kilometers). Based on the numbers captured, Orloff (2011) hypothesized that substantially more than 5 percent of the pond's population must be migrating beyond 2,200 feet (670 meters) from their breeding pond. Based on studies at Jepson Prairie (Central DPS), researchers estimated that California tiger salamanders use a much greater area around the pond, as compared to Trenham and Shaffer's (2005) original 2,200-foot (670-meter) estimate, with 95 percent of salamanders found within 1.1 miles (5,587 feet; 1.7 kilometers) of a breeding pond from the most outlying pool edge (Searcy and Shaffer 2008, 2011, Searcy et al. 2013, C. Searcy *in litt*, 2014).

Diet

California tiger salamander larvae typically feed on invertebrate prey. This includes zooplankton, small crustaceans, and aquatic insects until the salamanders grow large enough to switch to larger prey (Anderson 1968, Fisher and Shaffer 1996). Larger larvae consume aquatic invertebrates, as well as the tadpoles of other amphibians such as Pacific chorus frogs (*Pseudacris regilla*), western spadefoot toads (*Spea hammondii*), California red-legged frogs (*Rana draytonii*), bullfrogs (*Lithobates catesbeianus*), and even juvenile mice (Anderson 1968; Trenham et al. 2000, Bobzien and DiDonato 2007). Less is known about the dietary habits of subterranean life stages. Stomach contents of several California tiger salamander sub-adults from the Santa Barbara County DPS included spiders, earthworms, and aquatic insects (Hansen and Tremper 1993). Van Hattem (2004) anecdotally reported a Central DPS California tiger salamander eating a moth while being observed underground.

G. Reasons for Listing and Continued Threats

In determining whether to list, delist, or reclassify (change from endangered to threatened status, or vice versa) a species under section 4(a) of the Act, we evaluate five major categories of threats to the species: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. The following is a summary and update of factors that supported the listing of the Santa Barbara County DPS of the California tiger salamander (USFWS 2000a, b) and were addressed in the 5-year status review (USFWS 2009) for the species:

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

At the time of listing, we determined that loss, destruction, degradation, and fragmentation of habitat was the primary threat to the Santa Barbara County DPS of the California tiger salamander, and it remains the current primary threat (USFWS 2000a, b; 2009). The ponds available to Santa Barbara County California tiger salamanders for breeding, and the associated upland habitats inhabited by salamanders for most of their life cycle, have been degraded and reduced in area through agricultural conversion, urbanization, and the building of roads and highways. Maintaining inter-pond dispersal potential (connectivity between ponds) is important for the long-term viability of California tiger salamanders; however, the inter-pond linkages between populations of California tiger salamanders in Santa Barbara County are considerably degraded (Pyke 2005).

The following sections summarize the greatest threats to the species through the destruction, modification, or curtailment of the Santa Barbara County California tiger salamander's habitat or range.

Habitat loss and Fragmentation

Habitat loss reduces the available feeding, breeding, and sheltering opportunities required for California tiger salamander survival and reproduction and thus lowers the carrying capacity of the landscape and threatens the continued existence of the species. Habitat fragmentation reduces population connectivity needed for dispersal and migration, resulting in isolation of metapopulations within the DPS, making them more vulnerable to small population and stochastic effects.

Conversion of California tiger salamander habitat to intensive agricultural uses results in the habitat loss and fragmentation that threatens the Santa Barbara County DPS. Agriculture is the foremost industry in northern Santa Barbara County, and some of the largest agricultural operations of over 1,000 acres (405 hectares) are located in the Santa Maria Valley (Santa Barbara County Association of Governments 2007), where two of the six metapopulations occur. Grading and leveling or deep-ripping operations associated with agricultural conversion of uplands have destroyed ponds and pools (Coe 1988), reducing breeding habitat and causing direct injury and mortality to larvae and juveniles occupying the pools. Also, conversion to intensive agriculture can create permanent barriers that can isolate California tiger salamanders and prevent them from moving to new breeding habitat, or prevent them from returning to their breeding ponds or upland habitat.

In addition to agricultural conversion, habitat loss and fragmentation resulting from urban development also threatens aquatic and upland habitat in the range of the Santa Barbara County DPS of the California tiger salamander. Urban growth causes habitat loss and fragmentation as build-out converts habitat to pavement and creates structures that inhibit normal California tiger salamander movements. The City of Santa Maria and surrounding land is the fastest-growing area in the County, and the population within the City of Santa Maria is forecasted to grow 35 percent by 2040 (City of Santa Maria 2006). To meet the needs of the increasing population, several thousand acres of residentially zoned land will be needed for residences, and several thousand more acres of commercial and industrial development (e.g., schools, parks, and other urban infrastructure) will be needed to support the new residents. The West Santa Maria and East Santa Maria California tiger salamander metapopulations (Figures 2 and 3) are isolated from one another by the cities of Orcutt and Santa Maria and U.S. Highway 101, and these metapopulations are further threatened by continued urban growth in the area. A detailed description of the threats of agricultural and urban development to each metapopulation of the California tiger salamander in Santa Barbara County can be found in USFWS (2009).

Roads and highways also create permanent physical obstacles and increase habitat fragmentation. Road construction can reduce or completely eliminate the viability of a breeding site, and in some cases, large portions of a metapopulation. Large roads and highways represent physical obstacles to California tiger salamanders and can prevent them from returning to their breeding ponds or upland habitat, hinder their ability to move to new breeding habitat, and prevent the recolonization of breeding sites; thus, significantly reducing the local breeding population (Trombulak and Frissell 2000). A majority of California tiger salamander breeding ponds are less than 1 mile (1.6 km) from highways or major roads (USFWS 2009). The East Santa Maria and West Santa Maria metapopulations were likely one large metapopulation in pre-settlement times, but have become isolated from one another by U.S. Highway 101 (Figures 2 and 3). The Santa Rita metapopulation is bisected by Highway 246, and the highway is immediately adjacent to a California tiger salamander breeding pond (Figure 7).

Two California tiger salamander breeding ponds in Santa Barbara County are within 0.2 mile (0.4 km) of a railroad that runs between them, possibly reducing migration, dispersal, and genetic interchange between the ponds. Along with the barriers created by fill that allows railroads to cross small canyons and watercourses, the railroad tracks themselves can act as barriers to migrating salamanders (Jones 1993) because they cannot cross over the rails and may have difficulty moving under the tracks unless adequate burrows are present that provide for passage underneath.

Habitat Alteration

Santa Barbara County California tiger salamanders are also negatively affected by factors that alter the quality of their habitat, including: measures to control burrowing rodents; dense vegetation, often non-native invasive species, that overtakes vernal pool habitats in the absence of grazing; alteration of hydrology; and pond water quality due to agricultural runoff.

California tiger salamanders are strongly associated with California ground squirrel and pocket gopher populations, as the burrows created by active colonies of ground squirrels are necessary for the salamanders to survive (Shaffer et al. 1993, Loredo et al. 1996). Because ground squirrels and pocket gophers are critical for burrow construction and maintenance, and therefore critical to the California tiger salamander, rodent population control efforts are a threat to salamander habitat quality (Shaffer et al. 1993, Loredo-Prendeville et al. 1994). Recovery of ground squirrel populations can be very rapid through immigration from nearby populations with high levels of reproductive success (Gilson and Salmon 1990), so once control efforts are halted, and the California tiger salamander habitat can recover relatively quickly.

Although poor grazing practices can have negative impacts on California tiger salamanders, grazing generally is compatible with the continued use of rangelands by the California tiger salamander as long as best management practices are followed, intensive burrowing animal control programs are not implemented, and grazing is not excessive (Jones 1993, Shaffer et al. 1993). Cattle ranching can be compatible with California tiger salamander conservation (USFWS 2003) because cattle also need open grasslands and ponds. Cattle grazing may mediate the effects of increased drying rates on vernal pools due to climate change, by reducing vegetation and allowing for longer periods of inundation that are adequate enough for California tiger salamanders to successfully breed (Pyke and Marty 2005). By keeping vegetation cover low, grazing can make areas more suitable for ground squirrels (whose burrows are used by California tiger salamanders), can facilitate the movement of California tiger salamanders from upland areas to breeding ponds (USFWS 2003), and allows more surface runoff into the pool basin thereby helping to maintain water available for California tiger salamander breeding. Exclusion of livestock grazing may also allow invasion of aquatic habitat by non-native annual grasses and forbs within and around the bed and shoreline of the pond (Barry 1998). In Santa Barbara County, the remaining vernal pool complexes and isolated ponds with large amounts of suitable California tiger salamander habitat are currently being grazed.

Some seasonal ponds have been converted to irrigation ponds, which are often modified or managed in ways that reduce the quality of these pools as California tiger salamander breeding habitat. Such modifications and management include: lining of ponds that cause changes in substrate and water quality; pumping methods that can result in mortality of California tiger salamander larvae; and frequent (often daily) changes in water levels that can result in desiccation of eggs (Collins 2000). Ponds and California tiger salamander larvae inhabiting the ponds are also subject to indirect effects of conversion to row crops such as increased siltation and eutrophication (the process of increased nutrient input) from runoff containing fertilizers which reduces water quality and introduces toxins that can interfere with normal larval development.

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

Overutilization was not known to be a factor at the time of listing and is not considered a threat at this time.

FACTOR C: Disease or Predation

Disease

Disease is an important causative factor in the global amphibian decline crisis (Daszak et al. 2003). Because the Santa Barbara County DPS of the California tiger salamander has limited genetic variation, it is likely to be more vulnerable to unpredictable factors, including disease (Shaffer et al. 2013). Although the exact cause of death is unknown, a possible disease outbreak was reported by a landowner in the Los Alamos Valley who saw large numbers of dead and dying California tiger salamanders in a pond (Sweet, pers. comm. 1998).

A pathogenic (disease-causing) chytrid fungus (*Batrachochytrium dedrobatidis*) (Bd), the causative agent of the amphibian disease chytridiomycosis, has been linked to amphibian declines worldwide (Berger et al. 1998, Bosch et al. 2001, Fellers et al. 2001, Lips et al. 2006, Skerratt et al. 2007, Kilpatrick et al. 2010). Bd was first documented in California tiger salamanders in Santa Clara County, California (Central DPS) (Padgett-Flohr and Longcore 2005). In a short-term laboratory study of the effects of Bd on California tiger salamanders, the species was found to be susceptible to Bd, but did not die from chytridiomycosis infection (Padgett-Flohr 2008). Longer-term studies are needed to determine the negative effects of Bd infection in California tiger salamanders in the wild. Bd has been documented in a population of California red-legged frogs (*Rana draytonii*) in southern Santa Barbara County (AECOM 2009), and from Vandenberg Air Force Base in northern Santa Barbara County (J. La Bonte et al., unpublished data). Although chytrid fungus has not been found responsible for California tiger salamander mortality in the laboratory conditions or the field, its potential to cause mortality or reduced fitness cannot be ruled out (CDFG 2010). A recently discovered, salamander-specific species of pathogenic chytrid fungus, *Batrachochytrium salamandrivorans* (Bsal), has been associated with a mass die-off of salamanders in the Netherlands (Martel et al. 2013); however, the pathogenicity of Bsal to California tiger salamanders, as well as its distribution in North America, is unknown.

Although their impact on the Santa Barbara California tiger salamander is unknown, several disease-causing agents have been associated with die-offs of closely related tiger salamanders and other amphibian species, including: the bacterium *Acinetobacter* (Worthylake and Hovingh 1989); *Ambystoma tigrinum* virus (ATV), an iridovirus that has caused amphibian die-offs and is lethal to California tiger salamanders (Picco et al. 2007, Picco and Collins 2008); and the water mold *Saprolegnia parasitica* (Lefcort et al. 1997).

Predation

California tiger salamanders in Santa Barbara County are susceptible to predation by several non-native species (Morey and Guinn 1992) such as non-native tiger salamanders (*Ambystoma tigrinum mavortium*), bullfrogs, mosquitofish, other introduced fish, and non-native crustaceans. Bullfrogs prey on California tiger salamander larvae (Anderson 1968) and have been found in at least four California tiger salamander breeding ponds in Santa Barbara County (USFWS 2009). Introduced predators can be indicators of ponds that are so highly disturbed that California tiger salamanders cannot survive to reproduce successfully (Shaffer et al. 1993).

Non-native tiger salamanders from the central United States, which are known to prey on many native amphibians, were introduced to California for fishing bait over 60 years ago (Ryan et al. 2009). Until recently, it was not known whether *A. tigrinum mavortium* co-occurred with native California tiger salamanders within Santa Barbara County. Two co-occurrence sites have been documented within the Purisima Hills metapopulation, making the Santa Barbara County DPS of the California tiger salamander susceptible to predation (and hybridization, see Factor E, below) by non-native tiger salamanders.

Mosquitofish, which prey on mosquito larvae, have been widely introduced in California by vector control agencies to control mosquitoes. Mosquitofish are also known to prey on the eggs and larvae of many amphibian species, including the California newt (*Taricha torosa*) (Graf and Allen-Diaz 1993, Gamradt and Kats 1996), California red-legged frog (Schmieder and Nauman 1993), and Pacific tree frog (Goodsell and Kats 1999). Significantly reduced survival of California tiger salamanders has been observed in permanent ponds with high densities of adult mosquitofish (Leyse and Lawler 2000, Loredo-Prendeville et al. 1994), suggesting that mosquitofish also prey on eggs and larvae of California tiger salamanders. California tiger salamanders may be especially vulnerable to mosquitofish predation due to their fluttering external gills, which may attract these visual predators (Graf and Allen-Diaz 1993). Although we do not have specific presence/absence data, mosquitofish may become a more serious threat to California tiger salamander breeding ponds within Santa Barbara County as they are increasingly used for mosquito control. As urban areas continue to expand, the introduction of mosquitofish into previously untreated ponds, in combination with other threats, may result in the elimination of California tiger salamanders from these breeding sites.

In addition to mosquitofish, predation from other introduced, non-native fish threatens the California tiger salamander. Bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and fathead minnow (*Pimephales promelas*) are some of the fish species that have been found in California tiger salamander breeding ponds in Santa Barbara County (Collins 2000). A number of ponds in or near occupied California tiger salamander habitat in the west Orcutt area have been occupied by introduced fish for more than 20 years (B. Daniels, pers. comm. 2000), likely extirpating any California tiger salamanders that may have bred there. The distribution of the California tiger salamander in the West Los Alamos metapopulation may be limited by catfish (order Siluriformes) that were introduced several years ago (Sweet 2000). California tiger salamanders are absent from a pond with introduced catfish that appears to have suitable breeding habitat, although a pond less than 250 feet (76 meters) away that appears less suitable for breeding, but is free of catfish, is occupied by California tiger salamanders (Sweet 2000).

Louisiana red swamp crayfish (*Procambarus clarkii*) may have eliminated some California tiger salamander populations in the Central DPS (Shaffer et al. 1993, Jennings and Hayes 1994), and have been documented in California tiger salamander ponds in Santa Barbara County (Sweet, pers. comm. 1999).

Additionally, California tiger salamander eggs, larvae, and adults are also prey for a variety of native species. Native predators include great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), western pond turtle (*Clemmys marmorata*), various garter snakes (*Thamnophis* spp.), larger California tiger salamander larvae, larger western spadefoot (*Spea hammondii*) larvae, California red-legged frogs, and raccoons (*Procyon lotor*) (Baldwin and Stanford 1987, Hansen and Tremper 1993, Petranka 1998). Predation by native species is not considered a threat to the Santa Barbara County DPS of the California tiger salamander; however, when combined with other impacts, such as predation by non-native species and habitat alteration, the collective result may be a substantial decrease in population abundance and viability and constitute a significant threat to the DPS.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

In the final rule to list the Santa Barbara County DPS of the California tiger salamander in 2000 (USFWS 2000b), we concluded that Federal, State, and local laws have not been sufficient to prevent past and ongoing losses of the California tiger salamander and its habitat. At the time, these included Federal protections such as the Clean Water Act, State laws such as CESA and CEQA, and local protections – specifically, the Santa Barbara County grading ordinance.

The primary cause of the decline of the Santa Barbara County DPS of the California tiger salamander is the loss, destruction, degradation, and fragmentation of habitat that results from human activities. Many Federal, State, and local regulations exist that have the potential to directly or indirectly benefit the California tiger salamander. In the past, they have had limited ability to prevent ongoing threats to the species and its habitat (USFWS 2009). The State listing of the California tiger salamander throughout its range in 2010 has increased regulatory consideration during project review at the local and State levels. Applicable laws are discussed further below.

<u>Federal Regulations</u>

Federal Endangered Species Act

The Act, as amended, is the primary Federal law providing protection for the Santa Barbara County DPS of the California tiger salamander. The listing of the DPS as endangered provided the full protection of Act. Sections 7, 9, and 10 of the Act have been the most relevant sections that have provided a conservation benefit to the species. Section 9 of the Act prohibits unauthorized taking of any federally listed endangered or threatened species. Section 3(18) defines “take” to mean “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[1] Since the USFWS listed the Santa Barbara County DPS of the California tiger salamander in 2000, its Division of Law Enforcement has investigated several potential violations of section 9. These incidents were primarily related to habitat disturbance that may have resulted in the take of salamanders; however, none of the investigations resulted in prosecution. Two resulted in settlements which included a fine and the purchase of an easement and restoration of a breeding pond in the Purisima Hills metapopulation area. The Act has incorporated the methods discussed below for individuals or entities to obtain exemptions from the prohibitions of section 9 for activities that are otherwise legal.

Section 7 of the Act provides for consultation between the USFWS and other federal agencies for actions they fund, authorize, or implement that may affect listed species. If, as a result of formal consultation, USFWS determines that the proposed action is not likely to jeopardize the continued existence of the species, USFWS will issue an incidental take statement in its biological opinion that provides an exemption to the section 9 prohibitions against take. Since the listing, we have conducted 14 formal consultations analyzing project effects to the Santa Barbara County DPS of the California tiger salamander pursuant to section 7 of the Act. We have conducted consultations primarily with the Army Corps of Engineers for flood control and water supply-related projects; with the California Department of Transportation for highway projects; with the Federal Communications Commission for construction of cell towers; and with the Federal Aviation Administration for airport expansion and other development projects. In general, consultations have resulted in the minimization of impacts through such strategies as timing of projects and using best management practices; in a few cases, habitat or conservation easements have been acquired.

Section 10 of the Act provides for the permitting of activities that are otherwise prohibited under section 9, either through recovery permits (for example, for research that would benefit the species (10(a)(1)(A))), or through an incidental take permit if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity ((10(a)(1)(B)). Project proponents develop habitat conservation plans (HCPs) to support their application for an incidental take permit; the USFWS reviews the HCP to ensure that the proposed action is not likely to jeopardize the continued existence of the species and that the project proponent minimizes and mitigates the effect of any permitted taking to the maximum degree practicable. One HCP for the Santa Barbara County DPS of the California tiger salamander currently under development is for the removal of the Laguna Sanitation District's soil stockpile, and operations and maintenance activities.

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[1]USFWS regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. We define harassment as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Incidental take refers to taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the "take" of federally endangered and threatened wildlife.

Clean Water Act

Under section 404 of the Clean Water Act, the U.S. Army Corps of Engineers (Corps) regulates the discharge of dredged or fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). However, recent Supreme Court rulings have called this definition into question. On June 19, 2006, the U.S. Supreme Court vacated two district court judgments that upheld this interpretation as it applied to two cases involving "isolated" wetlands. Currently, Corps regulatory oversight of such wetlands (e.g., vernal pools) is in doubt because of their "isolated" nature. In response to the Supreme Court decision, the Corps and the U.S. Environmental Protection Agency have released a memorandum providing guidelines for determining jurisdiction under the Clean Water Act. The guidelines provide for a case-by-case determination of a "significant nexus" standard that may protect some, but not all, isolated wetland habitat (USEPA and USACE 2007). Although the overall effect of the new permit guidelines on loss of isolated wetlands is not known at this time, it is likely that the Corps has less authority to regulate the placement of dredged or fill material in isolated waters than previously.

<u>California State Regulations</u>

California Environmental Quality Act (CEQA)

Section 15065 of the California Environmental Quality Act (CEQA) requires a finding of significance if a project has the potential to ''reduce the number or restrict the range" of a rare or endangered plant or animal. 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). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of habitat that supports listed or rare species.

The County of Santa Barbara is the lead agency responsible for implementing the CEQA process for projects within unincorporated portions of the County. The conservation benefit that is achieved for listed or rare species through CEQA process is dependent upon the discretion of the agency involved, and has not been consistent. For instance, although the County is required to consider listed species when permitting development actions under CEQA, they often defer the responsibility of CEQA and Act compliance to the landowners. At times, landowners have not contacted the USFWS, which results in many such projects being carried out without USFWS input or awareness. Thus, these projects miss the opportunity to engage the USFWS for recommendations in the early stages of project planning to meet project objectives as well as the requirements of the Act.

California Department of Fish and Game Code

Since the listing under the Act in 2000, the USFWS has worked with CDFW to prohibit the sale of "waterdogs" (non-native tiger salamanders of the genus *Ambystoma*) as bait and pets. In October of 2014, the California Fish and Game Commission passed an amendment to Title 14 of the California Code of Regulations (§ 200.31) making it clear that any possession of non-native tiger salamanders is illegal, and removing a previous loophole that had allowed their use as fish bait (State of California Office of Administrative Law 2014). With this recent amendment, this regulation is no longer considered inadequate.

California Endangered Species Act (CESA)

The California tiger salamander is listed by the State of California as threatened throughout its range and is protected under the California Endangered Species Act (CESA) (California Fish and Game Code, section 2080 et seq.). CESA prohibits the unauthorized "take" (as defined in Fish and Game Code) of State-listed threatened or endangered species and requires State agencies to mitigate for any adverse impacts to the species or its habitat. The California tiger salamander was not listed by the State until 2010; since then, local agencies have included consideration of California tiger salamanders as a state-listed species during review of projects they permit.

<u>Local Regulations</u>

County of Santa Barbara

The County is the lead agency responsible for implementing the CEQA process for projects within unincorporated portions of the County (see CEQA discussion above). In addition, land use planning is guided by the County's comprehensive plan (Santa Barbara County Planning Department 2014), along with a series of more specific Area Plans. Together, the comprehensive plan and area plans prescribe guidelines for land use, including those for specific elements such as conservation, environmental resources management, and open space.

Depending on how parcels are zoned for land use and how much area is affected by an individual action, certain agricultural land conversions do not require discretionary permits from the County of Santa Barbara (B. Gillette, County of Santa Barbara, pers. comm. 2007) and may not be required to consider impacts to California tiger salamanders or their habitat under CEQA or CESA. For instance, under the Santa Barbara County Code, the grading ordinance currently provides for "protection and conservation and the promulgation of safe and environmentally sane earthwork practices," and exempts agriculturally associated earthwork from the ordinance (Santa Barbara County 2014). A clause within the ordinance specifically states that "any grading where there is potential for significant environmental damage" is not exempt (Santa Barbara County 2014). However, clear definitions of what constitutes "significant environmental damage" are lacking in the ordinance, limiting the County's ability to analyze the effects of the agricultural grading occurring in the county. Additionally, because of recent and ongoing legal challenges to the County of Santa Barbara's authority of the ordinance, the County does not routinely enforce the "significant environmental damage" clause of its grading ordinance. Therefore, removal of habitat through unchecked agricultural grading continues to be a primary threat to the Santa Barbara County California tiger salamander.

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

As identified in the listing rule, several other factors, including hybridization with, and competition from, introduced species; vehicle-strike mortality; and contaminants are threats to the Santa Barbara County DPS of the California tiger salamander and its aquatic and upland habitats. In addition, we now recognize that other factors, including climate change and drought, are also threats.

<u>Hybridization</u>

Larval and adult individuals of the non-native tiger salamander (*A. tigrinum mavortium*) were widely sold as fish bait (waterdogs) in California during the past century, and a number of populations of the non-native species have become established in the State, some within the range of the California tiger salamander. Non-native tiger salamanders can have negative effects on California tiger salamander populations through hybridization, resulting in loss of genetically pure native salamanders (Shaffer et al. 1993, Riley et al. 2003). Non-native tiger salamanders are present at the Lompoc Federal Penitentiary grounds in Santa Barbara County (outside of but near the California tiger salamander's range), and a hybrid was discovered at a site in the Purisima Hills metapopulation in 2009; which is the closest metapopulation to the penitentiary. The potential loss of any metapopulations of the Santa Barbara County DPS of the California tiger salamander to hybridization is a serious threat.

Several studies of the Central DPS of the California tiger salamander have shown the extent of the threat of hybridization to the species. The extent of genetic mixing between native and non-native tiger salamanders can depend on the type of breeding habitat, as significantly more pure native genotypes were found in one study in vernal pools as compared to artificial ponds (Riley et al. 2003). Non-native alleles (alternate forms of a gene) typically predominate in perennial ponds, suggesting that the life history traits of non-native tiger salamanders give them an advantage in perennial ponds (Fitzpatrick and Shaffer 2004, 2007a). Once California tiger salamanders and hybrids co-occur in the same environment, however, time to metamorphosis is delayed in California tiger salamanders, eliminating their natural ability to compete based on early metamorphosis alone (Ryan et al. 2009, 2013). Further information regarding California tiger salamanders and hybridization with non-native tiger salamanders elsewhere in California is available in Johnson et al. (2010 a, b, 2011), Fitzpatrick et al. (2009, 2010), and Fitzpatrick and Shaffer (2007b).

Competition

Introduced species also can have negative effects on California tiger salamander populations through competition (Shaffer et al. 1993). Competition with non-native tiger salamanders can reduce metamorphic size and lengthen time to metamorphosis in California tiger salamanders (Ryan et al. 2009), which can increase desiccation and predation risk as well as competitive ability (Trenham et al. 2000). Therefore, when competing with non-native tiger salamanders and hybrids in ponds, California tiger salamanders are at a distinct disadvantage (Ryan et al. 2009).

Competition from fish that prey on mosquito larvae and other invertebrates can reduce the survival of salamanders. Both California tiger salamanders (Stebbins 1962, Anderson 1968, Holomuzki 1986) and mosquitofish feed on microinvertebrates and macroinvertebrates. Large numbers of mosquitofish may out-compete California tiger salamander larvae for food (Graf and Allen-Diaz 1993). The introduction of other fish inadvertently (e.g., fathead minnow; P. Collins, Santa Barbara Museum of Natural History, pers. comm. 1999), for recreational fishing (e.g., largemouth bass, green sunfish; Sweet, pers. comm. 1999), or other purposes may also affect the prey base, reducing survival and growth rates of salamanders.

Vehicle-strike Mortality

Vehicles on roads contribute to direct mortality of Santa Barbara County California tiger salamanders. Salamanders are at risk of being run over by vehicles on their first dispersal as juveniles away the pond, and on future migrations to and from the ponds for breeding, accelerating metapopulation fragmentation through increased mortality and preventing recolonization of sites that would otherwise be only temporarily extirpated (Trombulak and Frissell 2000).

In the East Santa Maria metapopulation, California tiger salamanders are frequently seen crossing Dominion, Foxen Canyon, and Orcutt-Garey Roads on rainy nights during breeding migrations. More than 50 percent of these observations include California tiger salamanders that are dead or dying from vehicle strikes (A. Abela et al., unpublished data). California tiger salamanders most often impacted by vehicle strikes are adults making breeding migrations in breeding condition. Thus, particularly in metapopulations that are already compromised by other factors, road morality threatens the viability of the Santa Barbara County DPS of the California tiger salamander.

<u>Contaminants</u>

Amphibians are extremely sensitive to pollutants, such as pesticides and other chemicals, due to their highly permeable skin, which can rapidly absorb pollutant substances (Blaustein and Wake 1990). Toxins at lower than lethal levels may cause abnormalities in larvae and behavioral anomalies in adults, both of which could eventually lead to mortality (Hall and Henry 1992, Blaustein and Johnson 2003). Pesticides may reduce or eliminate the prey base, increasing the rate of starvation in California tiger salamanders. Sources of chemical pollution that may threaten California tiger salamanders include hydrocarbon and other contaminants from the application of chemicals for agricultural production, burrowing animal control, oil production, and road runoff (Service 2009). Although there is some evidence that some amphibians may be affected when they come into secondary contact with chemicals (such as pesticides on crops applied to the habitat during the migration and dispersal seasons) (Sparling et al. 2001), Davidson et al. (2001, 2002) found no significant overall relationship between upwind agriculture and the California tiger salamander's decline. While this indicates that long-distance spread of agricultural pesticides may not be a significant threat to California tiger salamanders, there is evidence that commonly used pesticides do have negative, measurable effects on amphibians in direct contact with them (Service 2009).

Rodenticides, widely used in Santa Barbara County (PAN Pesticides Database – California Pesticide Use 2005), can be absorbed through the skin and are considered toxic to fish, birds, and other wildlife (Tasheva 1995, Salmon and Schmidt 1984). Given the permeable nature of amphibian skin, California tiger salamanders that come into contact with rodenticides are likely harmed.

New technologies for extracting oil from shale that underlies most of Santa Barbara County have significantly increased the number of oil extraction operations in the county in recent years (Santa Barbara County Planning and Development 2013). Oil sump ponds may act as toxic sinks, attracting salamanders seeking breeding sites. Oil and other contaminants in runoff from roads have been detected in adjacent ponds, and have been linked to die-offs of and deformities in California tiger salamanders and spadefoot toads, and die-offs of invertebrates that form most of both species' prey base (Sweet 1993). Several known breeding ponds occur along secondary roads and highways in northern Santa Barbara County and may be threatened by oil and other contaminants from road runoff.

A commonly used method to control mosquitoes, including in Santa Barbara County (California Department of Pesticide Regulation 2007), is the application of methoprene, which increases the level of juvenile hormone in insect larvae and disrupts the molting process, causing death. Because the success of many aquatic vertebrates (including California tiger salamanders) relies on an abundance of invertebrates in temporary wetlands, any delay in insect growth could reduce the numbers and density of available prey for California tiger salamanders (Lawrenz 1984-1985). Although in one study, methoprene did not cause increased mortality of gray treefrog (*Hyla versicolor*) tadpoles (Sparling and Lowe 1998), it did cause reduced survival rates and increased malformations in northern leopard frogs (*Rana pipiens*) (Ankley et al. 1998) and increased malformations in southern leopard frogs (*R. utricularia*) (Sparling 1998). Exposure to methoprene has also been correlated with delayed metamorphosis and high mortality rates in northern leopard frogs and mink frogs (*R. septentrionalis*) (Blumberg et al. 1998). Specific studies have not been conducted on the effects of methoprene on the Santa Barbara County DPS of the California tiger salamander; however, the effects documented on other amphibian species and its application in Santa Barbara County do not allow us to rule it out as a threat to the species.

A bacterium, *Bacillus thuringiensis israeli* (Bti), is also used in Santa Barbara County for mosquito control (City of Santa Barbara 2007). Bti reportedly does not affect insects other than larvae of mosquitoes and blackflies, but research does not indicate which insects have been tested (Federation of BC Naturalists 2003). Its effects on salamander prey base have not been quantified. Because of a lack of information regarding which mosquito control methods are used and where, and about the bacterium's effects on salamanders, the degree to which the practices pose a threat to California tiger salamanders in Santa Barbara County cannot be determined at this time.

Drought and Climate Change

Climate variability, such as fluctuations between wet and dry periods, is part of natural processes; however, climatic models suggest that much of the recent trends in climate are driven by anthropogenic causes, and models indicate that these trends are likely to continue into the future (Barnett et al. 2008).

Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2014). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) under a lower emissions scenario, and by up to 8.1 degrees Fahrenheit (4.5 degrees Celsius) under a higher emissions scenario (Cayan et al. 2008). Because of the diversity of California's landscape, however, it is unknown at this time what effect (e.g., changes in precipitation, number and severity of storm events) increasing temperatures will have at the local level.

Global amphibian declines have been increasingly attributed to factors resulting from global climate change over the last decade (Corn 2005, Wake 2007, Reaser and Blaustein 2005). Factors such as epidemic disease (Pounds et al. 2006), changes in breeding phenology (Terhivuo 1988; Gibbs and Breisch 2001; Beebee 1995), changes in environmental conditions such as leaf litter (Whitfield et al. 2007), increased evaporation rate (Corn 2005, but see Pyke and Marty 2005), increased frequency of storm events and drought (Kagarise-Sherman, and Morton 1993) and ultraviolet radiation (Blaustein et al. 1998) have been identified as dynamics that can affect amphibian persistence. Diseases, such as the amphibian chytrid fungus, may become more virulent in changing climatic conditions (Pounds et al. 2006). Warmer temperatures have been linked to earlier breeding in some amphibians (Blaustein et al. 2001, Beebee 1995). Changes to the hydroperiod of ephemeral ponds due to changing weather patterns have significant implications for the diversity of amphibians that rely on those ponds for breeding (Corn 2005). Ultraviolet radiation has been shown to have negative effects on amphibian eggs and embryos around the world (Blaustein et al. 1998).

While it appears reasonable to assume that California tiger salamanders may be affected by factors resulting from climate change, it is difficult to predict how such climatic changes will affect the Santa Barbara County DPS of the California tiger salamander. Because California experiences highly variable annual rainfall events and droughts, environmental conditions for California tiger salamander breeding and metamorphosis are not consistent. In years of drought, some pools/ponds may not fill at all. Breeding migrations and breeding events are dependent on weather. A lack of rain results in the temporal loss of vernal pools and can result in the degradation of complexes of long-lasting pools that provide important breeding habitat. Droughts may occasionally preclude reproductive success at a given pond; therefore, maintaining connectivity between ponds is important for the long-term viability of the Santa Barbara County California tiger salamander. In addition to direct climatic effects on habitat, warmer temperatures are associated with increased locomotor performance of hybrids, suggesting that increased temperatures may translate to increased movement of the "hybrid swarm" (hybrid population with interbreeding between hybrid individuals and its parent types) of non-native tiger salamander alleles through the landscape (Johnson et al. 2010a).

H. Past Conservation Efforts

Species-specific Research and/or Grant-supported Activities

Most of the known and potential California tiger salamander breeding ponds and surrounding upland habitats in Santa Barbara County occur on private lands, necessitating compatible land stewardship from private property owners, rather than public entities that can preserve and manage the habitat as a public resource. Through cooperative agreements, USFWS has allocated grant money for at least two projects that have improved California tiger salamander habitat in Santa Barbara County. One project received $4,000 for berm repair in 2006 to prevent the sedimentation of a vernal pond, which at the time was a potential California tiger salamander breeding pond (USFWS 2006). Since the project was implemented, California tiger salamander breeding has been discovered at the pond. Another project was provided approximately $2,500 for the restoration of an eroding hillside, protecting a California tiger salamander breeding pond from the threat of sedimentation (USFWS 2001).

The County of Santa Barbara led an effort to create a regional conservation strategy from March 2006 through March 2008. The USFWS participated in monthly meetings with a steering committee to develop the plan, and the County committed staff and funding to the effort. The USFWS allocated approximately $267,000 in habitat conservation planning funds via section 6 of the Act (USFWS 2007a) for this project. The USFWS allocated an additional $10,000 for a facilitator to build consensus among the diverse group of stakeholders working on the plan and maintain focus on the project. The County chose to discontinue the regional plan process in March 2008, and funds for both grants were returned to the USFWS unused (Becky Miller, pers. comm., 2009).

In 2007, the USFWS provided $491,000, through section 6 of the Act via the Cooperative Endangered Species Conservation Fund, to purchase conservation easements over California tiger salamander breeding ponds and their uplands in the Purisima Hills metapopulation.

Approximately $215,275 of this grant was used to purchase the development rights on 539 acres (218 hectares) of potential upland and aquatic California tiger salamander habitat within the Purisima Hills metapopulation; 60 of these acres (24 hectares) fall within Unit 5 of the designated critical habitat for the Santa Barbara County DPS of the California tiger salamander (USFWS 2007b).

In 2001, a University of California Santa Barbara student was awarded $18,146 from the USFWS to study California tiger salamander upland habitat use at the Santa Maria Airport. This study provided information about the dispersal habits, abundance, and upland habitat use of California tiger salamanders in this portion of the West Santa Maria metapopulation (critical habitat unit 1) (Sykes 2006).

In 2009, the USFWS funded $39,000 for non-native tiger salamander eradication in Santa Barbara County. Property access restrictions limited the number of new ponds that could be sampled. Additionally, previously collected samples were re-analyzed with novel molecular techniques and the regions of known and potential occurrence of hybrids and non-native tiger salamanders were mapped (Hunt 2012).

In 2014, the USFWS awarded $137,333 to CDFW through section 6 of the Act, to conduct a non-native tiger salamander research and eradication study for the region where hybridization has been documented in Santa Barbara County. In coordination with local nonprofit organizations, biologists will work with local landowners on properties that may be occupied by non-native tiger salamanders and develop cooperative agreements to access the properties for hybrid and non-native tiger salamander eradication.

<u>Conservation banking</u>

The La Purisima Conservation Bank, located in the Purisima Hills metapopulation, was approved by USFWS and CDFW in March 2014. This bank sells credits to offset impacts from projects that result in the loss of California tiger salamander habitat. The habitat in the bank is protected by a perpetual conservation easement on over 853 acres of California tiger salamander habitat and has a funding mechanism for the perpetual management of the habitat and California tiger salamander population within the bank (Adams 2014).

<u>Other Cooperative Conservation Efforts</u>

Rangeland experts, academia, and the Alameda Resource Conservation District recently collaborated to produce the publication *Managing Rangelands to Benefit the California Red-Legged Frog and California Tiger Salamander* (Ford et al. 2013), which was partially funded by the USFWS. This document uses the best available science to provide guidelines for managing rangelands that support or have the potential to support California red-legged frogs and California tiger salamanders range wide. The document also provides suggestions for integrative grazing management to benefit these two species while aligning with other goals for conservation and production on rangelands.

In 2012, the USFWS issued a programmatic biological opinion to the Natural Resources Conservation Service (NRCS) for activities conducted in Santa Barbara County. The biological opinion exempts “take” (as defined in section 3(19) of the Act) of California tiger salamanders and California red-legged frogs for agricultural improvement projects funded by NRCS that also benefit these species. Permit programs such as these aim to encourage private landowners to implement voluntary conservation by streamlining the permitting process when listed species could be impacted during the construction of a project with a net benefit to listed species.

II. Recovery Program

A. Recovery Priority Number

The recent 5-year status review of the Santa Barbara County DPS of the California tiger salamander changed the recovery priority number to 3C (USFWS 2009), indicating that the DPS has a high potential for recovery, and a high degree of threat. The "C" in the recovery priority number indicates that conflict exists with "construction or other development projects or other forms of economic activity" (USFWS 1983).

B. Recovery Strategy

The range of the Santa Barbara DPS of the California tiger salamander is naturally restricted to Santa Barbara County in southern California. The species is further constrained by inhabiting seasonal wetlands (such as vernal pools) that have suffered extensive destruction and fragmentation, resulting in loss of habitat and isolation of metapopulations. The most significant threat to the Santa Barbara County DPS of the California tiger salamander continues to be destruction, alteration, and fragmentation of habitat for agricultural and urban uses. Additional threats include hybridization with non-native tiger salamanders that have been introduced to the native species' range, predation and competition from non-native species, vehicle-strike mortality, and lack of regulatory compliance over habitat loss and alteration. Finally, other potential threats to the species include contaminants, disease, and drought and climate change.

The strategy to recover the Santa Barbara County DPS of the California tiger salamander focuses on alleviating the threat of habitat loss and fragmentation in order to increase population resiliency (i.e., ensure a large enough population to withstand stochastic events) and redundancy (i.e., a sufficient number of populations to ensure the species can withstand catastrophic events). We think that recovery of this species could be achieved through the conservation of remaining aquatic and upland habitat that provides essential connectivity, reduces fragmentation, and sufficiently buffers against encroaching development. Appropriate management of these conserved areas would also reduce mortality by addressing non-habitat related threats. Habitat restoration and creation to achieve proper functioning of some of these wetland complexes may be necessary to ensure stable and well-distributed populations. Research and monitoring should be undertaken to determine the extent of other threats and reduce them to the extent possible, including those from non-native and hybrid tiger salamanders and other non-native species, vehicle-strike mortality, contaminants, disease and climate change.

Because the majority of the habitat for the Santa Barbara County California tiger salamander is on privately-owned lands, habitat-based conservation efforts will require the cooperative efforts of many entities, both local agencies and private partners, and will play an important role in achieving suitable and sustainable habitat necessary for the recovery of the species. This will require extensive outreach and education programs to ensure public and private support. This recovery strategy is intended to support and produce self-sustaining metapopulations of the Santa Barbara County DPS of the California tiger salamander that maintain its geographic distribution through habitat-based conservation efforts and the reduction of threats.

C. Recovery Goal

The goal of this draft recovery plan is to sufficiently reduce the threats to the Santa Barbara County DPS of the California tiger salamander to ensure its long-term viability in the wild, and allow for its removal from the list of threatened and endangered species. The interim goal is to recover the population to the point that it can be downlisted from endangered to threatened status.

D. Recovery Objectives and Criteria

RECOVERY OBJECTIVES

1. Protect and manage sufficient habitat within the metapopulation areas to support long-term viability of the Santa Barbara County DPS of the California tiger salamander.
2. Reduce or remove other threats to the Santa Barbara County DPS of the California tiger salamander.

RECOVERY CRITERIA

Downlisting may be warranted when the recovery criteria below have been met in a sufficient number of metapopulation areas such that the Santa Barbara County DPS of the California tiger salamander exhibits increased resiliency and redundancy to prevent endangerment in the foreseeable future.[2]

Delisting may be warranted when the recovery criteria have been met in a sufficient number of metapopulation areas to support long-term viability of the Santa Barbara County DPS of the California tiger salamander.[3]

In developing the recovery criteria, we used information and analyses obtained from California tiger salamander researchers. Dr. Chris Searcy, University of Toronto, provided an analysis and explanation on the necessary number of ponds and upland habitat area to support minimum viable population sizes (Appendix A). Dr. H. Bradley Shaffer, University of California, Los Angeles, provided an analysis and explanation on the monitoring of effective population size (N_e) (Appendix B). We have adopted these appendices as bases for our recovery criteria.

Criteria:

1. At least four functional breeding ponds[4] per metapopulation area are in fully preserved status and managed for the benefit of the Santa Barbara County DPS of the California

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[2] We presently believe that the recovery criteria must be met in three metapopulation areas for downlisting to be warranted; further research and monitoring should clarify the exact number of metapopulations necessary.
[3] We presently believe that the recovery criteria must be met in all six metapopulation areas for delisting to be warranted; further research and monitoring should clarify the exact number of metapopulations necessary.
[4] The average size of known breeding ponds in Santa Barbara County is 1.47 acres, so four ponds with this size are required to preserve a minimum viable population for each metapopulation based on calculations in Appendix A. In metapopulation areas where ponds are smaller than 1.47 acres, more than 4 ponds may be needed to support the minimum viable population size since effective population size is related to pond area.

tiger salamander.[5] Ponds should have pool depths ranging between 15.75 and 31.5 inches (40-80 centimeters) with first priority being preservation of ponds, followed by restored or created ponds. (addresses Factor A threats).

2. A minimum of 623 acres (252 hectares) of functional upland habitat around each preserved pond (see criteria 1) is in fully preserved status[6]. This functional upland habitat area may overlap with the functional upland habitat around adjacent ponds (addresses Factor A threats).
3. Adjacent to the fully preserved ponds (see criteria 1) and fully preserved upland habitat (see criteria 2), a minimum of 1,628 acres (659 hectares) of additional contiguous, functional upland habitat is present,[7] which is at least 50 percent unfragmented[8] and partially preserved.[9] This additional contiguous habitat area may overlap with the functional upland habitat around adjacent ponds (addresses Factor A threats).
4. Effective population size (N_e) in the metapopulation (see Appendix B) shows an overall positive trend across 10 years [10] (addresses Factor A, C, and E threats).
5. Management is implemented to maintain the preserved ponds (see criteria 1) free of non-native predators and competitors (e.g., bullfrogs and fish) (addresses Factor C and E threats).
6. Risk of introduction and spread of non-native genotypes is reduced to a level that does not inhibit normal recruitment and protects genetic diversity within and among metapopulations (addresses Factor E threats). [11]
7. The effects of vehicle-strike mortality have been minimized to a level that does not threaten viability and protects connectivity within metapopulations including providing means for effective migration and dispersal in a roadway-impacted landscape (addresses Factor E threats).[12]

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[5] Fully preserved status is either: (1) owned in fee title by an agency or conservation organization; or, (2) privately-owned lands protected in perpetuity with conservation easements. These lands must have funding secured for long-term management and monitoring.

[6] The area of functional upland habitat (623 acres) is derived from recent estimates of area to support approximately 75% of a California tiger salamander population (Central DPS) (see Appendix A).

[7] The area of this additional functional upland habitat (1628 acres) supporting the 25% of the population most distant from the pond, combined with the fully protected habitat (623 acres) supporting 75% of the population, is estimated to support approximately 95% of tiger salamander population (see Appendix A).

[8] If California tiger salamanders can select specific functional habitat, then this level of fragmentation can still support the 25% of the population most distant from the pond. Further research and monitoring are needed to determine the efficacy of this model (and adjust it up or down, accordingly).

[9] Partially preserved lands refer to areas with land uses that are compatible with successful growth and survival of juveniles and adults, but may not necessarily be fully protected.

[10] Ten years of monitoring is required to encompass two full generational cycles (California tiger salamanders reach sexual maturity at approximately 4-5 years) and to encompass a range of climatic and other unpredictable factors.

[11] This requires early detection of non-native phenotypes (i.e., paedomorphic, breeding individuals that remain aquatic, or hybrid-appearance individuals) and subsequent genetic assessment. Further research and monitoring are needed to determine the level of risk from hybridization which does not threaten long-term population viability.

[12] Further research and monitoring are needed to determine the level of mortality from vehicle-strikes that does not threaten population viability and protects connectivity within metapopulations.

III. Recovery Action Narrative

The actions identified below are those that, in our opinion, are necessary to bring about the recovery of the Santa Barbara County DPS of the California tiger salamander, and ensure the long-term conservation of the species. However, these actions are subject to modification as dictated by new findings, changes in species status, and the completion of other recovery actions. Each action has been assigned a priority according to our determination of what is most important for the recovery of the species based on the life history, ecology, distribution, abundance, and threats (see the Background section of this document) and the following definitions of the priorities:

Priority 1: An action that must be taken to prevent extinction or to prevent a species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline of the species population/habitat quality or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

The following Recovery Action Narrative provides details of the actions necessary to achieve full recovery. Actions are laid out in an outline format that starts with an overarching recovery action, and "steps down" to more specific recovery actions. The "stepped down" actions are discrete actions that can be funded, permitted, or carried out independently.

1. Protect and manage habitat for the Santa Barbara County California tiger salamander.

Nearly all populations of the Santa Barbara County California tiger salamander occur on private lands. Suitable habitat for each of the California tiger salamander metapopulations should be secured and protected (as specified in the Recovery Objectives and Criteria) through mechanisms such as land acquisition, acquisition of property rights or fee title purchase (i.e. development rights), open space and conservation easements, and conservation agreements. The presence of aquatic breeding habitat is essential to the species, and preservation of natural vernal pools and seasonal ponds is the highest priority, followed by preservation of man-made ponds. This protection is necessary to prevent further declines in distribution and abundance of the Santa Barbara County DPS of the California tiger salamander.

Open space and conservation easements provide a method to acquire specific property rights needed to conserve biological resources and physical or scenic characteristics of the land. These easements offer the landowner an economic incentive of reduced property taxes while, in many circumstances, the landowner can continue to use the land in the ways prior to the easement. Easements may be accepted by the State, cities, counties, or nonprofit organizations whose primary purpose is to preserve and protect land in its natural condition.

When prioritizing parcels of California tiger salamander habitat for protection, we consider not only prior use of the habitat by the species, but also current and likely future threats to the species. Sites where major threats cannot be abated, even after placed under protection, are of limited value for recovery of this species. Upland and aquatic habitat, once protected, may require further management efforts, such as the retirement of a current intensive agricultural practice, to retain habitat characteristics important for California tiger salamander survival.

USFWS should consult with the Planning Departments for the County of Santa Barbara and Cities of Santa Maria and Los Alamos regarding opportunities for conservation easements and acquisition.

The following Recovery Actions will assist in the recovery of the Santa Barbara County DPS of the California tiger salamander by protecting habitat and restoring or enhancing habitat, reducing threats and facilitating informed management where necessary. This will ensure that viable metapopulations of Santa Barbara County DPS of the California tiger salamander are protected throughout the species' range.

1.1 **Permanently protect Santa Barbara County California tiger salamander breeding ponds and their adjacent uplands (see Recovery Criteria 1, 2, 3) through acquisition and conservation easements.[13] (Priority 1)**

Maintain a sufficient extent of current upland and aquatic breeding habitat through conservation easements or other land protection. In all instances, secure funding for long-term management and monitoring through an endowment or other funding mechanism, and protect the species from incompatible uses through long-term conservation agreements with landowners. Preserve metapopulation dynamics within and between management units through adequate protection of aquatic and upland habitat. The USFWS and CDFW should solicit private landowner participation and support for recovery, establish open space or conservation easements by the property owner, establish permanent resource management easements, or acquire lands through fee acquisition from willing sellers.

Land purchase could be made through an existing land trust. Fee title ownership includes obtaining all property rights. This acquisition can be accomplished by fee, simple purchase, dedication, complete donation, exchange, or transfer from one agency to another. The fee title method of land preservation provides control over land use and avoids potential problems associated with partial ownership or rights to access, water, or minerals.

1.2 Develop management plans for protected California tiger salamander habitats. (Priority 1)

[13] Areas will be owned in fee title by a government agency or other organization and managed in a manner that promotes Santa Barbara County California tiger salamander conservation. All sizes of conservation easements and other acquisitions pursuant to action 1.1 will be derived from the recovery criteria.

Develop management plans at each protected area of California tiger salamander aquatic and upland habitat. Include descriptions of on-the-ground activities necessary to maintain and/or restore California tiger salamander aquatic and upland habitat. These plans should include strategies to abate threats such as non-native tiger salamanders, other non-native predators, small mammal eradication programs, pesticides, and sedimentation. If new threats are identified or other new information becomes available affecting California tiger salamander recovery, management plans should be re-evaluated and revised so that abatement of those threats can be addressed. USFWS should review management plans as they are being developed and approve final management plans.

1.3 Develop a Regional Habitat Conservation Plan or Conservation Strategy for the County of Santa Barbara and the City of Santa Maria. (Priority 1)

The County of Santa Barbara initiated a regional conservation strategy for the California tiger salamander, but they discontinued their efforts in 2008, citing insufficient resources To ensure that lands in northern Santa Barbara County are appropriately managed for recovery of the California tiger salamander, a regional HCP or Conservation Strategy should be developed that will take into account future effects of agricultural and urban development within the range of the California tiger salamander. This would provide landowners with an opportunity to obtain incidental "take" (as defined in the section 3(19) of the Act) coverage for ground-disturbing activities in areas covered by the HCP through the County or City permitting processes, while ensuring that impacts to California tiger salamanders are appropriately mitigated. This will also ensure that conservation areas and mitigation for impacts are planned on a landscape scale to achieve the most recovery benefit for the species. Such a plan must provide for adequate conservation of upland and breeding habitat to mitigate the effects of County-permitted development on the California tiger salamander and its habitat.

1.4 USFWS and local jurisdictions work together to improve and implement procedures to ensure activities permitted by local jurisdictions do not result in impacts or negative effects to California tiger salamanders and receive proper authorization from USFWS and CDFW. (Priority 1)

These procedures will include agreed-upon protocols for how the City of Santa Maria and County of Santa Barbara, among others, would process permits for projects that could impact or affect California tiger salamanders, and how notification of these activities would be provided to USFWS and CDFW prior to City or County approvals.

We recommend that the County of Santa Barbara revise its grading exemption for agricultural activities[14] that do not result in "significant environmental damage" so that agricultural conversion or other grading activities that fall within the range of the California tiger salamander would not be exempt from the discretionary permit process without review pursuant to the Act or CESA.

1.5 Develop a Safe Harbor Agreement(s) or obtain financial incentives for landowners to maintain vernal pools/stock ponds in California tiger salamander habitat. (Priority 1)

USFWS should: work with local jurisdictions such as resource conservation districts (RCDs) and city and county governments to inform landowners of conservation measures that are available to them, such as Safe Harbor Agreements for stock pond maintenance in California tiger salamander habitat; work with landowners to develop Safe Harbor Agreements and/or programmatic Safe Harbor Agreements, as appropriate; and assist private landowners in their efforts to obtain economic incentives for maintaining vernal pools and/or stock ponds and working towards the recovery of the California tiger salamander.

1.6 Reduce burrowing animal control in California tiger salamander habitat. (Priority 2)

Reduce California ground squirrel and Botta's pocket gopher eradication efforts deemed to threaten California tiger salamander on protected lands, and other areas as feasible. Limited, localized, small mammal eradication efforts may occur if deemed necessary for livestock safety (such as around watering troughs or other areas determined to have high livestock use) or flood risk management (such as along levees), provided the eradication efforts do not decrease California tiger salamander populations.

In coordination with the NRCS, RCDs, and Regional Water Quality Control Board (RWQCB), develop a plan to reduce the use of rodenticides in areas within migration and dispersal distances of California tiger salamander habitat and successfully implement for a minimum of 10 years.

1.7 Assess all protected habitat areas for contaminants. (Priority 2)

If contaminants are present, conduct research to determine if contaminants are a threat to California tiger salamander metapopulations. If contaminants are determined to be a threat to a California tiger salamander metapopulation (i.e., the metapopulation may not be sustainable because of contaminants)

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[14] The Santa Barbara County grading ordinance currently provides for "protection and conservation and the promulgation of safe and environmentally sane earthwork practices," and exempts agriculturally associated earthwork from the ordinance (Santa Barbara County 2014). The code specifically states that "any grading where there is potential for significant environmental damage" is not exempt (Santa Barbara County 2014).

then a site-specific plan should be created to ensure that the contaminant threat is resolved.

1.8 Manage sedimentation to protect California tiger salamander breeding ponds. (Priority 2)

Manage sediment to ensure that agricultural grading near California tiger salamander breeding ponds does not create runoff that results in sedimentation of ponds. This should be done through the development and implementation of sedimentation control strategies in coordination with local jurisdictions, including the Santa Barbara County Agricultural Commissioner, NRCS, RWQCB, and local landowners. If necessary, install berms to halt or prevent sedimentation of ponds or other appropriate sediment control measures.

2. Restore and maintain habitat for the Santa Barbara County California tiger salamander, and reduce vehicle-strike mortalities and barriers to dispersal from roads.

2.1 Restore and enhance California tiger salamander habitats.

Lands managed for the benefit of the California tiger salamander should undertake activities to restore upland habitat of the California tiger salamander. Such activities include, but are not limited to, voluntary replacement of crops with native grassland or scrub (see Wang et al. 2009) and instituting low-intensity grazing or mowing in lieu of ground-disturbing activities such as tilling, deep ripping, or grading.

If a breeding pond was historically ephemeral but converted through human-caused activities to become perennial, the breeding pond should be restored back to ephemeral to the extent feasible.

USFWS should work with private landowners, providing them with technical assistance in the development of restoration strategies on their lands.

Although there are many opportunities for upland habitat restoration throughout the range of the Santa Barbara County California tiger salamander, we recommend the following areas for restoration:

2.1.1 East Santa Maria Metapopulation Area: Restore pools SISQ-9E and SISQ-9W; maintain connectivity between pool SAMA-1 (Figure 3) and the known California tiger salamander breeding ponds and pools to the east, including the creation of a minimum of three additional functioning breeding ponds. (Priority 1)

2.1.2 Santa Rita Metapopulation Area: Restore upland habitat on the south side of Highway 246 opposite of LOAL-2W and LOAL-2E (Figure 5). (Priority 1)

2.1.3 Restore aquatic habitat. (Priority 1)

Restore aquatic habitat, which may involve excavation of vernal wetlands to their former (pre-modern) size and shape, and the planting of native grassland and vernal wetland plants.

Within protected habitat areas, the USFWS and CDFW's decision of whether or not sites should be restored to natural vernal wetland habitat should be based primarily on the following criteria: (1) the historical natural condition of the site (if possible to ascertain), and (2) the habitat and hydrology needs of the California tiger salamanders in that recovery area.

2.1.4 Restore upland habitat. (Priority 1)

Many upland areas have been heavily impacted by agricultural land conversion. Some upland areas can be restored to improve both dispersal and upland habitat for the Santa Barbara County California tiger salamander. This will usually involve reverting land back to grazing and other non-ground disturbing land uses, such as passive recreation.

2.1.5 Work with private landowners in habitat restoration efforts. (Priority 1)

Provide technical assistance and funding to private landowners for the restoration and/or enhancement of California tiger salamander habitat. Develop cooperative agreements with willing landowners to protect California tiger salamander habitat on private lands. Work with USFWS Partners for Fish and Wildlife Program and NRCS EQIP, WHIP, and other programs to provide funding for restoration and enhancement projects to benefit California tiger salamanders.

2.2 Develop and implement guidance for land use and habitat maintenance for each California tiger salamander metapopulation.

2.2.1 Develop and implement habitat maintenance guidelines for California tiger salamander breeding ponds in each metapopulation area. (Priority 2)

2.2.2 Develop and implement land use guidelines for California tiger salamander breeding ponds in each metapopulation area. (Priority 2)

2.2.3 Follow grazing best management practices to prevent degradation of California tiger salamander habitats. (Priority 3)

Cattle grazing is the agricultural land use most compatible with California tiger salamander conservation. However, significant disturbance can occur to vernal pool landscapes and California tiger salamanders under poor grazing management. Grazing species, livestock density, and time of grazing are important items for consideration in managing for California tiger salamander conservation[15].

2.2.4 Restrict the use of pesticides and other environmental contaminants that are known to be or are likely to be harmful to California tiger salamanders. (Priority 2)

Coordinate with EPA to inform the USFWS, NRCS, CDFW, and other land management or regulatory agencies of pesticides and other chemicals frequently used in the outdoor environment that could be harmful to California tiger salamanders. USFWS, in coordination with these agencies should develop guidelines for pesticide use along with EPA recommendations for use of those substances in Santa Barbara County and work with EPA to restrict the use of contaminants that would affect California tiger salamanders and/or their breeding ponds.

2.2.5 Work with local landowners and agencies in California tiger salamander habitats where agricultural chemicals are used. (Priority 2)

Develop best-use practices for use of agricultural chemicals near California tiger salamander habitat in coordination with USFWS and CDFW and the RWQCB and County of Santa Barbara. USFWS should inform private landowners and highway and road maintenance agencies of the threat posed to the California tiger salamander by the use of herbicides and pesticides near sensitive habitats. USFWS should work with these entities to develop guidelines to ensure protection of California tiger salamanders and their habitat.

2.3 Reduce vehicle-strike mortality and remove or retrofit barriers to California tiger salamander dispersal from roads.

2.3.1. Develop and implement a plan to minimize the effects of vehicle-strike mortality on California tiger salamanders. (Priority 1)

California tiger salamanders most often impacted by vehicle strikes are those making breeding migrations; that is, those in breeding condition. Develop and implement a plan to minimize and reduce vehicle-strike mortality and include specific provisions for: Highway 246 (within the Santa Rita metapopulation; Figure 7); Black Road (West Santa Maria metapopulation; Figure 2); Highway 101 in Los Alamos (West Los Alamos and East Los Alamos metapopulations;

[15] See "Managing Rangelands to Benefit California Red-legged Frogs and California Tiger Salamanders" (Ford et al. 2013) for specific guidelines regarding livestock grazing compatible with California tiger salamander habitat.

Figures 4 and 5); and Dominion and Orcutt-Garey Roads (East Santa Maria metapopulation; Figure 3).

2.3.2 Install under crossings at strategic locations to reduce California tiger salamander vehicle-strike mortality. (Priority 1)

Strategic locations to develop under-crossings include sites where California tiger salamanders are frequently found crossing the road and are killed by vehicle strikes. These localities include, but are not limited to: Highway 246 between Buellton and Lompoc adjacent to ponds LOAL-2W and LOAL-2E (Figure 7); Dominion Road in Orcutt between Clark Avenue and Orcutt-Garey Road (adjacent to pond TWDA-10 (Figure 3)); Orcutt-Garey Road between Dominion Road and Foxen Canyon Road; Foxen Canyon Road south from Orcutt-Garey Road to 2 miles south (adjacent to pond TWDA-15 (Figure 3)); Highway 101 in Los Alamos (between ponds SISQ-3 and SISQ-2 (Figure 4) and adjacent to LOAL-19 (Figure 5)); and Black Road between Highway 1 and Betteravia Road. USFWS and CDFW should work closely with the California Department of Transportation to coordinate the installation of these under-crossings.

2.3.3 Restore habitat in key migration/dispersal corridors. (Priority 1)

Barriers to migration and dispersal include habitat entirely lost to development, as well as suboptimal habitat that does not provide adequate refuge in the form of small mammal burrows or other cover. Such barriers could include agricultural fields. Prioritize restoration of dispersal corridors within 5,587 feet (1,703 meters) of breeding ponds, and between breeding ponds.

3. Reduce and remove threats from non-native species.

Non-native salamanders threaten the Santa Barbara County California tiger salamander with hybridization. The presence of non-native predators, particularly fish, bullfrogs, and crayfish, also pose a threat to the California tiger salamander. USFWS should work with its partners to eliminate or reduce populations of these non-native species as much as possible in areas occupied by California tiger salamanders in Santa Barbara County. As a short-term method, physical removal of these non-native species may be most beneficial. However, proactive means of reducing the conditions in which these non-native species thrive is a long-term priority.

3.1 Develop and successfully implement a management plan to survey for and eradicate non-native and hybrid tiger salamanders. (Priority 1)

Areas of highest priority for this action include the La Purisima Golf Course and Lompoc Federal Penitentiary. Develop a monitoring plan to ensure risk abatement for the introduction and containment of non-native genotypes within the range of the Santa Barbara County California tiger salamander, including a management plan for reducing the degree of hybridization in areas where non-native genes have been introduced[16].

3.2 Remove the threat to the California tiger salamander posed by the transport, collection, possession, and sale of non-native salamanders as bait and pets.

3.2.1 Work with the State of California to create or modify state regulations on the importation of non-native tiger salamanders in the Family Ambystomatidae into California and prohibit their sale within the State, except for research, medical, or conservation purposes. (Priority 1)

3.2.2 Work with the State of California to increase enforcement of the regulations under State law that it is illegal to possess salamanders of the genus *Ambystoma* through better game warden education, training, and tip follow-up. (Priority 1)

3.3 Prevent the introduction of non-native predators into California tiger salamander ponds by working with local and/or State agencies to develop and enforce ordinances, regulations, or laws to expressly prohibit artificial stocking of non-native fish within any aquatic system that has the potential to convey non-native fish to breeding habitat occupied or potentially occupied by California tiger salamanders. (Priority 1)

3.4. Develop and implement strategies to remove non-native fish, crayfish, and bullfrog populations from preserved California tiger salamander breeding ponds. (Priority 1)

Develop guidance for efforts to remove non-native fish, crayfish, and bullfrogs from California tiger salamander breeding ponds in coordination with USFWS and CDFW. This guidance should include predator removal to minimize California tiger salamander mortality and minimize effects on cattle and other animals that use the aquatic habitat. One possible method is to drain ponds from August to October. If a pond is small, exhaustive sampling with a seine to remove predators may be feasible[17]. The agencies should develop mechanisms to streamline these efforts and reduce regulatory restrictions that constrain efficiency in such efforts.

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[16] Pending genetic analysis, the degree of genetic introgression of a given population will remain 'undetermined.' If the breeding habitat where hybrid or non-native individuals are found is adjacent to, or within, a region preserved to meet recovery criteria, then the breeding habitat must be maintained in a manner consistent with California tiger salamander life cycle (e.g., hydrology and absence of non-native predators left intact), except as a means of temporary eradication efforts. Eradication or management activities will be coordinated on a case-by-case basis in consultation with the USFWS.

[17] Methods for removing non-native fish and bullfrogs are discussed in Ford et al. (2013).

4. Prevent and reduce the potential for the transmission of disease in California tiger salamander metapopulations.

4.1 Work with experts in the field of amphibian pathology/disease to develop disease prevention strategies for the Santa Barbara County DPS of the California tiger salamander. (Priority 2)

Include methodology on how to respond to a disease event if one were to occur in a California tiger salamander metapopulation and how to reduce the transmission of disease between metapopulations. Inform landowners and local and State agencies on strategies to employ to prevent disease transmission into California tiger salamander metapopulations.

4.2 Implement guidelines to prevent disease transmission into California tiger salamander breeding ponds. (Priority 2)

Incorporate methods to monitor populations of California tiger salamanders for pathogens and parasites into the California tiger salamander survey protocol.

4. 3 Follow "The Declining Amphibian Populations Task Force Fieldwork Code of Practice" (See Appendix C) to limit the spread of disease between individuals and populations of California tiger salamander. (Priority 1)

5. Conduct research on threats to the Santa Barbara County California tiger salamander.

5.1 Conduct a population viability analysis for the Santa Barbara County California tiger salamander. (Priority 2)

Population viability analysis is a species-specific method of risk assessment frequently used in conservation biology to determine the probability that a population will go extinct within a specified timeframe. As monitoring data become available from implementation of Recovery Action 6.1, a population viability analysis for each metapopulation should be conducted.

5.2 Conduct research to develop assays for detecting California tiger salamanders and non-native tiger salamanders from water samples using environmental DNA (eDNA). (Priority 1)

Development of these assays and methods would enable workers to quickly and efficiently establish the status of ponds (e.g., whether a pond is a California tiger salamander or hybrid breeding pond); eDNA sampling would save large amounts of effort and funds that could then be put toward California tiger salamander conservation and recovery efforts. These assays could also be used elsewhere within the species' range.

5.3 Conduct research on the effects of ranaviruses, *B. dendrobatidi*s, and *B. salamandrivorans* within the range of the Santa Barbara County California tiger salamander. (Priority 2)

This will allow agencies to determine the extent to which these diseases are a likely threat to the species and, if deemed appropriate, develop viable detection, prevention, and treatment strategies.

5.4 Conduct research on alternatives to using mosquitofish for vector control. (Priority 2)

Alternatives include other biological control methods such as the application of several species of bacteria (*Bacillus* sp.) that kill only mosquito larvae. Extensive research may be required to understand the implications of introducing these bacterial species or other methods as control agents.

6.0 Undertake activities in support of developing and implementing management and monitoring plans.

6.1 Monitor effective population size (N_e, as per Recovery Criterion 4) in each metapopulation to track population status and determine whether measures need to be modified or additional measures need to be taken to protect and enhance habitat and/or reduce threats. (Priority 1)

Seek permission from private landowners or public land managers to monitor California tiger salamander populations on their property. Follow guidelines in Appendix B "Monitoring Effective Population Size (N_e) in the Santa Barbara County California Tiger Salamander."

6.2 Determine the most effective strategies to control non-native and hybrid tiger salamander populations. (Priority 1)

6.3 Identify potential California tiger salamander breeding ponds within its range in Santa Barbara County and survey these ponds. (Priority 2)

These efforts will involve coordination with private land owners for access and permission to survey these ponds. Cooperative agreements with landowners may be necessary to accomplish this action.

6.4 Conduct biennial aerial surveys to quantify the status of California tiger salamander habitat and identify areas that have high potential for habitat creation/restoration. (Priority 3)

6.5 Establish and maintain a database that tracks Santa Barbara County DPS of the California tiger salamander habitat increase/decrease, mortalities, population trends, and other demographics. (Priority 2)

This database should be maintained by the USFWS or CDFW. Track the amount of California tiger salamander habitat impacted by projects as well as the onsite and offsite habitat conserved. Conduct post-project surveys to document the reproductive status of any affected California tiger salamander metapopulation(s). Research conducted regarding the California tiger salamander and feedback from habitat managers would be used to update avoidance and minimization measures. Each USFWS biological opinion that addresses California tiger salamander mortalities and loss of its habitat should provide a summary of the extent of previously authorized mortalities and habitat loss per metapopulation.

7. Conduct public education and outreach programs.

7.1 Prepare public outreach documents about the California tiger salamander and its habitats for the general public in Santa Barbara County. (Priority 2)

Develop outreach documents in conjunction with, and make available to, municipal and outreach offices such as the County of Santa Barbara's Planning and Development Department, Santa Barbara County Agriculture, the City of Santa Maria, NRCS, and RCDs.

7.2 Implement USFWS Schoolyard Habitat Program at schools within the range of the Santa Barbara County California tiger salamander. (Priority 3)

A USFWS Schoolyard Habitat project is a naturalized habitat area that is created by students, for students. The area is designed to be ecologically sound and provide habitat for local native plant and wildlife species. The habitat area acts as an outdoor classroom for students, is integrated into the curriculum, and is designed to encourage long-term stewardship. Schoolyard Habitat Programs within the range of the California tiger salamander would aim to educate children about the species and its habitat.

7.3 Conduct an information session for Realtors in Santa Barbara County to inform them of properties likely to contain California tiger salamander habitat for the purpose of educating prospective buyers about the California tiger salamander. (Priority 2)

7.4 Develop an interactive website to be used for educating the public about the Santa Barbara County DPS of the California tiger salamander. (Priority 3)

IV. Implementation Schedule

The following implementation schedule outlines actions and estimated costs for this draft recovery plan. It is a guide for meeting the objectives discussed in Chapter II. This schedule prioritizes actions, provides an estimated timetable for performance of actions, indicates the responsible parties, and estimates costs of performing actions. Cost estimates are provided for the entire recovery period (estimated to be 30 years). These actions, when accomplished, should further the recovery and conservation of the listed species.

Key to Terms and Acronyms Used in the Implementation Schedule:

Priority numbers are defined per USFWS policy (USFWS 1983) as:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline in the species population/habitat quality or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

Definition of Action Durations:

Number: The predicted duration of the action in years.

Continual: An action that is not currently underway but will be implemented on a routine basis, once initiated.

Ongoing: An action that is currently being implemented and will continue until action is no longer necessary.

Unknown: Either action duration or associated costs are not known at this time.

Responsible Parties:

Responsible parties are those agencies and other partners who may voluntarily participate in implementation of particular actions listed within this draft recovery plan. Responsible parties may willingly participate in project planning, or may provide funding, technical assistance, staff time, or any other means of implementation; however, responsible parties are not obligated to implement any of these actions. Other parties are invited to participate in the recovery of the Santa Barbara County DPS of the California tiger salamander, as well.

ALL All responsible parties

CDFW California Department of Fish and Wildlife

CRCD Cachuma Resource Conservation District

CITY City governments

CLTRNS California Department of Transportation

CNTY County of Santa Barbara

EPA	U.S. Environmental Protection Agency
FBP	Federal Bureau of Prisons
NGO	Non-governmental organizations (e.g., The Land Trust for Santa Barbara County, The Nature Conservancy)
NRCS	Natural Resources Conservation Service
PVT	Private parties
RWQCB	Regional Water Quality Control Board
TBD	To be determined
USFWS	U.S. Fish and Wildlife Service
UNIV	University

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
1.1	Permanently protect Santa Barbara County California tiger salamander breeding ponds and their adjacent uplands (see Recovery Criteria 1, 2, 3) through acquisition and conservation easements	1	CDFW, CNTY, CITY, PVT, TBD, USFWS	20	27,390			Average of ~5,478 acres[18] is required to be placed into easements per metapopulation area. At an approximate easement cost of $5,000/acre[19] = $27,390,000. Total cost is for all six metapopulation areas.
1.2	Develop management plans for protected California tiger salamander habitats	1	CDFW, CRCD, USFWS, TBD, PVT, NRCS	Ongoing	500			$50,000/year for 10 years

[18] Using the average Santa Barbara County California tiger salamander breeding pond size (1.47 acres), 4 ponds per metapopulation area would need be necessary to support a minimum viable population size (Searcy et al. 2014; Recovery Criterion 1). An estimated 95% of the salamander population will be encompassed in 2,251 acres around each pond: 623 acres in permanent protection and 1,628 acres sufficiently unfragmented constituting no less than 50% of the adjoining area (Recovery Criteria 2 and 3). Therefore, we estimate approximately 1,437 acres total would need to be preserved per pond. Assuming no overlap of protected area among the 4 protected ponds, each metapopulation will need 5,748 acres either: (1) owned in fee title by a government agency or conservation organization and managed for the benefit of the Santa Barbara County California tiger salamander; or, (2), privately-owned lands that are protected in perpetuity with conservation easements and managed in a manner that promotes the conservation of the Santa Barbara County California tiger salamander.

[19] The $5,000/acre easement cost is based on an estimate of approximate easement value for a 1,000 acre parcel with development rights removed by the easement. If the 1,000 acre parcel were grazing land only (no development rights), the easement value would be closer to $2,000 an acre. Easement values in California tiger salamander habitats in Santa Barbara County are highly variable and depend upon individual property characteristics; price per acre values range broadly depending on development potential and extent of grazing-only lands, from $2,500 per acre to $20,000/acre (Jim Hammock, pers. comm., 2014). Estimates are for easement costs only; acquisition costs would be much higher. Necessary management of the protected habitat will incur additional costs per acre as identified in management-related actions in the implementation table.

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
1.3	Develop a Regional Habitat Conservation Plan or Conservation Strategy for the County of Santa Barbara and the City of Santa Maria.	1	CNTY, CITY, CRCD, CDFW, NGO, NRCS, PVT, USFWS	3	300			3 years of development at $100,000/year
1.4	USFWS and local jurisdictions work together to improve and implement procedures to ensure activities permitted by local jurisdictions do not result in impacts or negative effects to California tiger salamanders and receive proper authorization from USFWS and CDFW	1	CNTY, CITY, CDFW, USFWS	Continual	TBD			
1.5	Develop a Safe Harbor Agreement(s) or obtain financial incentives for landowners to maintain vernal pools/stock ponds in California tiger salamander habitat	1	USFWS, CDFW, CRCD, NGO	Continual	TBD			
1.6	Reduce burrowing animal control in California tiger salamander habitat	2	USFWS, CDFW, NRCS, CNTY, EPA, RWQCB, NGO,	Continual	TBD			
1.7	Assess all protected habitat areas for contaminants	2	USFWS, CDFW, EPA, CNTY, RWQCB, NGO, NRCS	3	300			Final cost determined by initial screening in affected habitats.

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
1.8	Manage sedimentation to protect California tiger salamander breeding ponds	2	NRCS, PVT, USFWS, CDFW	Continual	TBD			
2.1.1	Restore and enhance California tiger salamander habitats: East Santa Maria Metapopulation Area	1	CDFW, NRCS, USFWS PVT, CRCD	Ongoing	TBD			
2.1.2	Restore and enhance California tiger salamander habitats: East Santa Rita Metapopulation Area	1	CDFW, NRCS, USFWS, PVT, CRCD	Ongoing	TBD			
2.1.3	Restore aquatic habitat	1	CDFW, NRCS, USFWS	Ongoing	TBD			
2.1.4	Restore upland habitat.	1	CDFW, NRCS, USFWS, PVT, CRCD	Ongoing	TBD			
2.1.5	Work with private landowners in habitat restoration efforts	1	CRCD, CDFW, CNTY, NGO, NRCS, PVT, USFWS	Ongoing	300			

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
2.2.1	Develop and implement habitat maintenance guidelines for California tiger salamander breeding ponds in a metapopulation area	2	CDFW, CRCD, CNTY, EPA, NGO, NRCS, PVT, RWQCB, USFWS	3	300			
2.2.2	Develop and implement land use guidelines for California tiger salamander breeding ponds in a metapopulation area	2	CDFW, CRCD, CNTY, EPA, NGO, NRCS, PVT, RWQCB, USFWS	3	300			
2.2.3	Follow grazing best management practices to prevent degradation of California tiger salamander habitats	3	CDFW, CRCD, CNTY, NRCS, USFWS	Ongoing	300			
2.2.4	Restrict the use of pesticides and other environmental contaminants that are known to be or are likely to be harmful to California tiger salamanders.	2	CDFW, CNTY, EPA, RWQCB, USFWS	Ongoing	300			$10,000/year
2.2.5	Work with local landowners and agencies in California tiger salamander habitats where agricultural chemicals are used.	2	CDFW, CRCD, NGO, RWQCB, USFWS, PVT	Ongoing	300			$10,000/year

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
2.3.1	Develop and implement a plan to minimize the effects of vehicle-strike mortality on California tiger salamanders.	1	CLTRNS, CDFW, USFWS, CNTY, CITY	5	125			$25,000/year
2.3.2	Install under crossings at strategic locations to reduce California tiger salamander vehicle related mortality	1	CLTRNS, CDFW, USFWS, CNTY, CITY	3	1200			300,000 per undercrossing, at 4 locations
2.3.3	Restore habitat in key migration/ dispersal corridors	1	CDFW, CITY, CNTY, NGO, NRCS, PVT, USFWS	Ongoing	6000			Two key dispersal corridors per metapopulation, $500,000 per corridor
3.1	Develop and successfully implement a plan to survey for and eradicate non-native and hybrid tiger salamanders	1	CDFW, CRCD, CLTRNS, FBP, NGO, NRCS, PVT, USFWS	10	480			$60,000/year for 8 years
3.2.1	Work with the State of California to create or modify state regulations on the importation of non-native tiger salamanders in the Family Ambystomatidae into California and prohibit their sale within the State, except for research, medical, or conservation purposes.	1	CDFW	5	50			

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
3.2.2	Work with the State of California to increase enforcement of the regulations under State law that it is illegal to possess salamanders of the genus Ambystoma through better game warden education, training, and tip follow-up.	1	CDFW, USFWS	Ongoing	10			
3.3	Prevent the introduction of non-native predators into California tiger salamander ponds by working with local and/or State agencies to develop and enforce ordinances, regulations, or laws to expressly prohibit artificial stocking of non-native fish within any aquatic system that has the potential to convey non-native fish to breeding habitat occupied or potentially occupied by California tiger salamanders.	1	CDFW, CITY, CNTY, NRCS, USFWS	Ongoing	100			$10,000/year for 10 years until sufficiently protective
3.4	Develop and implement strategies to remove non-native fish, crayfish, and bullfrog populations from preserved California tiger salamander breeding ponds.	1	CDFW, CRCD, NGO, NRCS, PVT, USFWS	3	150			3 years for development of plan; implementation would be ongoing
4.1	Work with experts in the field of amphibian pathology/disease to develop disease prevention strategies for the Santa Barbara County DPS of the California tiger salamander	2	CDFW, USFWS, UNIV, USFWS	Ongoing	25			

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
4.2	Implement guidelines to prevent disease transmission into California tiger salamander breeding ponds	2	ALL	Ongoing	10			
4.3	Follow "The Declining Amphibian Populations Task Force Fieldwork Code of Practice" (See Appendix C) to limit the spread of disease between individuals and populations of California tiger salamander.	1	ALL	Ongoing	10			
5.1	Conduct a population viability analysis for the Santa Barbara County California tiger salamander	2	CDFW, UNIV, USFWS	10	5,000			
5.2	Conduct research to develop assays for detecting California tiger salamanders and non-native tiger salamanders from water samples using environmental DNA (eDNA).	1	UNIV, USFWS	3	30			3 years at $10,000/year
5.3	Conduct research on the effects of ranaviruses, *B. dendrobatidis*, and *B. salamandrivorans* within the range of the Santa Barbara County California tiger salamander.	2	CDFW, PVT, USFWS, UNIV	5	50			Three years of monitoring and two years to develop implementation strategies, $10,000/year
5.4	Conduct research on alternatives to using mosquitofish for vector control.	2	CDFW, CITY, CNTY, USFWS, UNIV	2	20			2 years at $10,000/year

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
6.1	Monitor effective population size (N_e, as per Recovery Criteria 4) in each metapopulation to track population status and determine whether measures need to be modified or additional measures need to be taken to protect and enhance habitat and/or reduce threats	1	CDFW, PVT, USFWS, UNIV	Ongoing	TBD			
6.2	Determine the most effective strategies to control non-native and hybrid tiger salamander populations	1	CDFW, CRCD, PVT, USFWS, UNIV, PVT	2	50			2 years at $25,000/year
6.3	Identify potential California tiger salamander breeding ponds within its range in Santa Barbara County and survey these ponds.	2	CDFW, CRCD, PVT, USFWS, UNIV	5	50			Ongoing effort for 5 years at $10,000/year
6.4	Conduct biennial aerial surveys to quantify the status of California tiger salamander habitat and identify areas that have high potential for habitat creation/restoration.	3	CDFW, USFWS	Ongoing	60			$5,000 twice annually, ongoing
6.5	Establish and maintain a database that tracks Santa Barbara County DPS of the California tiger salamander habitat increase/decrease, mortalities, population trends, and other demographics.	2	CDFW, USFWS	Ongoing	34			$5,000 to initially establish; then ongoing, $1000 (in labor) per year to maintain

Action Number and Description		Priority	Responsible Parties	Duration (years)	Total Cost Estimate (in $1,000)			Comments
7.1	Prepare public outreach documents about the California tiger salamander and its habitats for the general public in Santa Barbara County	2	CDFW, CRCD, CITY, CNTY, NGO, USFWS	Ongoing	3,000			Amount is for initial development and printing. This should be made available at municipal and outreach offices such as County Planning and Development, Agriculture, and RCDs. Initial development and printing will take 1 year, and the documents should be distributed continually and updated every 5 years
7.2	Implement USFWS Schoolyard Habitat Program at schools within the range of the Santa Barbara County California tiger salamander.	3	USFWS, CITY	5	40			$4,000 from USFWS and $4,000 matching from the school per habitat (assuming 1 habitat per year for 5 years)
7.3	Conduct an information session for Realtors in Santa Barbara County to inform them of properties likely to contain California tiger salamander habitat for the purpose of educating prospective buyers about the California tiger salamander	2	USFWS	1	1.5			1 GS-11 biologist, 5 days, including presentation
7.4	Develop an interactive website to be used for educating the public about the Santa Barbara County DPS of the California tiger salamander	3	USFWS	2	20			First two years are for development, requiring ongoing maintenance thereafter

Total cost to recovery: $46,806,000

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VI. Appendices

Appendix A. Pond buffer area and minimum viable population size estimates (Searcy *in litt.* 2014)

This is a description of my newest estimate for the distance from the shoreline of a breeding pond needed to include 95% of a California tiger salamander population.

My first step was to use the procedure described in Searcy and Shaffer (2011) to fit a repeated-measures ANOVA that models the density of California tiger salamanders as a function of distance from the edge of the breeding pond, while accounting for variation between the two monitored breeding ponds at Jepson Prairie and the variation observed over the eight years of the study (2005-2013). This entailed calculating the density of each age class of salamanders (metamorphs, juveniles, and adults) at each distance from the pond shoreline at which we have drift fences (10, 100, 200, 300, 400, 500, 600, 700, 850, and 1000 m). I then took a weighted sum of these densities, weighting each age class by its relative reproductive value (1 for adults, 0.38 for juveniles, and 0.14 for metamorphs). These weightings come from an integral projection model that I have created using recapture data from the Jepson Prairie study. These weightings replace the weightings used in Searcy and Shaffer (2011), which were based on demographic data from Hastings Natural History Reservation (Trenham et al. 2000). Now that demographic data is available from Jepson Prairie, where the density distribution data was also collected, it makes sense to use only data from this population. I fit the repeated-measures ANOVA to the weighted sum, which represents the density of reproductive value, which values salamanders by their probability of contributing to future population growth. The resulting function relating density of reproductive value to distance from pond edge is: density = 5.436*e-0.002516*distance. This function represents the density of salamanders emanating in all directions from the breeding pond, so in order to calculate the total number of salamanders across the two-dimensional landscape, you need to multiply by 2πr and integrate it. In this case, r = distance+250, since a pond with an area that is the average of Olcott Lake and Round Pond (the two breeding ponds used in the study) would have a radius of 250 meters. I then solved the equation 0.95*Int[2π*(distance+250)*5.436*e-0.002516*distance,{distance,0,∞}] = Int[2π*(distance+250)*5.436*e-0.002516*distance,{distance,0,x}] for x. This yields the distance one would have to go from the breeding pond in order to include 95% of the salamander population, which turns out to be 1703 m. This is the same approach used in Searcy and Shaffer (2011), but the rate of exponential decay is slightly more negative (-0.002516 as opposed to -0.002317), which yields a slightly lower migration distance. A 1703 m buffer around a breeding pond would encompass 2251 acres, assuming that the pond was a point source. A very similar calculation yields 504 m as the distance needed to encompass 50% of the salamander population, which would require a 197 acre buffer area, and 896 m would encompass 75% of the salamander population, which would require a 623 acre buffer.

The following are a few notes on the total pond area needed to sustain a viable California tiger salamander metapopulation.

According to Traill et al. (2007), the average minimum viable population size for a population of herptiles is 5409 individuals. Since our equation relating pond area to population size is in terms of effective population size, we need a conversion factor between effective and census population size. I calculated the census number of metamorphs for Blomquist Pond, taking the average of the six years covered in Trenham et al. (2000). I chose to base the census population size on metamorphs, because all metamorphs should be captured each year, while a large fraction of the juveniles and adults remain underground each year. Using the census number of metamorphs, I then calculated the census number of juveniles and adults based on the growth, survivorship, and maturity functions in the integral projection model developed from the Jepson Prairie recapture data. My final calculations for the census population size at Blomquist Pond were: 190 adults, 362 juveniles, and 397 metamorphs. Wang and Shaffer (unpublished data) give two estimates for the effective population size of Blomquist Pond: 11 and 16. I averaged these two values (13.5) and then divided the census population size of Blomquist Pond by this value to get the conversion factors: adults (14.074x), juveniles (26.815x), and metamorphs (29.407x). When calculating the minimum viable population size, I only considered adults and juveniles, since metamorphs are not present for the majority of the year. Getting a census population size of 5409 individuals thus requires an effective population size of 5409/(14.074+26.815) = 132. The equation relating effective population size to pond area from Wang et al. (2011) is Ne = 7.721*ln(area) – 30.999. So, in order to get the sufficient pond area with a single pond, that pond would need to be 364,189 acres. In order to get it with two ponds, each would need to be 71 acres (slightly smaller than Olcott Lake). In order to get it with three ponds, each would need to be 4.1 acres, which is a typical size for the playa pools at Jepson Prairie. So, in almost any landscape, getting the sufficient pond area would require at least three ponds, which will provide at least some redundancy in breeding sites. The average pond size in Santa Barbara County is 1.47 acres, so it would require four ponds with this size in order to get a stable metapopulation. In order to get it with eight ponds, each would need to be 470 m^2, and in order to get it with nine ponds, each would need to be 370 m^2.

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Appendix B. Monitoring Effective Population Size (N_e) in the Santa Barbara County California Tiger Salamander

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For any pond-breeding amphibian, there are at least three ways to estimate population size, and therefore population increases or decreases over time. One is to use drift fences to estimate the number of adults or metamorphs at a site. A second is to count the number of larvae in a breeding site at some time in the larval period. The third is to use molecular genetic techniques to estimate the size of the population. The first two approaches return point samples of the census population size—that is, how many individuals are actually at a breeding site at one or more points in the life cycle. Such estimates are often expensive and time-consuming to collect and difficult to interpret, given that only some individuals in the population breed in any year. In particular for California tiger salamanders (CTS), we have strong evidence that in low rain years, most individuals do not breed, whereas in high rain years, more come out to breed. This makes the interpretation of counts within and across years difficult, since the count reflects the rain year, the time of year when the count is done relative to breeding and metamorphosis, and the actual census size of the true population. For larval counts, it may also reflect the density of predators (including predatory insects, introduced bullfrogs and fishes, and native birds, snakes, and other taxa) as well as an indirect indication of breeding activity for that year.

Alternatively, one can use genetic approaches to estimate the *effective population size*, or N_e. This approach is based on sampling a reasonable number of individuals, collecting an estimate of variation at a reasonable number of genes, and using that to estimate the number of unrelated individuals that would have to breed at random to produce the variation seen in that random collection of offspring. N_e is usually smaller than the census size—in CTS our estimates are that it is often about 10 fold less, but N_e estimates are very reproducible and are correlated with the census size. In addition, N_e is a more accurate indication of the total population size, rather than just the number of individuals that happened to breed in a particular year. In that sense, changes in N_e are probably a more accurate representation of population trends than any given estimate of the census size for a given year. In addition, N_e can be based on non-destructive larval sampling—we need only to capture ~30-50 larvae, snip off the end of the tail, and within a few minutes, return the larva to the point of capture. Recent experimental work from our lab (Polich et al. 2013) suggests that under semi-naturalistic conditions there is no decrease in survival or fitness associated with this tissue sampling, and that at least in replicated mesocosms, larvae regrow the missing portion of their tail and metamorphose as normal-size individuals.

To track the population increases or decreases in the Santa Barbara DPS of CTS using N_e, we propose using the sibship assignment method as implemented in the program COLONY (Jones and Wang 2010). This method uses genetic data to determine the probabilities of all possible pairs of samples from a population being full-sibs or half-sibs. These probabilities are then used to determine N_e based on an equation that relates the probability of drawing these assignments from a randomly sampled, single cohort of larvae to the number of effective breeding adults. The method also returns 95% confidence intervals on each estimate of N_e. We have applied this method to CTS in the past (Wang et al. 2011, Wang and Shaffer unpublished data), and it returns biologically reasonable estimates that have been shown to be more accurate than other estimation methods.

Given that individual breeding ponds have a relatively high level of random variation in breeding success in any given year, we recommend that for each Santa Barbara metapopulation, molecular estimates of N_e be collected from three to five ponds. Ideally, these would be ecologically variable ponds that vary with respect to natural vs. manmade, size/depth, and the amount of open space around each. Given the tradeoffs that are always faced between accuracy and cost, we recommend that each pond be sampled roughly three times in a decadal period—ideally on years one, five and 10 in the cycle. The number of animals that breed clearly affects estimates of N_e, and these estimates will be lower in drought years and higher in higher rainfall years. Given that, an alternative strategy would be to sample each pond every year, or to use three sampling periods per decade but only sample in non-drought years. Sampling each year will yield the most accurate estimate of yearly variation (and trends) in N_e, but it is also the most expensive and time-consuming. Our recommendation is to avoid a strategy that explicitly ignores drought years, since they are a component of the biology of CTS populations, and they should be incorporated into time series of population trends. Sample sizes of 30-50 larval tail tips for each pond should provide adequate information on N_e, and ideally those samples should be collected during the late-larval period, probably in April in most years. Tissue samples should be sufficiently large to ensure that there is plenty of tissue for multiple DNA extractions and sequencing experiments, since the technology will almost certainly evolve and change every few years.

In the past, microsatellites were the technology of choice for this kind of work, and they still could be used for this work. However, recent advances in using single nucleotide polymorphisms (SNPs) have led to the widespread use of these variable, stable, informative markers, and we recommend using them for this work. 100-300 variable SNPs should suffice for these analyses, depending on the level of variation that exists in each population. Our lab is currently in the final stages of screening a panel of 8500 SNPs for an analysis of CTS hybridization in central California, and we can develop a sub-panel of this gene capture array that we can use for the Santa Barbara Distinct Population Segment. This would require a preliminary analysis with our larger SNP panel to determine which SNPs are most variable, and a re-design of the capture array that focuses on those SNPs that are segregating at high allele frequencies within the Santa Barbara population.

Program COLONY will return estimates of N_e and their 95% confidence estimates, and those estimates can be tracked over time to gain insights into trends in population size. However, given that the 95% confidence levels for N_e can be fairly large (about +/- 20% of the point estimate for our work on CTS using microsatellites, see Wang et al. 2011), using these data to determine population trends can be difficult. Of course, the same is true for population estimates of breeding adults from drift fence studies or larval numbers from seining surveys for pond breeding amphibians. There is no simple solution for this sampling problem, as has been widely recognized by the community for many years. In anticipation of trying to solve this problem, I have initiated discussions with Professor Jamie Lloyd-Smith, a mathematical ecologist at UCLA, and his initial thinking is that a mixed model that takes into account rainfall as a covariate, and the hierarchical structure of years nested within ponds, and ponds nested within metapopulations, is probably the way to go with these data. In addition, if we could increase the sampling frequency, perhaps to every other year or even every year, it would increase the power to detect trends across years.

Finally, all tissue samples should be archived in a stable repository where they will be well-curated and available for future analyses.

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Appendix C. The Declining Amphibian Populations Task Force Fieldwork Code of Practice (DAPTF 1998)

The Declining Amphibian Task Force (DAPTF) was established in 1991 by the World Conservation Union to address multiple conservation issue related to amphibians. The DAPTF prepared a code of practice to provide guidelines for use by anyone conducting field work at amphibian breeding sites or in other aquatic habitats. Observations of diseased and parasite-infected amphibians are now being frequently reported from sites all over the world. This has given rise to concerns that releasing amphibians following a period of captivity, during which time they can pick up unapparent infections of novel disease agents, may cause an increased risk of mortality in wild populations. Amphibian pathogens and parasites can also be carried in a variety of ways between habitats on the hands, footwear, or equipment of fieldworkers, which can spread them to novel localities containing species which have had little or no prior contact with such pathogens or parasites. Such occurrences may be implicated in some instances where amphibian populations have declined. Therefore, it is vitally important for those involved in amphibian research (and other wetland/pond studies including those on fish, invertebrates and plants) to take these steps to minimize the spread of disease and parasites between study sites:

1. Remove mud, snails, algae, and other debris from nets, traps, boots, vehicle tires and all other surfaces. Rinse cleaned items with sterilized (e.g. boiled or treated) water before leaving each study site.
2. Boots, nets, traps, etc., should then be scrubbed with 70% ethanol solution (or sodium hypochlorite 3 to 6%) and rinsed clean with sterilized water between study sites. Avoid cleaning equipment in the immediate vicinity of a pond or wetland.
3. In remote locations, clean all equipment as described above upon return to the lab or "base camp". Elsewhere, when washing machine facilities are available, remove nets from poles and wash with bleach on a "delicates" cycle, contained in a protective mesh laundry bag.
4. When working at sites with known or suspected disease problems, or when sampling populations of rare or isolates species, wear disposable gloves and change them between handling each animal. Dedicate sets of nets, boots, traps, and other equipment to each site being visited. Clean and store them separately and the end of each field day.
5. When amphibians are collected, ensure the separation of animals from different sites and take great care to avoid indirect contact between them (e.g. via handling, reuse of containers) or with other captive animals. Isolation from un-sterilized plants or soils which have been taken from other sites is also essential. Always use disinfected/disposable husbandry equipment.
6. Examine collected amphibians for the presence of diseases and parasites soon after capture. Prior to their release or the release of any progeny, amphibians should be quarantined for a period and thoroughly screened for the presence of any potential disease agents.
7. Used cleaning materials (liquids, etc.) should be disposed of safely and if necessary taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

Appendix D. Metapopulation Maps

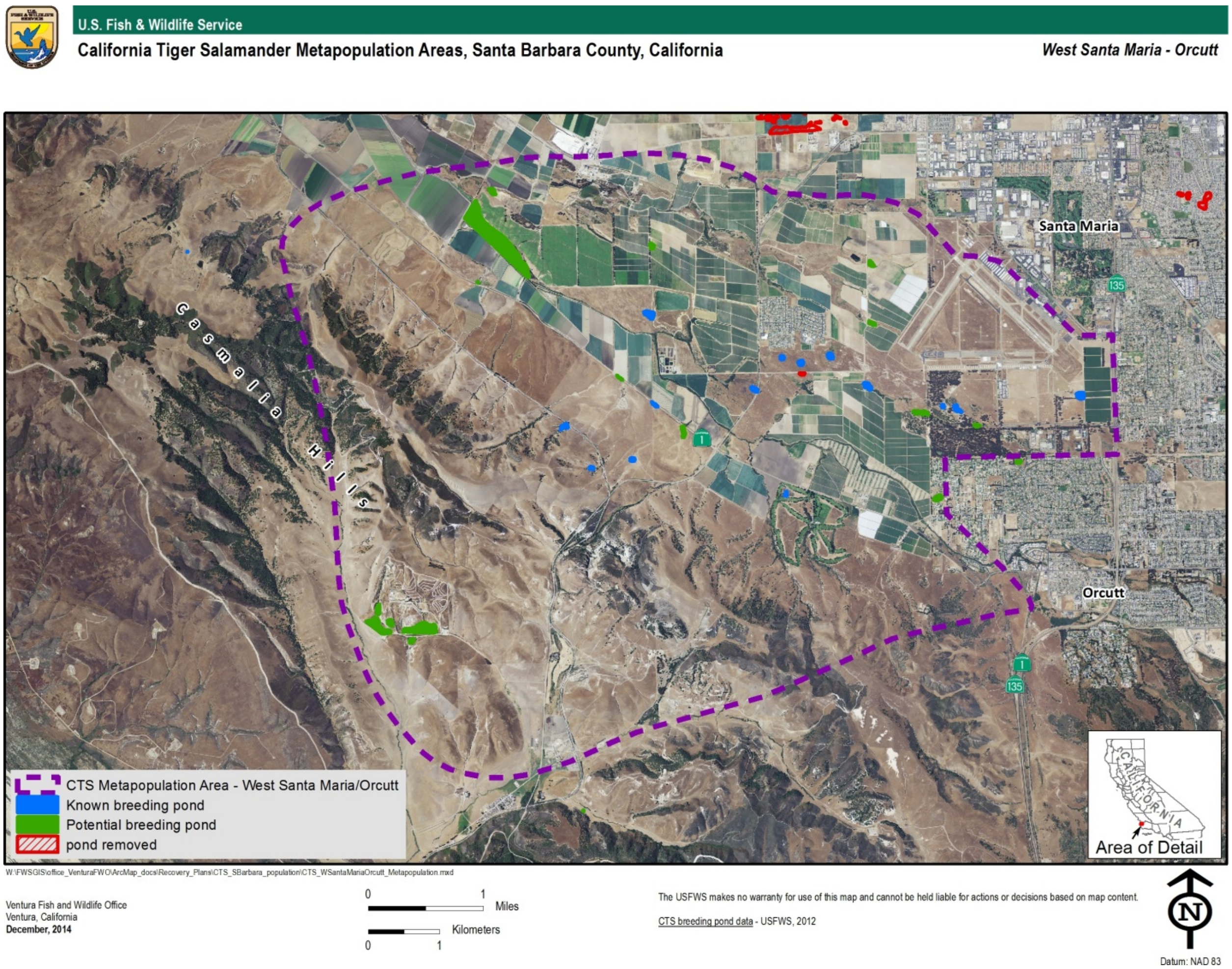

Figure 2. West Santa Maria/Orcutt Metapopulation Area.

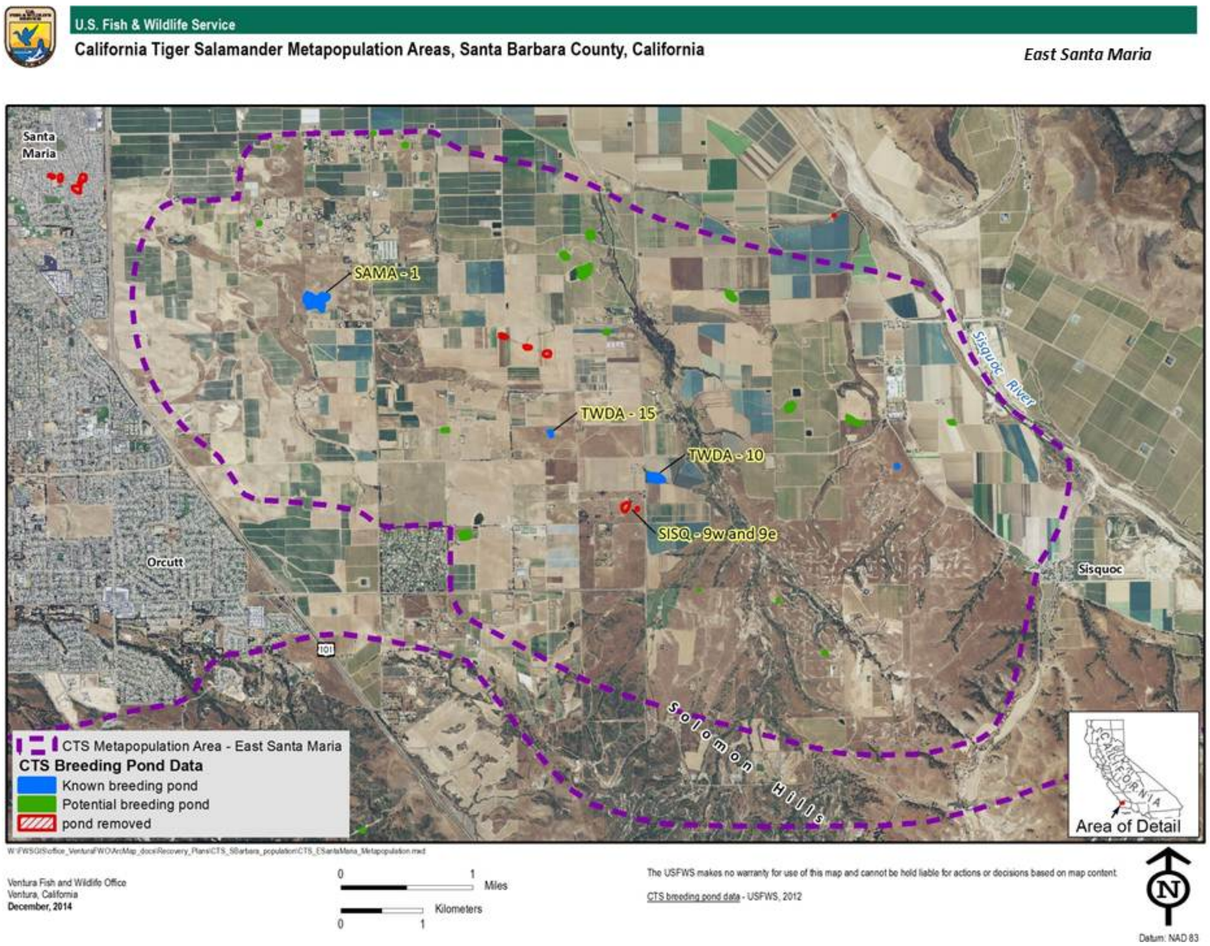

Figure 3. East Santa Maria Metapopulation Area

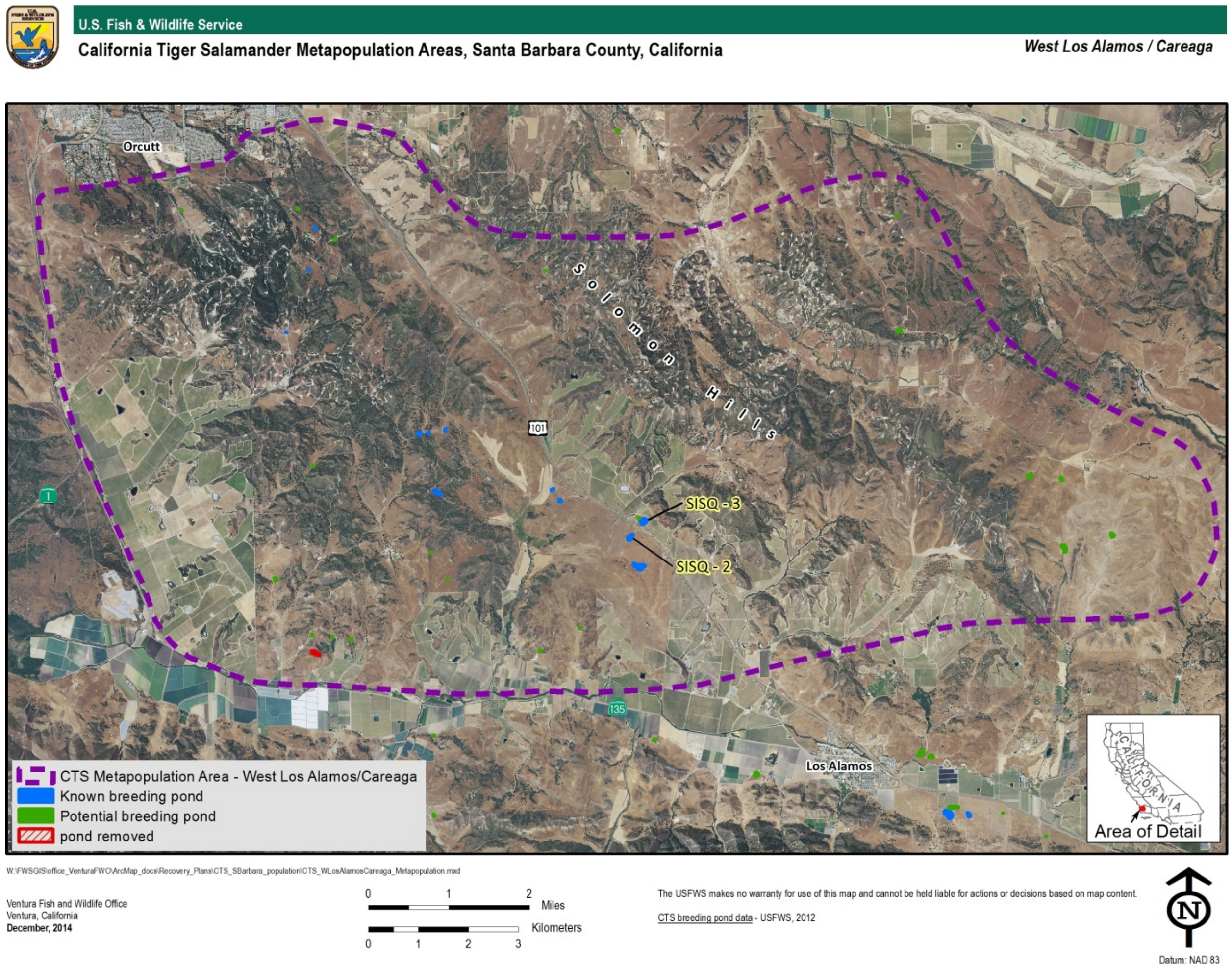

Figure 4. West Los Alamos/Careaga Metapopulation Area.

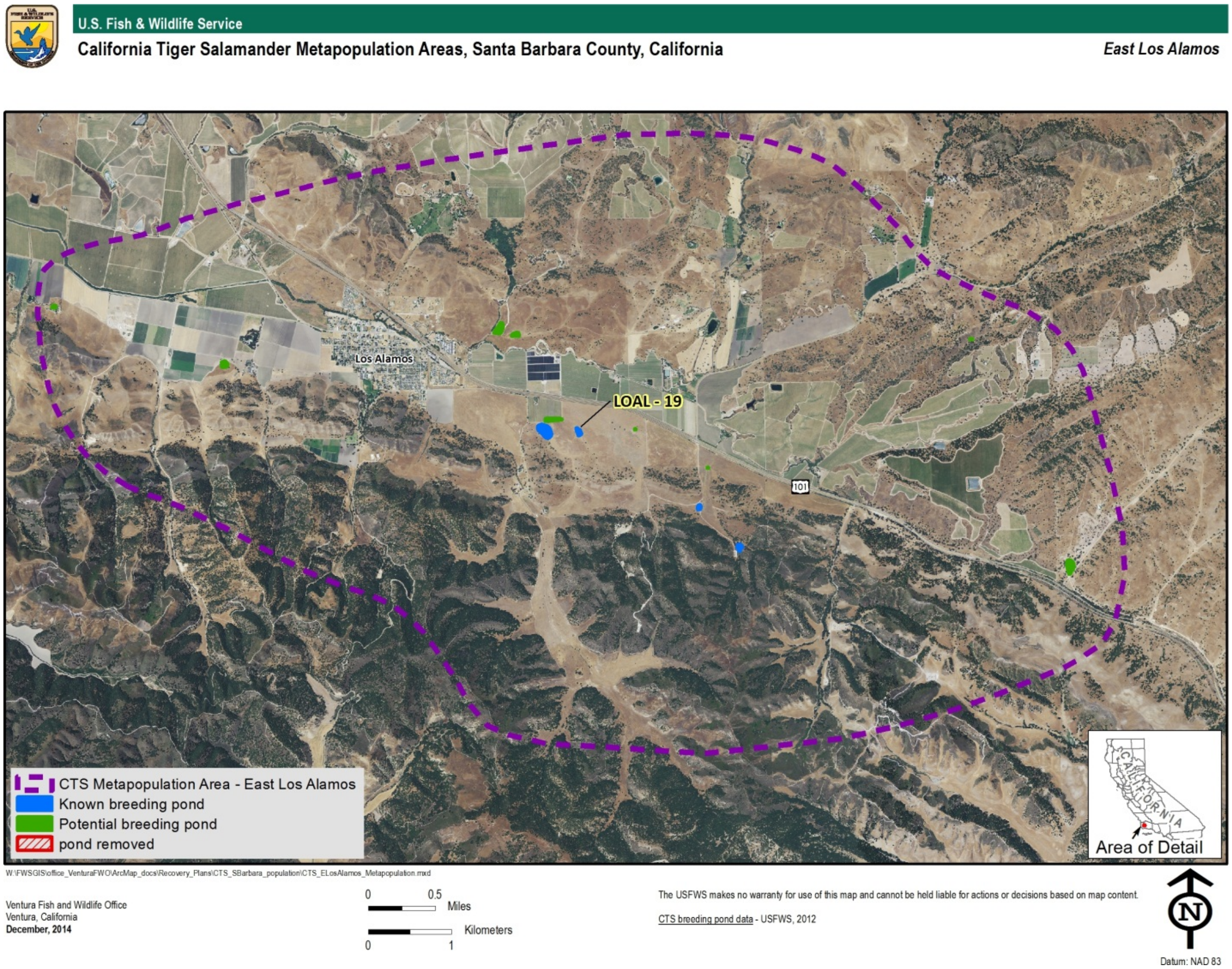

Figure 5. East Los Alamos Metapopulation Area.

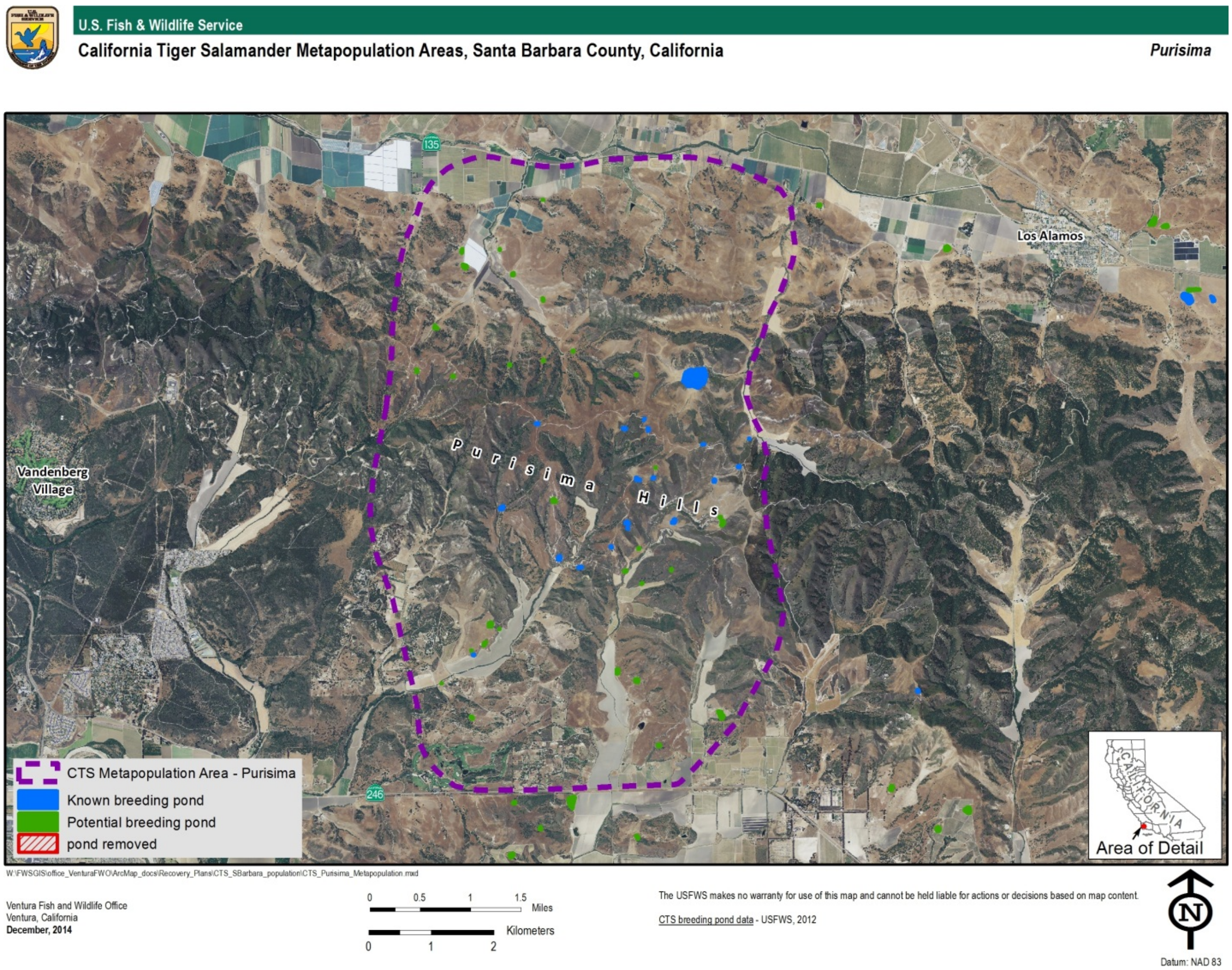

Figure 6. Purisima Metapopulation Area.

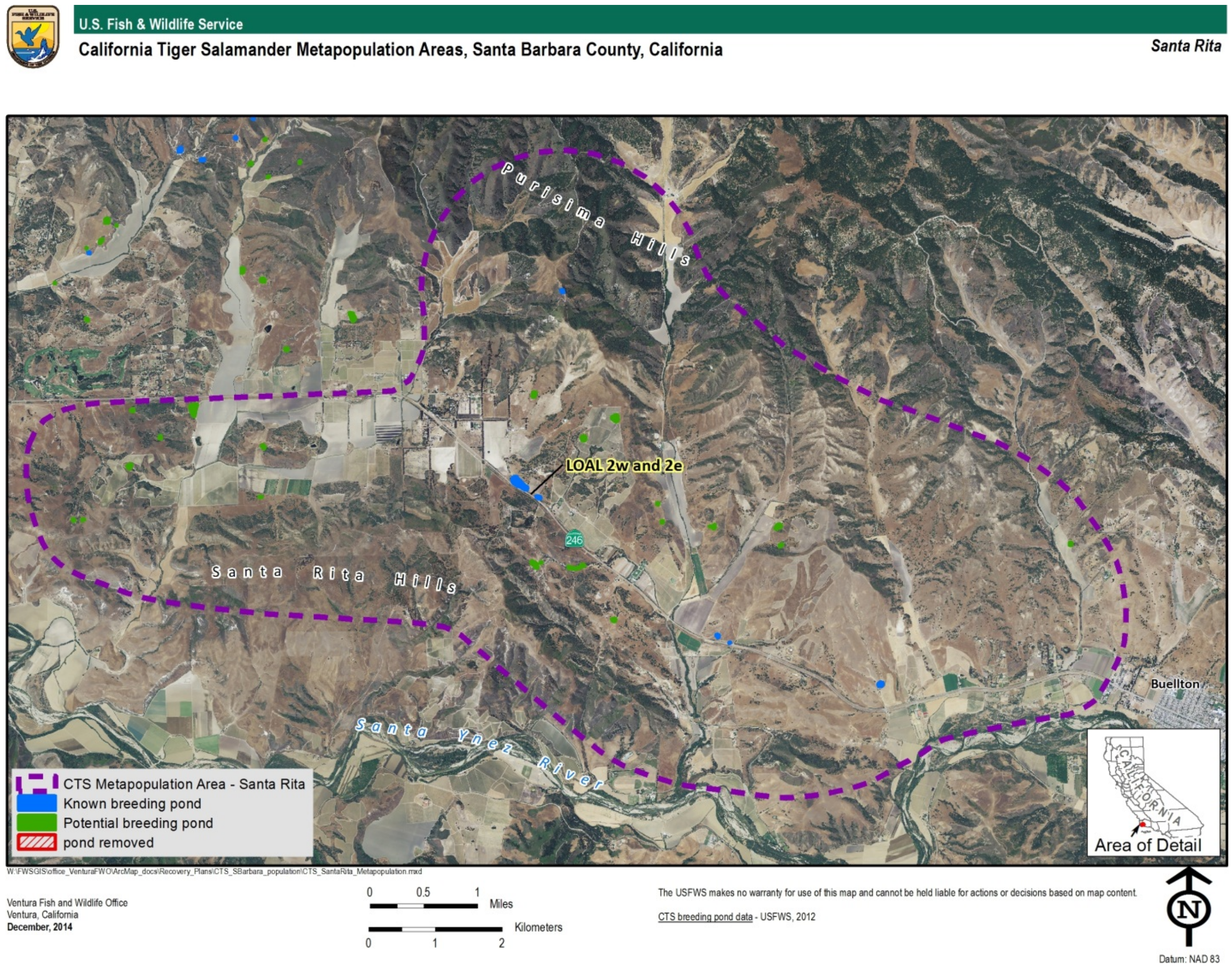

Figure 7. Santa Rita Metapopulation Area.