California Tiger Salamander (*Ambystoma californiense*)
Santa Barbara County Distinct Population Segment

5-Year Review:
Evaluation and Summary

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

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5-YEAR REVIEW
California Tiger Salamander (*Ambystoma californiense*)
Santa Barbara County Distinct Population Segment

GENERAL INFORMATION

Species: California tiger salamander, Santa Barbara County Distinct Population Segment (*Ambystoma californiense*)
Date listed: January 19, 2000 (Classification: Endangered; emergency rule) and September 21, 2000 (Classification: Endangered; final rule)
Federal Register (FR) citations: 65 FR 3096 (emergency rule) and 65 FR 57242 (final rule)

BACKGROUND

Most recent status review

[Service] U.S. Fish and Wildlife Service. 2009. California Tiger Salamander (*Ambystoma californiense*) Santa Barbara County Distinct Population Segment 5-Year Review: Summary and Evaluation. USFWS. Ventura Field Office. Ventura, California.

FR Notice citation announcing this status review

[Service] U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 76 Species in California and Nevada. Federal Register 86:27462-27464. May 20, 2021.

Critical Habitat Designation

Critical habitat for the Santa Barbara (SB) County Distinct Population Segment (DPS) of the California tiger salamander (CTS; *Ambystoma californiense*) was designated on November 24, 2004 (69 FR 68568).

State Listing

The State of California listed the CTS across its entire range, encompassing the Central California, Santa Barbara County, and Sonoma County DPSs, as threatened on August 19, 2010 (14 CCR § 670.5).

ASSESSMENT

Information acquired since the last status review

This 5-year status review was conducted by the U.S. Fish and Wildlife Service (Service) Ventura Fish and Wildlife Office. Data for this status review were solicited from interested parties through a Federal Register notice announcing this status review on May 20, 2021 (86 FR 27462-27464). We did not receive any information from the public about the SB CTS DPS in response to the notice. We also contacted species experts to request any data or information we should consider in our review. Additionally, we conducted a literature search and a review of information in our files, including a review of SB CTS section 10(a)(1)(A) recovery permit annual reports. We also reviewed data from the California Protected Areas Database (CPAD), maintained by the GreenInfo Network (CPAD 2020), and the California Natural Diversity Database (CNDDB), maintained by the California Department of Fish and Wildlife (CNDDB 2022).

Background

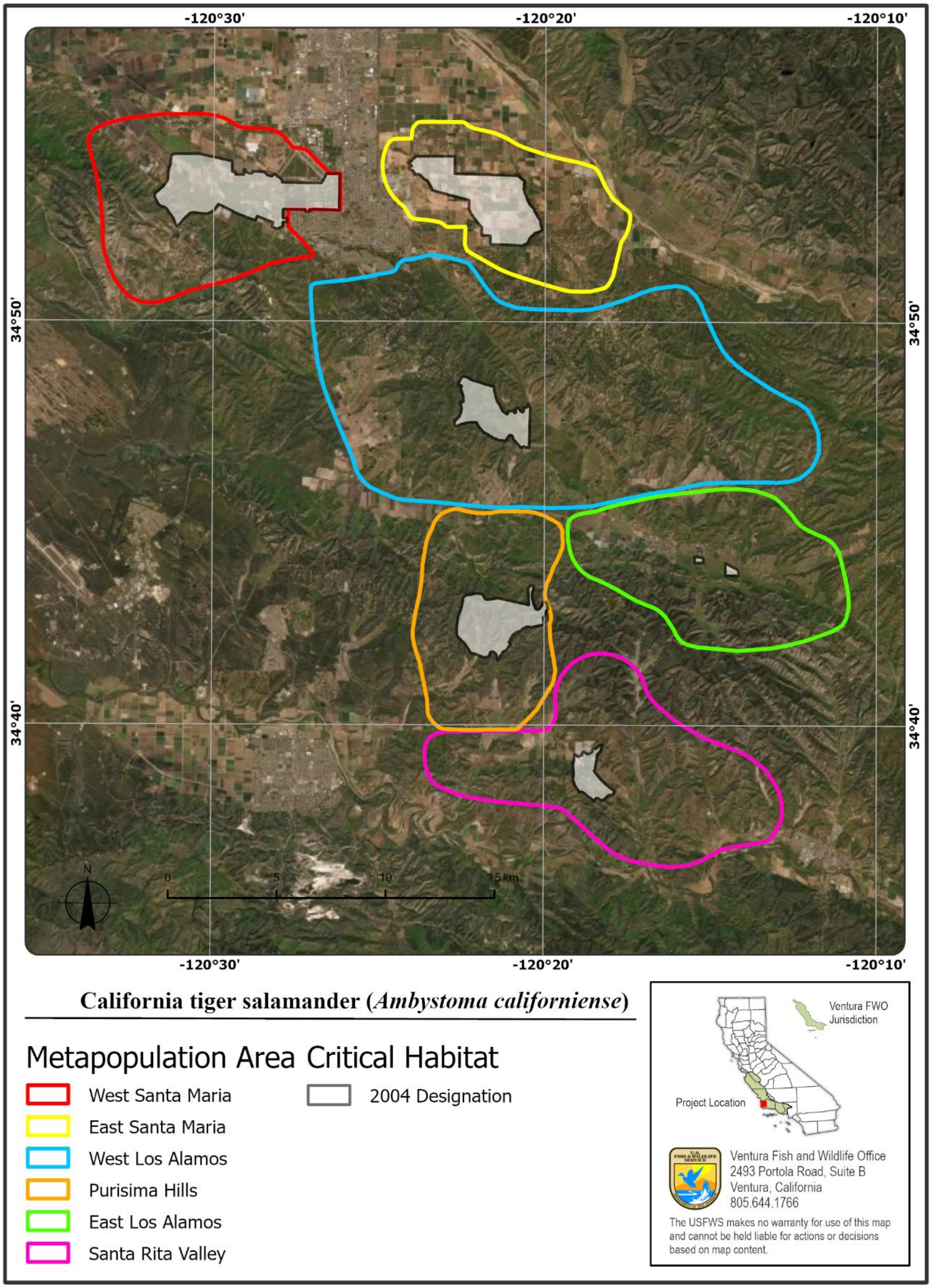
Nomenclature

The CTS 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), which was later confirmed with genetic data (Shaffer and McKnight 1996, pp. 429-430; Irschick and Shaffer 1997, pp. 31-36). Recent genetic studies show that there has been little, if any, gene flow between the Central California DPS, Sonoma County DPS, and Santa Barbara County DPS for a substantial period of time (Shaffer and Trenham 2002, pp. 3-7; Shaffer et al. 2004, pp. 3039-3043; Shaffer et al. 2013, pp. 4-8).

Distribution

SB CTS is currently managed as one DPS inhabiting six metapopulation areas distributed throughout northern Santa Barbara County, California (Figure 1; Service 2009, pp. 7-9; Service 2016, p. I-2). A metapopulation comprises a set of local populations or breeding sites within an area, where migration from one local population or breeding site to other areas containing suitable habitat is possible, but not routine (Service 2016, p. I-2). The West Santa Maria and East Santa Maria metapopulation areas are located at the northern end of the range of the DPS. The West Los Alamos and East Los Alamos metapopulation areas are in the central range of the DPS. The Purisima Hills and Santa Rita Valley metapopulation areas are at the southern range of the DPS.

Figure 1. Six metapopulations areas and designated critical habitat units (69 FR 68568) for the Santa Barbara County Distinct Population Segment of the California tiger salamander (*Ambystoma californiense*).



Habitat Associations

CTS require two habitats to complete their life cycle: vernal pools or ponds (i.e., aquatic breeding locations) and uplands with small-mammal burrows (i.e., terrestrial non-breeding locations).

During the breeding period, CTS require a relatively short period to complete aquatic larvae development and may breed successfully in pools or ponds that last for little more than 3 months (i.e., 12 weeks). In colder weather, the developmental period for CTS is prolonged, with periods more than 4 months being common. This requirement restricts CTS breeding to deeper vernal pools, vernal playas, large sag ponds, and artificial ponds that have sufficiently long periods of inundation (Service 2009, p. 6; Service 2016, p. I-6). It was recently reported within the range of the Central DPS that CTS may also breed in perennial or near-perennial fishless streams and pools (Alvarez et al. 2021a, pp. 235-236).

Following metamorphosis, particularly on rainy nights (Trenham 2001, pp. 344-345), CTS emigrate from their aquatic habitat to seek shelter in upland habitat. CTS remain in the uplands during the non-breeding season (Loredo et al. 1996, pp. 282-283), a period when ambient conditions are warm and dry (Service 2009, pp. 10-11; Service 2016, p. I-5). California ground squirrel (*Spermophilus beecheyi*) and Botta's pocket gopher (*Thommomys bottae*) burrows are the primary sources of CTS upland refugia (Loredo et al. 1996, pp. 283-284; Trenham 2001, pp. 343-345).

Recent integration of ecological niche modeling and field data demonstrate that the climate factors defining CTS range limits in the Central DPS are the same as those that determine interannual variation in local population size, including total annual precipitation, mean minimum temperature of the coldest month, and mean diurnal range (Searcy and Shaffer 2016, pp. 426-429).

Population Genetics

Toffelmier and Shaffer (2021, p. 4) evaluated SB CTS genetic diversity and potential hybridization using samples collected from 1986 to 2017. Of 471 total samples, only 22 non-native tiger salamander (*Ambystoma mavortium*; BTS) genotypes were identified, and these genotypes were only found in the four known BTS source ponds (i.e., outlying west of the Purisima Hills and Santa Rita Valley metapopulation areas). In other words, no non-native BTS genotypes were identified at any sites within SB CTS metapopulation area boundaries. Consequently, at this time, SB CTS hybridization with BTS likely poses little to no threat to SB CTS recovery (Toffelmier and Shaffer 2021, p. 11).

Reduced genetic diversity likely comprises an ongoing threat to SB CTS recovery. Across the DPS, Toffelmier and Shaffer (2021, pp. 12-14) found that genetic variation is extremely low, including estimates of low nucleotide diversity, heterozygosity, and allelic richness. Estimated individual- and population-level inbreeding was very high; whereas, estimated genetic effective population size was very low across metapopulation areas. Across all ponds and years, expected heterozygosity and population-level inbreeding coefficients significantly, though not greatly, declined over time. However, observed heterozygosity, allelic richness, nucleotide diversity, and effective population size did not decline over time, suggesting no change in these metrics.

Evaluations of population structure revealed a gradient of genetic diversity from north to south. Estimated observed and expected heterozygosity, allelic richness, and nucleotide diversity were significantly different among metapopulation areas, suggesting that some metapopulations are more diverse than others. Effective population size and individual- and population-level inbreeding coefficients were not different among metapopulation areas, suggesting that all metapopulations are highly inbred. The most genetic diversity was found in the north (i.e., West and East Santa Maria metapopulation areas), and the least genetic diversity was found in the south (i.e., Purisima Hills and Santa Rita Valley metapopulation areas; Toffelmier and Shaffer 2021, p. 13). This gradient in genetic diversity was attributed to a greater number of natural ponds in the northern portion of the DPS (Toffelmier and Shaffer 2021, pp. 17-18). Increased number and size of natural, rather than artificial, ponds was found to enhance SB CTS genetic diversity (Toffelmier and Shaffer 2021, pp. 12-17). Additional analyses suggested that SB CTS genetic diversity is higher at a focal pond when: (a) other ponds are located closely nearby (i.e., within 562 meters [1,844 feet], an empirically derived dispersal distance; Moilanen and Nieminen 2002, pp. 1134-1139; Peterman et al. 2015, pp. 62-65; Searcy et al. 2013, pp. 82-86; Toffelmier and Shaffer 2021, p. 8), and (b) more ponds are natural and located within 2,000 meters (6,562 feet; Toffelmier and Shaffer 2021, pp. 12-17).

Toffelmier and Shaffer (2021, p. 14) concluded that SB CTS genetic diversity is lower than that of other Ambystomatid salamanders and most other vertebrate groups (McCartney-Melstad et al. 2018, pp. 4433-4437; Robinson et al. 2016, pp. 1183-1187). Diversity in SB CTS was found to be 2.3 times less than estimated for Central CTS in eastern Merced County (Wang et al. 2011, pp. 915-917; Toffelmier and Shaffer 2021, p. 14).

Abundance and Population Trends

Currently, we do not have data on absolute number of SB CTS because individuals spend most of their lives underground. Historical abundance of SB CTS is also unknown. A typical breeding population in a pond can fluctuate due to random, natural processes (Service 2009, p. 7; Service 2016, p. I-4). CTS can move between ponds (Trenham et al. 2001, pp. 3525-3526) or even forego breeding for 2 to 8 years (Loredo and Van Vuren 1996, pp. 897-899; Trenham et al. 2000, pp. 370-373). For example, in years where rainfall is insufficient for creating suitable breeding habitat, both males and females will forego breeding for that year and each year thereafter for which breeding ponds do not fill with water (Jennings 2000, pp. 193-196). These tendencies can result in negative aquatic surveys despite the presence of the species in adjacent uplands (Trenham et al. 2000, pp. 367-368, 371; Alvarez et al. 2013, p. 46). At one Central CTS study site in Monterey County, Trenham et al. (2000, p. 369) found the number of breeding adults visiting a pond varied from 57 to 244 individuals. A Central CTS breeding site in Contra Costa County showed a similar pattern of variation, suggesting that such fluctuations are typical (Loredo and Van Vuren 1996, pp. 897-898). At the local landscape level, nearby breeding ponds can vary by at least an order of magnitude in the number of individuals visiting a pond, and these differences appear to be stable across years (Trenham et al. 2001, pp. 3526-3528).

While absolute numbers of SB CTS is largely unknown, new information is available about estimated effective population sizes based on genetic techniques. Toffelmier and Shaffer (2021, p. 14) reported that, median effective population size for the DPS was 12.2 individuals, ranging from 0.9 to 141.2 individuals. These results indicate overall very low effective population size and high variability across the SB CTS DPS. Based on Toffelmier and Shaffer's (2021, pp. 16 and 23) analysis of landscape conductance of SB CTS genes, increased effective population size likely correlates with shorter distances between ponds, which provide reduced isolation and increased landscape permeability, both of which influence SB CTS dispersal dynamics and resultant breeding opportunities. Toffelmier and Shaffer (2021, p. 14) reported that median effective population size of 12.2 individuals was much lower than that of other CTS DPSs (e.g., 2.3 times less than estimated for Central CTS in eastern Merced County; Wang et al. 2011, pp. 915-917), and likely also lower than that of most other vertebrate groups (McCartney-Melstad et al. 2018, pp. 4433-4437; Robinson et al. 2016, pp. 1183-1187; Toffelmier and Shaffer 2021, p. 14). Additionally, effective population size did not appear to trend across the SB CTS DPS over time, based on the data analyzed (Toffelmier and Shaffer 2021, pp. 12 and 15).

The number of available SB CTS breeding ponds is better known than population abundance and trends. We know that increasing numbers of CTS are correlated with increasing area of breeding ponds, especially natural ones (Wang et al. 2011, pp. 918-919; Toffelmier and Shaffer 2021, pp. 12-17; Toffelmier et al. *in litt*. 2022). The Service currently recognizes two categories of SB CTS ponds: known and potential breeding ponds. Known breeding ponds include vernal pools that have had evidence of SB CTS reproduction, eggs, larvae, or metamorphs (Service 2009, pp. 7-9; Service 2016, pp. I-2 and I-4). Potential breeding ponds include vernal pools where SB CTS breeding has not been recorded. Such ponds are often, but not always, located within SB CTS dispersal distance of other natural or artificial vernal pools, whether of known or potential breeding status (Service 2009, pp. 7-9; Service 2016, pp. I-2 and I-4).

During 1996-2000, before the time of the final listing, 27 known breeding ponds were documented across the SB CTS DPS (65 FR 57242). At the time of the final listing rule, 14 known breeding ponds were documented, and 1 known breeding pond was noted as destroyed (i.e., ca. 1998); therefore, 26 known breeding ponds had been documented in total (65 FR 57242). Of these, 5 known breeding ponds occurred in the West Santa Maria metapopulation area; whereas, 4 known and 3 potential breeding ponds occurred in the West Los Alamos metapopulation areas (65 FR 57242). Numbers of breeding ponds were not reported for the other 3 metapopulation areas. While the total number of known breeding ponds more than doubled between 2000 and 2009 (i.e., whether due to enhanced detection, easing of access restrictions, or otherwise), few new known breeding ponds have been discovered since; notably, however, 236 potential breeding ponds, located within metapopulation areas, are now classified across the SB CTS DPS (Table 1).

Table 1. Metapopulation areas (Service 2016, p. I-3) including historic and current number of known and potential breeding ponds. Ponds summarized denote extant breeding location status at the time of record. Potential breeding ponds were not summarized in the last review (Service 2009, pp. 8-9).

Metapopulation Area	Number Known Ponds (2009)	Number Known Ponds (2022)	Number Potential Ponds (2022)[1]
West Santa Maria	15	14[2]	33
East Santa Maria	6	4	43
West Los Alamos	11	12	50
East Los Alamos	4	4	21
Purisima Hills	18	20	46
Santa Rita Valley	5	5	43
Total	59	59	236

[1]This calculation only includes those potential ponds that occur within the metapopulation area boundaries. Please see Figures A-1 to A-6 for depiction of potential ponds located outside the metapopulation areas.
[2]One breeding pond, GUAD-12, lies outside the boundary to the west of the West Santa Maria metapopulation area.

Evaluation of Threats

CTS require a combination of pond habitat for breeding and upland habitat to complete their life cycle. The species depends on a series of interconnected breeding and upland habitats, making it particularly sensitive to changes in habitat amount, configuration, and quality. At time of listing, we identified habitat loss, degradation, and fragmentation (i.e., from urbanization and agriculture); overgrazing; vehicle-strike mortality; contaminants; and non-native species introductions as the primary threats to SB CTS (65 FR 57242). At the time of the 2009 5-year status review and 2016 Recovery Plan, all threats identified at the time of listing remained (Service 2009, p. 36; Service 2016, p. II-1). We also found drought and climate change to be new threats to the species. In the present status review, we find all threats identified in our previous assessments to be ongoing. We also identify inbreeding depression as a new threat and entrapment in technogenic structures as a potential threat to the DPS.

Habitat Loss, Degradation, and Fragmentation

At the time of listing, we determined that habitat loss, degradation, and fragmentation due to urbanization and agriculture were the primary threats to SB CTS (65 FR 57242), and these remain the current primary threats (Service 2009, p. 36; Service 2016, p. II-1). We also describe information on land use, conservation efforts, and potential violations of federal and state law with respect to SB CTS habitat.

Urbanization

SB CTS was re-assigned a recovery priority number of 3C in the last 5-year review (Service 2009, p. 37), which suggests a high potential for species recovery as well as a high degree of threat in conflict with land development (e.g., urbanization; Service 2009, p. 37; Service 2016, p. I-1). Across the DPS, urbanization or the conversion of natural landscapes to residential, industrial, or commercial lands continues to threaten SB CTS population recovery by decreasing the amount of available habitat and inhibiting inter-pond dispersal and habitat connectivity (Service 2009, pp. 13-19; Service 2016, pp. I-8 to I-11). Conversion of aquatic and upland habitats causes habitat loss that reduces landscape capacity to support a minimum viable population of SB CTS, thus inhibiting the population's ability to withstand stochastic disturbance events (Service 2016, p. II-1). In addition, established roads and highways can inhibit SB CTS dispersal capacity without sufficient barrier fencing and road-crossing structures (e.g., underground tunnels spaced < 12.5 m [3.3 feet] apart; Brehme et al. 2021, p. 11) to help prevent vehicle-strike mortality (Service 2009, pp. 28-29; Service 2016, p. I-17).

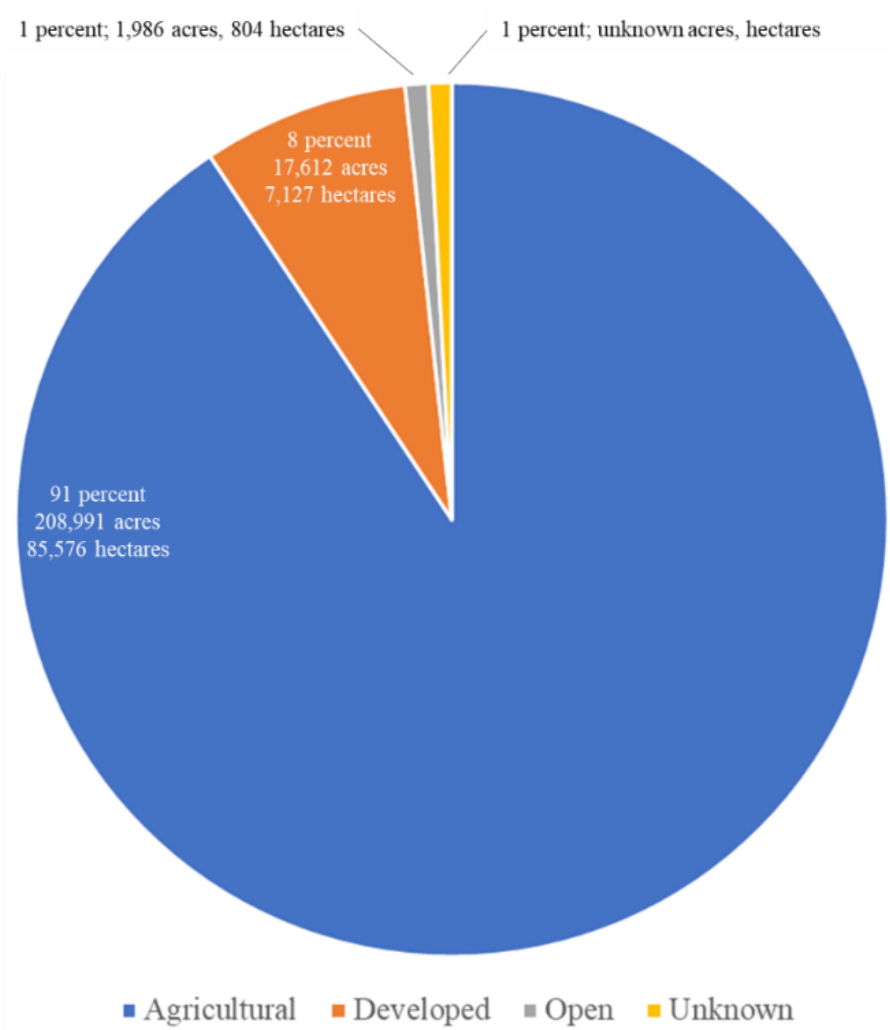
Agriculture

Conversion of aquatic and upland habitats to intensive agricultural land uses (e.g., row-crop, viticulture, cannabiculture) results in habitat loss, degradation, and fragmentation that continues to threaten SB CTS (Service 2009, pp. 14 and 36; Service 2016, pp. I-8 to I-9 and II-1). Northern Santa Barbara County is dominated by agricultural land uses, and several large agricultural operations are located in the Santa Maria Valley (e.g., farms > 1,000 acres [405 hectares] in size; Santa Barbara County Association of Governments 2007), where two of the six SB CTS metapopulation areas occur. Grading and leveling or deep-ripping operations associated with agricultural conversion of uplands have destroyed many ponds and pools (Coe 1988, pp. 356-358), reducing SB CTS breeding habitat and causing direct injury and mortality to larvae and juveniles occupying the pools (Service 2009, p. 14; Service 2016, p. I-9). Land conversion to intensive agriculture can also create permanent barriers that can isolate SB CTS and prevent movement between aquatic and upland habitats (Service 2009, p. 14; Service 2016, p. I-9).

Land-use and Conservation

At the time of this 5-year review, the vast majority of land use across the SB CTS DPS is agricultural (e.g., row-crop, viticulture, cannabiculture) or developed (i.e., "urbanized" residential, industrial, commercial, recreational, and communal; Santa Barbara County Planning and Development 2021). In contrast, little area comprises other open land uses (i.e., lands with "no agricultural potential, [but] outstanding natural resource value") or unknown/unclear land uses (Figure 2; Santa Barbara County Planning and Development 2021; Figure 2).

Figure 2. Composition of mutually exclusive land uses across Santa Barbara County. Approximately 91 percent of the area across all parcels supports agricultural (e.g., row-crop, viticulture, cannabiculture) land uses compared to 8 percent that supports developed land (i.e., residential, industrial, commercial, recreational, and communal; Santa Barbara County Planning and Development 2021). Approximately 1 percent of the area across all parcels supports other open land uses (e.g., lands with "no agricultural potential, [but] outstanding natural resource value;" Santa Barbara County Planning and Development 2021). The remaining 1 percent of area represents lands with presumably unknown or unclear uses.



Despite such land use patterns, the ongoing threat of habitat loss, degradation, and fragmentation due to urbanization and agriculture is being countered by aquatic and upland habitat conservation across the SB CTS DPS (Table 2). To benefit SB CTS recovery, there are two conservation easements within the West Santa Maria metapopulation area (Figure A-1). There are no conservation easements in either the East Santa Maria (Figure A-2) or East Los Alamos (Figure A-4) metapopulation area. Both the West Los Alamos (Figure A-3) and Santa Rita Valley (Figure A-6) metapopulation areas contain one conservation easement each. The Purisima Hills metapopulation area currently hosts four conservation easements, including the La Purisima Mitigation Bank, Phase I (Figure A-5).

Table 2. Summary of conserved SB CTS ponds and associated lands by metapopulation area. Ponds summarized denote extant breeding location status at the time of record. Missing values indicate no ponds are currently preserved in the respective metapopulation area.

Metapopulation Area	Number Conserved Breeding Ponds[1]	Conserved Pond Area (2022)[2]	Total Conserved Area (2022)
West Santa Maria	4 K	825 acres 334 hectares	2,078 acres[3] 841 hectares
East Santa Maria	-	-	-
West Los Alamos	-	-	651 acres 263 hectares
East Los Alamos	-	-	-
Purisima Hills	7.33 (5.33 K, 2 P)[4]	1,261 acres 510 hectares	1,753 acres[5] 709 hectares
Santa Rita Valley	1 K	-	463 acres 187 hectares
Total	12.33 (10.33 K, 2 P)	2,086 acres 844 hectares	4,945 acres 2,001 hectares

[1]Summarizes both known (K) and potential (P) breeding ponds.
[2]Representing contiguous or semi-contiguous conserved acreage around known breeding ponds.
[3]Includes one conserved property, Casmalia (i.e., 1254 acres or 508 hectares), which currently contains no known or potential breeding ponds.
[4]Summarizes breeding ponds located on the conserved Rancho San Lorenzo (i.e., 33 percent of a preserved pond) and La Purisima Mitigation Bank, Phase I properties.
[5]Includes one conserved property, Yellow Foxtrot - Breese Canyon (i.e., 325 acres or 132 hectares), which currently contains no known or potential breeding ponds. Additionally, includes one conserved property, Haugan/Wisniewska (i.e., 16 acres or 7 hectares), which currently contains one potential, but no known, breeding pond(s).

Violations of Federal and State Law

Both the federal Endangered Species Act and California Endangered Species Act prohibit the unauthorized "take" of threatened (e.g., CTS range wide at the state level) and endangered (e.g., SB CTS at the federal level) species. Since the Service listed the Santa Barbara County DPS of CTS in 2000, its Division of Law Enforcement has investigated several potential violations of section 9 of the Endangered Species Act. Such 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 incidents 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 (Service 2016, pp. I-13 to I-14). In May 2021, alleged destruction of a known SB CTS breeding pond was detected during evaluation of recent aerial imagery within the West Santa Maria metapopulation area, and this case is currently being reviewed by state and federal agencies. Since the last 5-year status review (Service 2009, pp. 8-9 and 15-16), at least 1 potential breeding pond (ca. 2011-2012) and 1 known breeding pond (ca. 2020-2021) have been destroyed within the West Santa Maria metapopulation area—these ponds are thus excluded from summaries of recognized breeding ponds in the present status review.

Overgrazing
Poor livestock-grazing practices can have negative impacts on CTS. Overgrazing may reduce water tables and increase nitrate levels, causing algal blooms, which contribute to the loss of wetland habitats (Howell et al. 2019, p. 8). However, cattle grazing is generally compatible with CTS habitat use and recovery when best management practices are followed (Service 2009, p. 20; Service 2016, pp. I-10, I-14, and III-6). Cattle ranching can be compatible with or beneficial to CTS conservation (68 FR 28648) because cattle also need open grasslands and ponds, helping preserve the quality and quantity of CTS breeding and non-breeding sites (Howell et al. 2019, p. 8; Biggs and Huntsinger 2021, p. 64). In addition, cattle grazing may mediate the effects of increased drying rates on vernal pools (e.g., due to climate change) by reducing vegetation and increasing periods of inundation necessary for successful CTS reproduction (Pyke and Marty 2005, pp. 1622-1623). By keeping vegetation cover low and regularly managed, cattle grazing can also make areas more suitable for California ground squirrels and Botta's pocket gophers, which provide CTS refugia during the non-breeding season (68 FR 28648). Cattle grazing can also promote greater surface-water runoff into vernal pool basins, helping to maintain water for CTS breeding. Across the SB CTS DPS, much of the remaining vernal pool habitat is currently being grazed using cattle (Service 2009, pp. 17-18 and 20; Service 2016, pp. I-10 and III-6).

Vehicle-strike Mortality
Across the DPS, vehicles on roads contribute to direct mortality of SB CTS (Bain et al. 2017, pp. 192-193 and 198-199; Stokes et al. 2021, p. 4). SB CTS are at risk of being run over by vehicles on their first dispersal when juveniles leave their origin pond, and on future migrations to and from ponds for breeding. Road mortality can contribute to population declines through increased mortality and patch isolation (Trombulak and Frissell 2000, pp. 19-20 and 22). In the East Santa Maria metapopulation area, SB CTS have been frequently seen crossing Dominion, Foxen Canyon, and Orcutt-Garey Roads on rainy nights during breeding migrations. More than 50 percent of these observations include SB CTS that are dead or dying from vehicle strikes (A. Abela et al., *unpubl. data*). SB CTS that are most often impacted by vehicle strikes are migrating adults in breeding condition, which are important for population growth and stability. Therefore, particularly in metapopulation areas already compromised by other threats, road morality could contribute to extirpations.

Contaminants
Amphibians are extremely sensitive to pollutants, such as pesticides and other chemicals, due to their highly permeable skin (Blaustein and Wake 1990, pp. 203-204). 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, pp. 67-69; Blaustein and Johnson 2003, pp. 87-90). Pesticides may also reduce or eliminate prey base, negatively impacting localized food chains and increasing the risk of starvation in CTS (Messerman et al. 2021, pp. 1305-1307)—perhaps even triggering conspecific cannibalism, though rare in native CTS (Cooper *in litt*. 2022). Sources of chemical pollution that may threaten CTS include hydrocarbon and other contaminants from the application of chemicals for agricultural production, burrowing animal control, oil production, and road runoff (Service 2009, p. 30).

Non-native Species Introductions

Hybridization

Unmanaged CTS hybridization with non-native salamander species risks genetic integrity of CTS as well as vernal pool ecosystem function due to hybrid predatory capacities (Searcy et al. 2016, p. 100; Toffelmier and Shaffer 2021, p. 2). Toffelmier and Shaffer (2021, p. 4) evaluated potential SB CTS hybridization with BTS based on samples from 1986 to 2017. All BTS genotypes were from the four known BTS source ponds, with no BTS genotypes at any sites within SB CTS metapopulation area boundaries. Consequently, at this time, SB CTS hybridization with BTS likely poses little to no threat to SB CTS recovery (Toffelmier and Shaffer 2021, p. 11).

Since federal listing in 2000, the Service has worked closely with the California Department of Fish and Wildlife to prohibit the sale of "waterdogs" (i.e., non-native tiger salamanders of the genus *Ambystoma*) as bait or pets. In October of 2014, CDFW passed amendments to Title 14 of the California Code of Regulations (CCR; i.e., 14 CCR §§ 200.12, 200.29, 200.31, and 671(C)(3)(c)(1)) clarifying that possession of non-native tiger salamanders is unlawful and prohibited in California, which removed a previous loophole that had allowed their use as fish bait (California Office of Administrative Law 2014).

Predation

Across the SB CTS DPS, non-native fish (e.g., mosquitofish, *Gambusia affinis*), amphibians (e.g., American bullfrog, *Lithobates catesbeianus*, and BTS), and crustaceans (e.g., red swamp crayfish, *Procambarus clarkii*) contribute to elevated levels of predation. Permanent (often artificial, constructed) ponds increase the likelihood of non-native species persistence and expansion (Fitzpatrick and Shaffer 2004, pp. 1286-1291; Fitzpatrick and Shaffer 2007, pp. 602-607; Service 2009, pp. 22-24; Service 2016, pp. I-11 to I-13). As a management tool, eliminating perennial or permanent ponds through seasonal draining or extensive physical modification (e.g., of vegetation, soils) can help limit the spread and establishment non-native predators (Fitzpatrick and Shaffer 2004, pp. 1288-1290; Fitzpatrick and Shaffer 2007, p. 605; Service 2009, p. 12; Service 2016, pp. I-16 and III-4).

Competition

SB CTS may also be limited through increased competition for food and shelter from non-native predators, other amphibians, and conspecifics (Service 2009, pp. 33-34; Service 2016, pp. I-16 to I-17). Competition from fish that prey on mosquito larvae and other invertebrates can reduce CTS prey base (Anderson 1968, pp. 274-282; Holomuzki 1986, p. 440; Stebbins and McGinnis 2012, p. 72). Large numbers of mosquitofish and other non-native predators may outcompete CTS larvae and other native amphibians for food in vernal pools (Graf and Allen-Diaz 1993; Lawler et al. 1999, pp. 615 and 619; Hamer et al. 2002, pp. 449-450). The introduction of other fish (e.g., fathead minnow [*Pimephales promelas*]; P. Collins, Santa Barbara Museum of Natural History, *pers. comm.* 1999) for recreational fishing (e.g., largemouth bass [*Micropterus salmoides*], green sunfish [*Lepomis cyanellus*]; S. Sweet, University California Santa Barbara, *pers. comm.* 1999) may also affect the prey base, reducing survival and growth rates of CTS (Service 2009, p. 34; Service 2016, p. I-17).

Drought and Climate Change

Climate change has contributed to global amphibian declines (Corn 2005, pp. 60-64; Wake 2007, pp. 8201-8202; Reaser and Blaustein 2005, pp. 60-61). Factors such as epidemic disease (Pounds et al. 2006, pp. 161-162 and 165), changes in breeding phenology (Terhivuo 1988, pp. 167-171; Blaustein et al. 2001, pp. 1806-1808; Gibbs and Breisch 2001, pp. 1176-1178; Beebee 1995, p. 219), increased evaporation rate (Corn 2005, pp. 63-64, but see Pyke and Marty 2005, pp. 1620 and 1622-1624), increased frequency of storm events and drought (Kagarise-Sherman and Morton 1993, pp. 192-194) and ultraviolet radiation (Blaustein et al. 1998, pp. 800-804) have been identified to affect amphibian persistence. Changes to the hydroperiod of vernal ponds due to changing weather patterns have had significant implications for the diversity of amphibians that rely on those ponds for breeding (Corn 2005, pp. 60-61).

Climate change projections indicate warmer air temperatures, more intense precipitation events, and increased summer drying (Field et al. 1999, pp. 5-10; Cayan et al. 2008, pp. S38-S40; Intergovernmental Panel on Climate Change 2014, pp. 3-8). Recent climate modeling suggests that annual maximum air temperatures along California's central coast are likely to increase by 1.51 degrees Celsius (2.72 degrees Fahrenheit) under a moderate-emissions scenario and by 2.84 degrees Celsius (5.12 degrees Fahrenheit) under a high-emissions scenario by 2100 (Langridge 2018, pp. 13-15). In Santa Barbara County, climate modeling indicates that annual maximum air temperatures will likely increase by 1.44 degrees Celsius (2.60 degrees Fahrenheit; i.e., moderate emissions) and by 2.78 degrees Celsius (5.00 degrees Fahrenheit; i.e., high emissions) by 2100 (Langridge 2018, pp. 13-15). Additionally, in Santa Barbara County by 2100, models suggest a decrease of 35.56 millimeters (1.40 inches; i.e., moderate emissions) and increase of 22.86 millimeters (0.90 inches; i.e., high emissions) in mean annual precipitation by 2100 (Langridge 2018, pp. 16-17).

According to recent climate modeling across the central coast of California, extreme drought events are predicted to increase in severity or duration, and this is despite potentially modest changes in mean annual precipitation through 2100 (Langridge 2018, pp. 6-7 and 16-17). In years of prolonged drought, some breeding ponds may not fill at all or incur reduced inundation levels and periods (Pyke and Marty 2005, pp. 1622-1623; Service 2009, p. 11; Service 2016, p. I-5), and adult male and female CTS may thus entirely forego reproduction until ponds fill again (Jennings 2000, pp. 193-196; Service 2009, p. 13; Service 2016, p. I-5 to I-7 and I-19). CTS require 4 to 5 years to reach sexual maturity, and less than 50 percent of first-time breeding CTS may survive to breed again (Trenham et al. 2000, pp. 371-372). Metamorph survivorship is also low, less than 5 percent in some areas (Trenham 1998). Drought-associated reproductive failure in whole cohorts can thus lead to extirpations because of severe impacts to recruitment over time (Service 2009, p. 28; Service 2016, pp. I-8, I-19, and II-1).

Inbreeding Depression

SB CTS genetic diversity is lower than that of other Ambystomatid salamanders and most other vertebrate groups (McCartney-Melstad et al. 2018, pp. 4433-4437; Robinson et al. 2016, pp. 1183-1187; Toffelmier and Shaffer 2021, p. 14). Recent genetics work found that population estimates of nucleotide diversity were extremely low, and estimated median effective population size was much lower than that of other CTS (Wang et al. 2011, pp. 915-917; Toffelmier and Shaffer 2021, p. 14). Additionally, Toffelmier and Shaffer (2021, pp. 21-22 and 24-25) found greatest evidence of inbreeding depression in SB CTS populations with the least genetic diversity, including ponds within the Purisima Hills and Santa Rita Valley metapopulation areas. These extremely low levels of genetic diversity and high levels of inbreeding suggest that SB CTS is at risk of inbreeding depression and a potential extinction vortex (Frankham et al. 2017, pp. 41-64; Toffelmier and Shaffer 2021, p. 14). While some breeding habitat has been preserved over the past three decades, expected increases in effective population sizes or genetic diversity have not been observed, suggesting that more targeted management (e.g., SB CTS headstarting and/or assisted migration) may be necessary to genetically rescue the DPS from threat of extinction (Toffelmier and Shaffer 2021, p. 15).

Entrapment in Technogenic Structures

Due to their ground-dwelling habits, amphibians and other herpetofauna are susceptible to falling and getting trapped within manmade structures (e.g., wells, storm drains, erosion-control netting, railroad lines, construction trenches; Enge et al. 1996, pp. 4-6; Stuart et al. 2001, p. 162; Kornilev et al. 2006, pp. 147-148; Manning 2007, p. 465; Garcia-Cardenete et al. 2014, pp. 344-346; McInroy and Rose 2015, pp. 18-19; Villa et al. 2018, pp. 55-60). Specifically, above-ground movement by CTS between aquatic and upland habitats may make them particularly susceptible to incidental entrapment. Alvarez et al. (2021b, p. 275) recently reported that Central CTS and other sympatric herpetofauna were trapped within underground utility boxes or vaults at Travis Air Force Base in Solano County. During November 2017 and September 2020, 362 vault checks at 67 unique vaults revealed that 79 CTS were trapped among a total of 2,275 individual vertebrates. Seventy-seven of 79 CTS trapped were post-metamorphic individuals; only 2 adults were observed trapped and the other 77 individuals were presumed to have dispersed from a nearby pond. Alvarez et al. (2021b, p. 276) suggested that locations of the vaults entrapping CTS may correlate with proximity to the off-site breeding pond. While threat of utility-vault entrapment was documented in the Central DPS, Alvarez et al.'s (2021b, pp. 276-278) findings suggest this may also be a threat in Santa Barbara County.

EVALUATION OF DOWNLISTING AND DELISTING CRITERIA

Downlisting and delisting criteria for SB CTS are described in the final Recovery Plan (Service 2016, pp. II-2 to II-3). Downlisting may be considered when all the following criteria have been met in a sufficient number of metapopulation areas such that SB CTS exhibits increased resiliency and redundancy and maintained or increased representation to prevent endangerment in the foreseeable future:

Criterion #1: At least four functional breeding ponds are in fully preserved status per metapopulation area.

At the time of this 5-year review, this recovery criterion has been met in the Purisima Hills metapopulation area (i.e., 5.33 known breeding ponds and 1 potential breeding pond conserved; Table 2). While there are 4 known breeding ponds conserved in the West Santa Maria metapopulation area, one of these ponds is surrounded by only 122 acres of upland habitat, indicating that it cannot contribute to Recovery Criterion #1 (i.e., given #2 and #3 below). Therefore, this criterion has been met in 1 out of the 6 metapopulation areas.

Criterion #2: A minimum of 623 acres (252 hectares) of functional upland habitat around each preserved pond is in fully preserved status.

At the time of this 5-year review, and because fully preserved upland habitat area is summarized on a per pond basis and allowed to overlap spatially (Service 2016, p. II-3), this recovery criterion is likely met by the Purisima Hills metapopulation area, but it has not been met in any of the other five metapopulation areas (Table 3).

Table 3. Area of functional upland habitat (i.e., grassland, shrub/scrub, bare ground landcover types) within SB CTS dispersal distance (i.e., 2.1 kilometers [1.3 miles]) around each preserved pond in fully preserved status per metapopulation area. Estimates of upland habitat area exclude individual pond area.

Metapopulation Area	Conserved Upland Habitat Area	Contiguous?
West Santa Maria	480 acres (194 hectares)[1]	Partially[2]
East Santa Maria	-	-
West Los Alamos	-	-
East Los Alamos	-	-
Purisima Hills	1,213 acres (491 hectares)[3]	Partially[4]
Santa Rita Valley	421 acres (170 hectares)	Yes

[1]Summarizes functional upland habitat around 4 known breeding ponds at the Betteravia conserved property.
[2]The Betteravia conserved property is bisected by a railroad, and thus 2 known breeding ponds (i.e., GUAD-40 and -2) are surrounded by 85 acres (34 hectares) of functional upland habitat; whereas the remaining 2 known breeding ponds (i.e., GUAD-1 and GUAD-4) are surrounded by 395 acres (160 hectares) of functional upland habitat.
[3]Includes (a) 645 acres (261 hectares) around 1.33 known breeding ponds (i.e., 33 percent of a pond preserved and another 1 known breeding pond preserved and connected via the Rancho San Lorenzo and the eastern portion of La Purisima Mitigation Bank, Phase I conserved properties), and (b) 558 acres (226 hectares) around 4 known breeding ponds and 2 potential breeding ponds preserved and connected via the central portion of the La Purisima Mitigation Bank, Phase I and Haugan/Wisniewska conserved properties.
[4]The La Purisima Mitigation Bank, Phase I conserved property contains functional upland habitat that is partially contiguous.

Criterion #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.

Because achievement of the third criterion depends on first satisfying Recovery Criteria #1 and 2, we report no new information on additional, contiguous functional upland habitat either (a) surrounding fully preserved known breeding ponds or (b) overlapping fully preserved tracts of functional upland habitat.

Criterion #4: Effective population size (N_e) in the metapopulation shows an overall positive trend across 10 years.

Based on genetic data collected from 1986 to 2017, Toffelmier and Shaffer (2021, p. 14) reported that, median effective population size for the SB CTS DPS was 12.2 individuals, ranging from 0.9 to 141.2 individuals. These results indicate overall very low effective population size and high variability across the DPS. Furthermore, the median size of 12.2 individuals was much lower than that of other CTS (e.g., 2.3 times less than estimated for Central CTS in eastern Merced County; Wang et al. 2011, pp. 915-917; Toffelmier and Shaffer

2021, p. 14), and is likely also lower than that of most other vertebrate groups (McCartney-Melstad et al. 2018, pp. 4433-4437; Robinson et al. 2016, pp. 1183-1187; Toffelmier and Shaffer 2021, p. 14). Additionally, based on the 30 years of data analyzed, effective population size did not appear to trend across the SB CTS DPS over time (Toffelmier and Shaffer 2021, pp. 12 and 15). Continued monitoring over time is thus needed for this criterion to be evaluated.

Criterion #5: Management is implemented to maintain the preserved ponds free of non-native predators and competitors (e.g., bullfrogs and fish).

Ponds in fully preserved status within existing conservation easements are managed for the benefit of SB CTS, which usually includes removal of non-native predators and competitors. In addition, preserved ponds are required to be monitored and managed to ensure non-native predators do not become established. As more ponds are preserved, management for non-native predators and competitors should continue to be included in management plans.

Criterion #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.

Toffelmier and Shaffer (2021, p. 4) evaluated potential SB CTS hybridization with BTS based on samples from 1986 to 2017. All BTS genotypes were found in the four known BTS source ponds, with no BTS genotypes at any sites within SB CTS metapopulation area boundaries. Consequently, at this time, SB CTS hybridization with BTS likely poses little to no threat to SB CTS recovery (Toffelmier and Shaffer 2021, p. 11). Therefore, this criterion has been met.

Summary of Recovery Criteria

Currently, no metapopulation area has fully satisfied the downlisting criteria. Only Recovery Criterion #6 has been met across all metapopulation areas. Because the majority of downlisting recovery criteria have not been met and because the majority of threats at time of listing are still present and active, we did not evaluate delisting criteria at this time.

CONCLUSION

After reviewing the best available scientific information, we conclude that Santa Barbara County Distinct Population Segment of the California tiger salamander remains an endangered species. The evaluation of threats affecting the species in consideration of the factors described in section 4(a)(1) of the Endangered Species Act and presented in the final Recovery Plan (Service 2016, pp. I-8 to I-19) remains accurate, with increased threat from inbreeding depression.

RECOMMENDATIONS FOR FUTURE ACTIONS

In this section, we make recommendations that will aid in the recovery and conservation of the SB CTS.

1. Implement occupancy and effective population size monitoring with sufficient spatiotemporal coverage across the SB CTS DPS.

2. Implement SB CTS genetic rescue via field collection, headstarting, and targeted population enhancement within and between metapopulation areas across the SB CTS DPS; include success criteria and genetics monitoring.

3. Establish new conservation easements for the benefit of SB CTS, especially within the West and East Santa Maria, East Los Alamos, and Santa Rita Valley metapopulation areas.

4. Evaluate SB CTS population- and individual-level responses to drought and climate change, especially as both forces influence pond filling and water-retention rates, as well as vernal pool abundance and distribution to inform management of existing and created ponds; determine the best management actions to address climate change related threats.

APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

Approved STEPHEN HENRY Digitally signed by STEPHEN HENRY Date: 2022.07.18 17:29:56 -07'00' Date: 7/18/2022

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APPENDIX A

Below is a set of maps of individual metapopulation areas including their critical habitat units, known and potential breeding ponds, and conservation easements established to benefit SB CTS recovery.

Figure A-1. West Santa Maria metapopulation area of the California tiger salamander (*Ambystoma californiense*) in Santa Barbara County, including its designated critical habitat unit (69 FR 68568) and 2 conservation easements. Known and potential breeding ponds are displayed for added spatial reference. One known breeding pond occurs outside the metapopulation area, west-northwest.

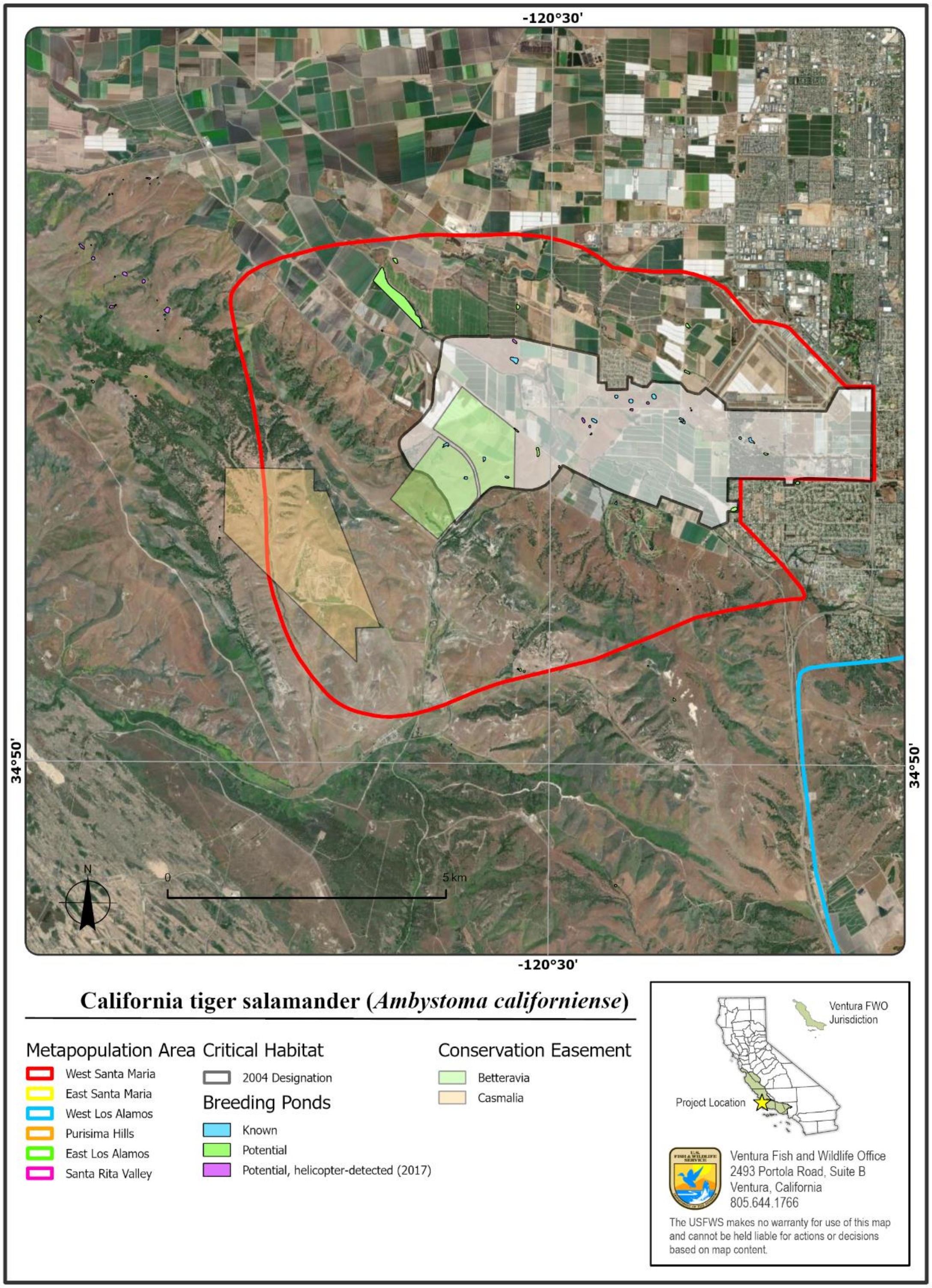

Figure A-2. East Santa Maria metapopulation area of the California tiger salamander (*Ambystoma californiense*) in Santa Barbara County, including its designated critical habitat unit (69 FR 68568). At present, this metapopulation area does not host any conservation easements. Known and potential breeding ponds are displayed for added spatial reference.

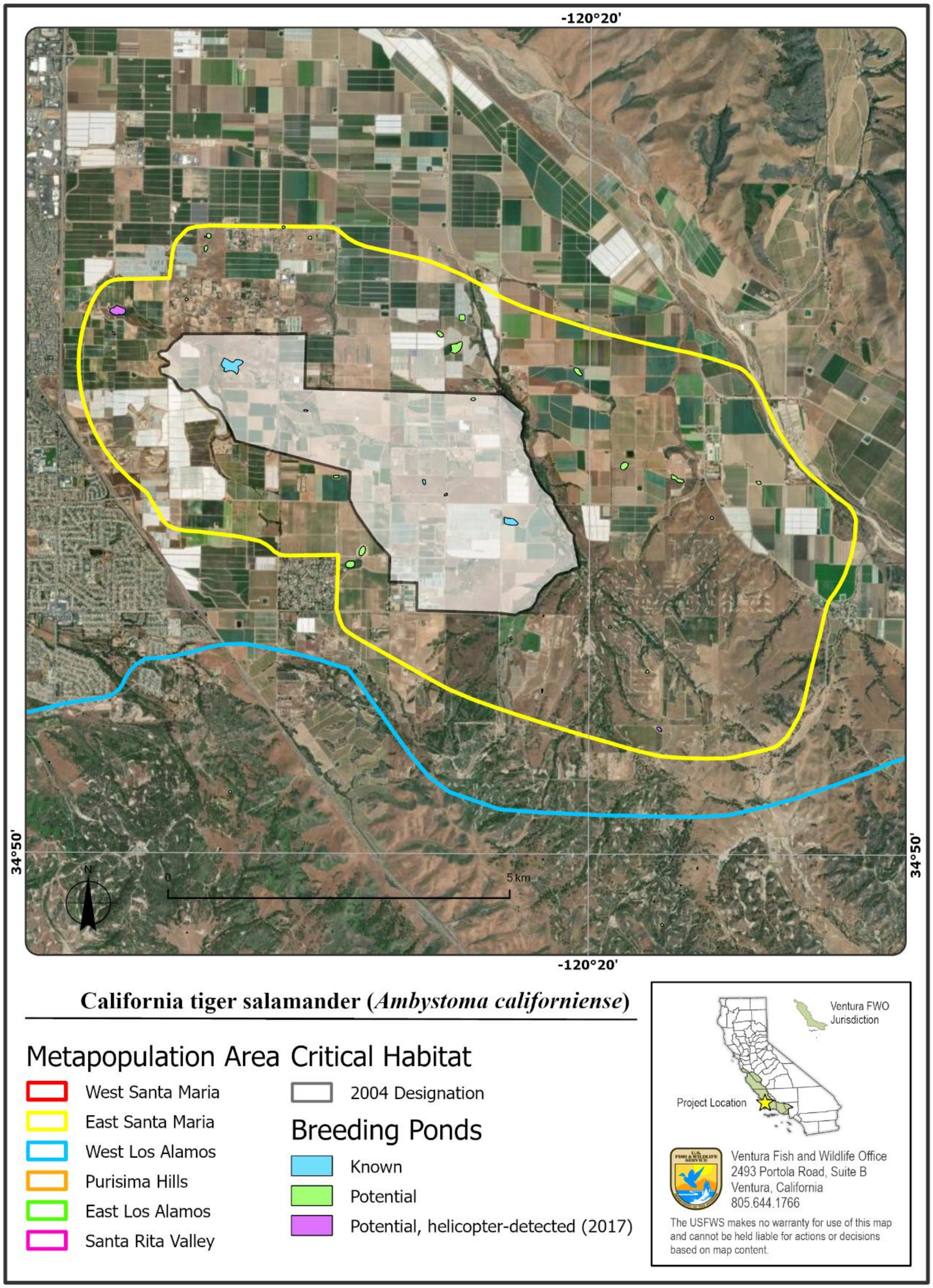

Figure A-3. West Los Alamos metapopulation area of the California tiger salamander (*Ambystoma californiense*) in Santa Barbara County, including its designated critical habitat unit (69 FR 68568) and 1 conservation easement. Known and potential breeding ponds are displayed for added spatial reference.

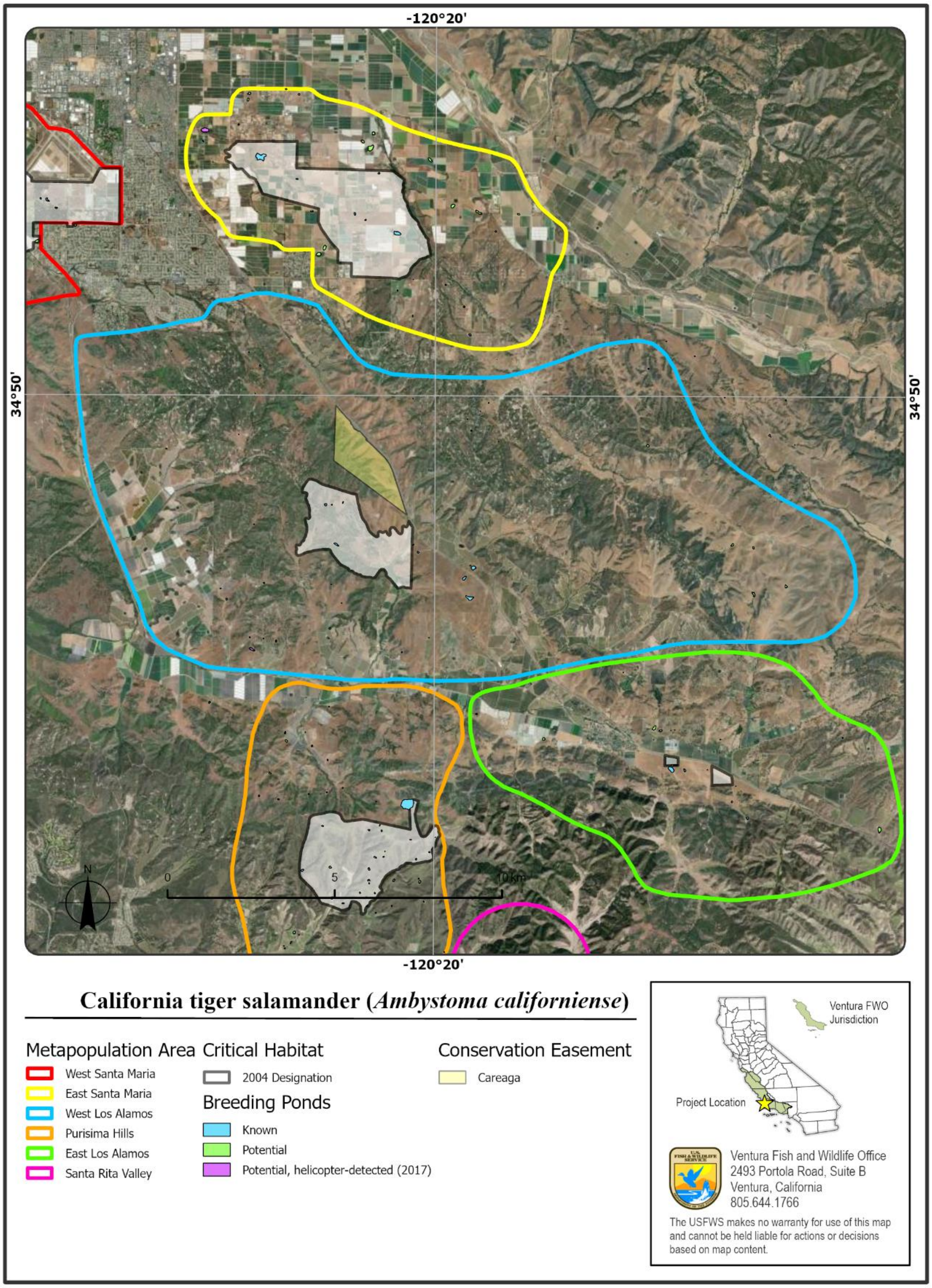

Figure A-4. East Los Alamos metapopulation area of the California tiger salamander (*Ambystoma californiense*) in Santa Barbara County, including its designated critical habitat unit (69 FR 68568). At present, this metapopulation area does not host any conservation easements. Known and potential breeding ponds are displayed for added spatial reference.

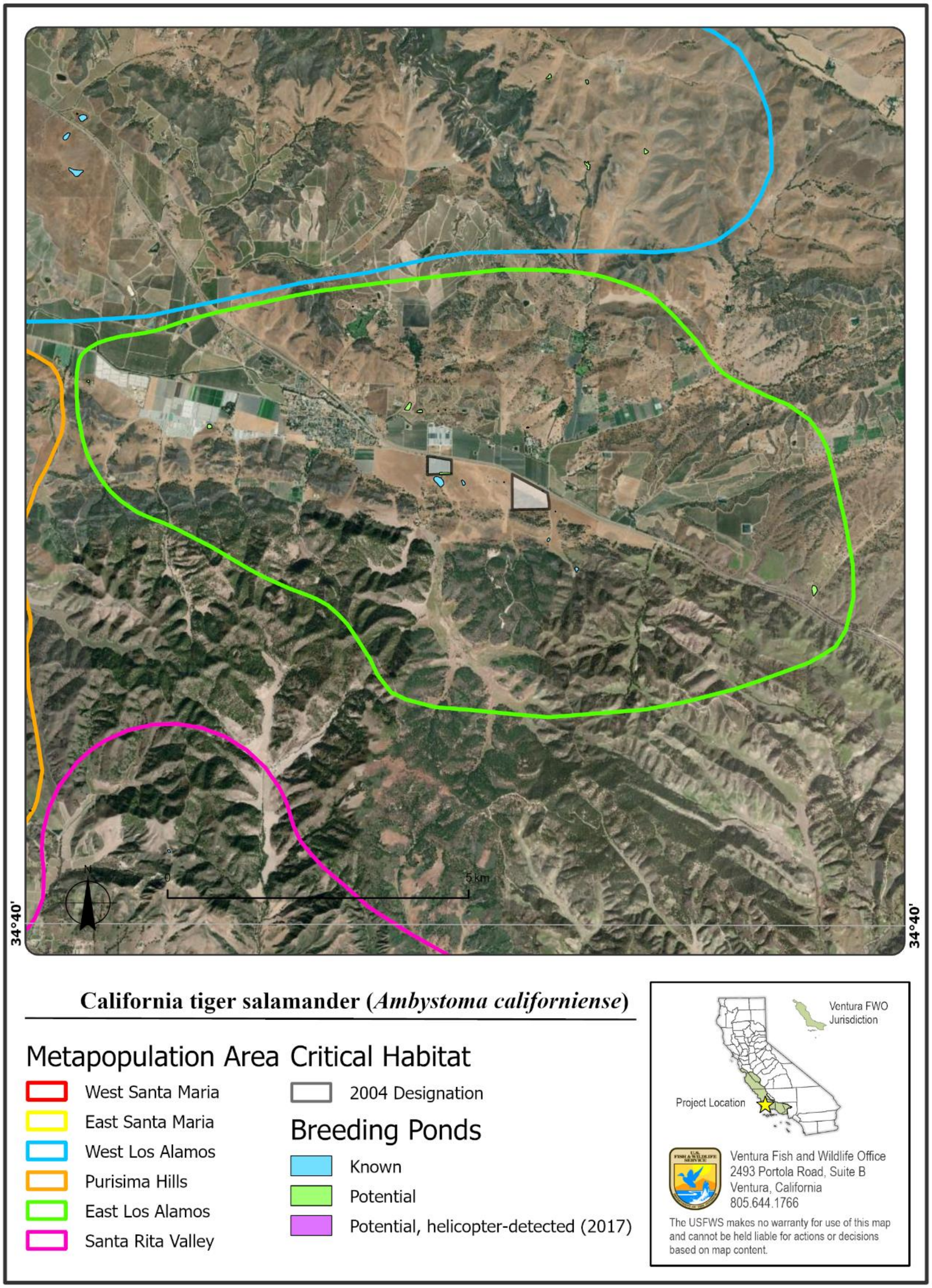

Figure A-5. Purisima Hills metapopulation area of the California tiger salamander (*Ambystoma californiense*) in Santa Barbara County, including its designated critical habitat unit (69 FR 68568) and 4 conservation easements. Known and potential breeding ponds are displayed for added spatial reference.

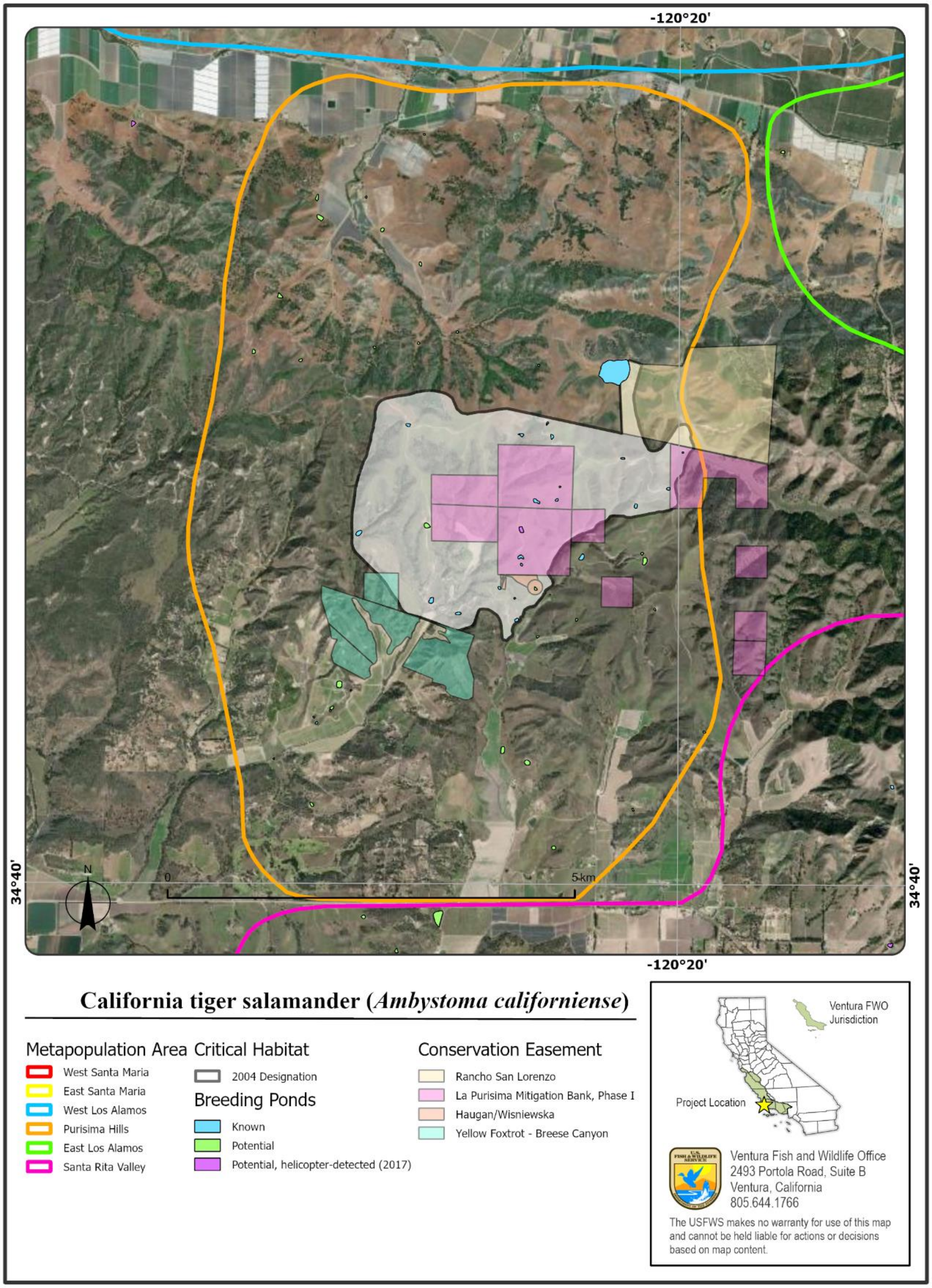

Figure A-6. Santa Rita Valley metapopulation area of the California tiger salamander (*Ambystoma californiense*) in Santa Barbara County, including its designated critical habitat unit (69 FR 68568) and 1 conservation easement. Known and potential breeding ponds are displayed for added spatial reference.