CALIFORNIA TIGER SALAMANDER

Ambystoma californiense
USFWS: Threatened
CDFG: Threatened

Species Account

Background

Status and Description The California tiger salamander consists of three population segments that were listed by the Federal Government at different times. In 2000, the Santa Barbara County Distinct Population Segment of the California tiger salamander was listed as Federally Endangered . In 2002, the Sonoma County distinct population segment was listed as Federally Endangered on an emergency basis. The Endangered listing for the Sonoma County population was made permanent in 2003 (USFWS 2003a). Also during 2003, the USFWS proposed listing the Central California Distinct Population Segment of the California Tiger Salamander as threatened (USFWS 2003b). This listing proposal included reclassifying the Santa Barbara and Sonoma county populations as threatened (USFWS 2003b). The determination to list all populations as Threatened made final on August 4, 2004 (USFWS 2004).The California tiger salamander was added to the State of California list of threatened species in 2010 (CDFG).

LSA Associates file photograph

Adult salamanders are 75-125 millimeters in length and are colored jet-black with white or yellow spots or bars (Stebbins 1985). Larvae are 10.5 millimeters in length when hatched and vary from 41 to 78 millimeters at metamorphosis. Larvae are usually a dull yellowish gray with broad, flat heads and large feathery gills. At metamorphosis larvae weigh approximately 10 grams at (Jennings 2000).

Range. The historic range of the California tiger salamander is believed to have included much of the Central Valley from the southern San Joaquin Valley into the southern Sacramento Valley, the foothills of the Coast Range from Monterey County to Santa Barbara County, and the areas around Petaluma in Sonoma County (Jennings and Hayes 1994). According to Jennings and Hayes (1994), California tiger salamanders have been extirpated from approximately 55% of this historic range.

Currently, the California tiger salamander occurs in grasslands, and oak woodlands (Shaffer *et al.* 1993, LSA observations) in the central Coast Range of California, from southern Solano County to eastern Kern County, and in the Sierra Nevada foothills, from southern Sacramento County to northern Tulare County (LSA 1994). The species occurs to an elevation of 3000 feet in the Central Coast Range (LSA 1994), but is considered uncommon at elevations over 1500 feet (Shaffer *et al.* 1993).

The range of the species appears to approach, but not enter, the historical flood plain of the Central Valley of California (LSA 1994, Küchler 1977). Shaffer *et al.* (1993) reported it was their opinion ***A****California tiger salamander was probably never abundant in the San Joaquin saltbush community of the southern San Joaquin Valley, and the species was probably distributed intermittently in the Tule Marsh floodplain surrounding the major rivers, since these marshes probably supported fish*." Several other species of California salamanders, including ensatina (*Ensatina eschscholtzi*), arboreal salamander (*Aneides luguberus*), California newt (*Taricha torosa*), and California slender salamander (*Batrachoseps attenuatus*) are similarly distributed on either side of the Central Valley.

In addition to the main Central Valley population, three apparent disjunct populations of California tiger salamander are recognized: the first located on the Santa Rosa Plain of Sonoma County, the second in central Monterey County, and the third in central Santa Barbara County. The Santa Barbara and Sonoma populations have been determined to be genetically distinct and are likely to represent true naturally occurring isolates. These populations may eventually be considered separate species (Shaffer *et al.* 1993). The central Monterey population is not genetically differentiated and may be a recent isolate or a documented population in an undocumented portion of the general range. Several authors have incorporated these disjunct populations into the general range of the California tiger salamander. However, no populations of California tiger salamander have ever been located in the areas between the isolated populations and the rest of the species range. More importantly, the genetic data indicates that at least the Santa Barbara and Sonoma populations have been isolated for upwards of 1-1.5 million years (Shaffer and McKnight 1996).

An isolated population of unknown origin exists in the Dunigan Hills of Yolo County. This population is genetically identical to animals in southern Solano County (Shaffer *et al.* 1993). The Dunnigan population breeds in a single man-made stockpond and no natural breeding sites appear to occur in the vicinity (LSA observation). There is also a record of an extirpated population from Gray Lodge at the base of the Sutter Buttes in Sutter County that disappeared in the 1960's (Hayes, date unknown). Several species of amphibians and reptiles, such as long nosed snake, slender salamander, San Joaquin whipsnake, and foothill yellow-legged frog have isolated populations associated with the Sutter Buttes. These two populations may be either isolates from a previously expanded range or introductions into these areas. Tiger salamander larvae have historically been used for fish bait and, in such manner, non-native species have been introduced into several locations in California (Shaffer *et al.* 1993). The native California tiger salamander may have been introduced outside of its naturally occurring range.

Occurrence in Plan Area. In Solano County, this species is associated with the Valley Floor Grassland and Vernal Pool Natural Community. The distribution and range of California tiger salamanders within the Plan Area was divided into two components, a known core breeding area and a potential range (See associated species distribution map). The known core breeding area was defined by buffering all of the breeding records within the Plan Area by 1.3 miles, with the exception of northeast Fairfield. This is the same methodology used by CDFG (2010) to estimate occupied habitat. CDFG (2010) used 1.3 miles because it is the maximum distance a California tiger salamander has been documented from the nearest breeding pond (Orloff 2007). For northeast Fairfield, Putah South Canal and Peabody Road defined the edge of the known core breeding area.

The known core breeding area is divided up into four partially isolated population nodes (Figure 4-7). The largest population node, which forms the core population in Solano County, is on the Jepson Prairie. The other sub-population nodes are northeastern Fairfield, Potrero Hills, and the Montezuma Hills. The corridor between the Jepson Prairie and the northeastern Fairfield population has been diminished to a very narrow and fragmented corridor from incompatible land uses (irrigated agriculture and Travis Air Force Base runway). The barrier created by the existing high traffic volumes on Highway 12 has largely eliminated California tiger salamander movement between the core population on the Jepson Prairie and the subpopulations in the Potrero Hills and the Montezuma Hills.

The potential range of California tiger salamanders within the Plan Area is an extension of the known core breeding area southeast into the Montezuma Hills, southwest into the remainder of the Potrero Hills, northwest into the Vacaville-Fairfield Green Belt, and northeast into remnant vernal pool habitat areas. There have been limited surveys for California tiger salamanders in the Montezuma Hills. Until recently (2009) there were no records for the species within this area; however, now there are three records for California tiger salamanders (two breeding ponds and one adult) (CNDDB 2009). These recent records expand the known range of the species south of Highway 12 into the Montezuma hills. The areas of potential range within the Potrero Hills are likely occupied but have not been surveyed.

There are several known breeding areas in northeast Fairfield adjacent to development and several other significant barriers. The edge of the known core breeding area in northeast Fairfield was defined by Putah South Canal and Peabody Road. The potential range was extended west and south of the Putah South Canal to Interstate 80. There are currently no known records within the hills of the Vacaville-Fairfield Green Belt area; however, there is suitable habitat and limited surveys have been conducted in this area. No records of California tiger salamanders occur north of I-80 on the west side of the Central Valley except for the one area in the Dunnigan Hills in Yolo County. Therefore, the potential range was cut off at Interstate 80. McCoy Basin and surrounding properties were also excluded from both the core breeding area and potential range of the species (Figure 4-7). Surveys conducted in this area have not identified this species (Volmar 2000; JSA 2001),

There is one historic record east of Dixon (Figure 4-7) and several small remnant patches of vernal pool habitat in the northeastern portion of the County. These areas were included in the potential range because of the historic record in Dixon; however, suitable habitat is very limited.

Associated Covered and Special Management Species. Additional Covered Species and Special Management Species that will benefit from this conservation strategy are the callippe silverspot butterfly, Valley elderberry longhorn beetle, foothill yellow-legged frog, Western pond turtle, and all other species associated with these two Natural Communities.

Preliminary Narrative Conceptual Model

This section provides a preliminary narrative conceptual model for California tiger salamanders. This model will be used to guide the conservation and management programs. Following concepts developed by Atkinson et al. (2004), the model describes the pressures affecting populations. Pressures are agents that either promote or inhibit change in the state of the environment (Atkinson et al. 2004).

Life Cycle and Biology.

Breeding Adults. Adults migrate to aquatic breeding sites during the first major rainfall events of fall and early winter, after which, they migrate back into upland habitat (Loredo et al, 1996; Trenham, 2001). Breeding habitat includes vernal pools, seasonal or fishless natural ponds, intermittent streams, or stock ponds. Males tend to arrive at breeding sites first and to remain in ponds longer than females (Twitty 1941, Loredo and Van Vuren 1996, Trenham 2000). It has been postulated that males arrive earlier and stay longer to maximize breeding success, while females may maximize reproductive success by waiting for a prolonged period of favorable environmental conditions (Douglas 1979, Loredo and Van Vuren 1996). Upon leaving breeding sites, adults have been observed to travel at least 130 meters before entering rodent burrows (Loredo *et al.* 1996).

Eggs and Larvae. Eggs are fertilized internally via a spermatophore (Twitty 1941). After which, they are laid singly or in clumps on both submerged and emergent vegetation or in ponds without vegetation, on the bottom or on submerged debris in shallow water. Females can lay between 400 to 1300 eggs (Trenham 1998; Trenham *et al.* 2000) and eggs hatch after 10-14 days (Storrer, 1922, Jennings and Hayes, 1994).

After hatching, larvae are 10.5 mm in length, but can vary from 41 to 78 mm in length at metamorphosis (Trenham 2000). Size at metamorphosis can be dependent on diet, pond age, pond temperature, and pond depth (Anderson 1968). The diet of small larvae consists mainly of small invertebrates, such as ostracods and copepods, and algae. As larvae grow, they appear to become more carnivorous eventually feeding on amphibian larvae, including their own species, and larger invertebrates, such as water beetles and backswimmers (LSA observations, Anderson 1968, Feaver 1971). Larvae metamorphose in late spring or early summer 60 to 94 days after the eggs are laid, usually coinciding with the drying out of their habitat (LSA, Anderson 1968, Feaver 1971, Loredo and Van Vuren 1996, Trenham *et al.* 2000). However, in perennial ponds, larvae have been observed to overwinter (LSA observations, Shaffer 1993, Alvarez pers. comm. 2000).

Juveniles. Very little is known about the activity patterns of juveniles. After metamorphosis, juvenile salamanders emerge from aquatic breeding sites where they have been observed moving up to 60 meters in an evening before seeking shelter in rodent burrows or cracks in the soil (Loredo *et al.* 1996). It is presumed that juveniles remain below ground in rodent burrows or other natural crevices for 2 to 6 years before reaching sexual maturing and returning to pools to breed (Loredo and Van Vuren 1996, Trenham *et al.* 2000).

Adult. Adult California tiger salamanders spend the majority of the year below ground in rodent burrows or other natural crevices (LSA observation, Storer 1925, Twitty 1941, Anderson 1968, Feaver 1971, Shaffer *et al.* 1993). Individuals are most frequently observed in the vicinity of burrows of California ground squirrels (LSA observation, Storer 1925, Loredo *et al.* 1996; Shaffer *et al.* 1993), but extensive populations have been found in locations that do not contain ground squirrel burrows (LSA data). The activity of California tiger salamanders in burrows has not been documented. Shaffer *et al.* (1993) postulated that salamanders primarily estivate while in burrows. Shaffer et al. (1993) sites the emaciated appearance of individuals when emerging from burrows during the winter rainy season as evidence of this. Other investigators have reported observing California tiger salamanders active in burrows during much of the year including summer months (Trenham 1998).

The diet of adult salamanders has not been studied but is assumed to be similar to other ambystomids and includes insects, worms, and other invertebrates. Adults have been observed feeding on earthworms while in burrows during the winter (LSA observation).

Habitat. In Solano County, this species is associated with the Valley Floor Grassland and Vernal Pool Natural Community (Figure 4-2). Adults occupy grasslands and the grassy understory of open woodlands, with abundant small-mammal burrows, particularly, California ground squirrel burrows, usually within 1 mile of breeding sites. Typical breeding sites include vernal pools, seasonal or fishless natural ponds, intermittent streams, or stock ponds. A recent study by Trenham and Shaffer (2005) hypothesized that contiguous upland habitat of 330 acres or more (2,100 foot radius) is needed to support a viable population and that multiple breeding sites need to be within 0.7 miles of each other (Trenham et al, 2000). Another recent study (Orloff 2011) found salamanders commonly move into upland habitats up to 2.2 kilometers (1.3 miles) from occupied breeding sites.

Population Structure. Population structure has been studied for a single pond located in Monterey County (Trenham *et al.* 2000). Mortality in this population was presumed high, with approximately 50% of juvenile salamanders not living past one year of age. The study assumed that mortality in older salamanders was the same as these juveniles and that, therefore, only 6.5% of individuals produced would live the four years necessary to reach maturity in this location. The study also, after discounting 20% of the population that bred in a separate pond, postulated that more than 50% of California tiger salamanders produced in this pond do not breed more than one time in their life. How this study may apply to populations of California tiger salamanders throughout the rest of their range is unclear.

Dispersal and migration. The ability for juveniles and adults to disperse and move between uplands and breeding habitats is important for the long-term survival of the species. California tiger salamanders are known to move through grasslands, agricultural areas, and across roads.

Jennings and Hayes (1994) report the species moves in nocturnal migrations over distances in excess of 3,280 feet (1000 meters). Trenham and Schaffer (2005) in an extensive study at Olcott Lake in Solano County found that 95 percent of the adult salamanders were within 1,480 feet (450 meters) and 95 percent of the subadult salamanders were found within 2,100 feet (640 meters) of the breeding pond (Olcott Lake). From this data, they predicted the maximum movement distance for both adults and juveniles from the breeding habitat to be 2,790 feet (850 meters). Orloff (2011) found a majority of the California tiger salamanders she captured were at least 800 meters from the nearest breeding site and that a smaller number of salamanders were captured as far as 2.2 kilometers (1.3 miles) from the nearest breeding sites.

Land Use Practices. The land use practices or primary pressures that directly affect California tiger salamanders in Solano County are: urbanization, intensive agriculture, cultivated grassland/dry-land farming and livestock grazing.

Urbanization and Intensive Agriculture. Urbanization and intensive agriculture or croplands results in direct habitat loss and fragmentation, decreased watershed area, altered hydrology, increased runoff and contaminants. Increased urban areas may also result in flood and mosquito control programs and increases in certain native predators and competitors and facilitate the spread of exotic species which may inadvertently affect California tiger salamanders.

Cultivated Grassland/Dry-land Farming. The direct affects of this practice on salamanders includes altered hydroperiod, reduced pool depth, periodically disking or tilling of the land and rodent control programs.

Livestock Grazing. The effects of livestock grazing on California tiger salamanders are complex. Cattle may have a negative affect on juvenile and adult salamanders directly via trampling while migrating to and from breeding sites. Livestock grazing can have positive affects on salamanders by reducing thatch build up, which may hinder salamander movement. The reduction in thatch also benefits California ground squirrel populations this could result in an increase in upland refuge sites (i.e. burrows) for adult and juvenile salamanders.

For Larvae, livestock grazing can reduce water quality by increasing turbidity and nitrate levels and decreasing dissolved oxygen levels. The negative effects of this are: abnormally high larval densities and reduced water quality which may increase the populations' susceptibility to infectious diseases. Increased nitrate levels may have negative effects on embryo and larval development (Marco et al. 1999 and De Solla et al. 2002). Other populations, outside of Solano County, are threatened by hybridization with introduced eastern tiger salamanders. Hybrids appear to be more successful in stock ponds significantly impacted by cattle. Thus, if eastern tiger salamanders are introduced into Solano County, populations of native California tiger salamanders are more susceptible to invasion in habitats significantly altered by cattle (Fitzpatrick and Shaffer, unpub. man.). Cattle can draw down water levels in breeding sites, leaving eggs and larvae with insufficient water to successfully hatch, develop and complete metamorphosis. The positive effects of this are: decreased water quality can alter the structure of aquatic food webs by decreasing the abundance of aquatic invertebrate predators, thus having a positive affect on larval densities. Increased water turbidity may also decrease predation from birds and reduce cannibalism levels.

Consequences of Land Use Practices. The Consequences of the above land use practices (i.e. secondary pressures) on California tiger salamanders in Solano County are:

Habitat Loss and Fragmentation. California tiger salamanders are most threatened by human activities that fragment and isolate breeding pools and refuge habitat (Jennings and Hayes 1994). These factors include the conversion and isolation of vernal pool habitats and grasslands to agricultural and urban developments (Barry and Shaffer 1994, Davidson et al, 2004). However, all of the anthropogenic pressures discussed in this model may affectively result in the isolation and fragmentation of habitats, precluding the dispersal between sub-populations.

Roads. Roads with projected night-time traffic volume of 20 cars per hour or greater act as significant barriers to migrating salamanders via direct mortality and by isolating adults from breeding sites (Twitty 1941, Barry and Shaffer, 1994).

Decreased Watershed Area. The surrounding watershed provides critical habitat for adult and juvenile California tiger salamanders. In addition, decreased watershed area can alter the hydroperiod of breeding sites leaving eggs and larvae with insufficient water to successfully hatch, develop and complete metamorphosis.

Altered hydrology. Alteration in pool hydrology from ephemeral to more permanent wetlands can promote the successful invasion of introduced predators such as fish, bullfrogs and crayfish and alter food web structure by increasing the abundance of aquatic invertebrate predators (Wellborn et al. 1996). Top invertebrate predators in permanent to semipermanent fishless habitats have strong negative effects on very active, rapidly developing prey such as California tiger salamander larvae (Wellborn et al. 1996). Evidence from field surveys suggest a negative relationship between invertebrate predators and the presence of California tiger salamanders (S. Bobzein, pers. comm.).

Altered pool hydrology that decreases the length of the inundation phase can also negatively affect salamanders. If the inundation period of breeding sites is insufficient for egg and larval development than that pool would be a reproductive sink for the population. Drought or irregular rainfall patterns, such as an early rainfall event followed by a hot dry period, or erratic fluctuations in water levels from lack of subsurface flows, can also decrease reproductive success, by causing pond levels to rapidly drop leaving eggs and larvae with insufficient water to successfully hatch, develop and complete metamorphosis.

Chemical Contaminants. Contaminants such as pesticides, heavy metals, treated effluent (estrogens), urban runoff and agricultural runoff can affect embryo and larval development, potentially leading to malformations, increased susceptibility to disease and death (Hayes et al. 2003, Marco et al. 1999 and De Solla et al. 2002).

Mosquito Control. The use of oil and other chemical pesticides for mosquito control can indirectly affect salamanders by altering food web dynamics (i.e. can result in decreased prey availability for larvae. In addition, mosquito fish, *Gambusia spp*, can have negative affects on salamanders (Leyse and Lawler 2000).

Rodent Control. Adult and juvenile California tiger salamanders are predominantly terrestrial, living underground in burrows of California ground squirrels, gophers, and other burrowing mammals. Rodent control programs may kill California tiger salamanders directly, via gassing burrows or directly consuming poison, or may kill them indirectly through the contamination of their food resource. Reducing populations of burrowing mammals also negatively affects California tiger salamanders by reducing upland refuge sites (Loredo *et al.* 1996).

Disking or Tilling. Disking or tilling may kill juvenile and adult salamanders in upland habitat and may also reduce burrowing mammal populations. The reduction in mammal burrows could indirectly affect salamanders by reducing upland refuge sites.

Introduced predators and Competitors and Increased Densities of Native Predators or Competitors. Increased predation pressure from natural predators such as raccoons and crows, whose populations are artificially inflated due to urbanization could reduce juvenile, adult and larval survival (Jennings and Hayes, 1994). Introduced predators such as fish, bullfrogs (*Rana catesbeiana*) and crayfish (such as *Procambarus clarkii*) negatively affect California tiger salamanders (Jennings and Hayes 1994, Shaffer *et al.* 1993). California tiger salamanders are also threatened by cross breeding with eastern tiger salamanders introduced into California for fish bait. Hybrids have been identified in a number of populations but are currently absent from Solano County (Shaffer *et al.* 1993).

Introduced annual plants. Excess grass height may hinder the upland movement of juvenile and adult salamanders. The build up of thatch has negative affects on California ground squirrel populations thus, decreasing upland refuge sites for adults and juveniles.

Special Issues, Uncertainties and Critical Assumptions. An important critical assumption in the conservation of this species is the ratio of upland habitat to breeding habitat required to support a viable population. Trenham and Shaffer (In Press) in an extensive study at Olcott Lake in Solano County found that juveniles were almost as abundant 2,200 feet from the pond as they were adjacent to the breeding pond. Adult abundance declined as distance from the breeding pond increased, but were still present 2,200 feet away. From this study, Trenham and Shaffer (unpublished) determined that 1,000 acre blocks of undeveloped upland habitat would be require around a breeding pond to support a viable population of California tiger salamanders. There is a considerable amount of uncertainty around the upland habitat requirements for this species. The conservation measures and management pertaining to upland habitat requirements for this species should be reevaluated upon release of additional information.

Issues Relating To Livestock Grazing . California tiger salamanders appear to be very successful in stock ponds with high turbidity and low biodiversity (i.e. very little vegetation and aquatic invertebrates). However, this environment does not manage for other sensitive species. The average lifespan of a natural vernal pool (1,000s of years) is much longer than that of stock ponds (100s of years). In our conservation measures and management for this species, we are making the assumption that natural vernal pool complexes are more important for the long term recovery of the species than stock ponds.

In general, grazing is compatible with their existence, and, at proper levels, may even enhance their populations. It is the lack of grazing or allowing cattle to draw down water levels at critical developmental stages that is detrimental to this species. A grazing regime appropriate for the enhancement of this species will be incorporated into the management plans for our planned reserves and will be reevaluated annually based on the results of proposed monitoring activities.

Disease. Several wildlife species and domestic animals have been killed in large numbers in the past 10 years by emerging diseases. Emerging diseases are those that have increased in incidence, virulence or geographic range, have shifted hosts or have recently evolved new strains. Specifically, disease has been implicated as a factor in the decline of amphibian populations worldwide. There is a lot of uncertainty around which diseases may affect California tiger salamanders and how these diseases may work synergistically with other factors of decline. The factor of disease was incorporated into the model with the understanding that at present, we do not know how disease impacts the different life stages but that it inevitably plays a role in population dynamics and further research is required in this area to successfully manage for this species.

Current Management and Monitoring Practices.

Key Monitoring and Adaptive Management Issues from Conceptual Model.

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