SPECIES ACCOUNT: *Ambystoma bishopi* (Reticulated flatwoods salamander)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/10/2009; Southeast Region (R4) (USFWS, 2017)

Physical Description

Reticulated flatwoods salamanders are moderately-sized (76 mm snout-to-vent length, 135 mm total length), slender salamanders with relatively short, pointed snouts and stout tails (Martof and Gerhart, 1965; Palis, 1996; Palis, unpublished data). Their heads are small and only about as wide as the neck and shoulder region (Petranka, 1998). They weigh from 4.5 to 11 grams (adult males and adult gravid [containing mature eggs] females), respectively (Palis, 1996; Palis, unpublished data). Their bodies are black to chocolate black with fine, irregular, light gray lines or specks that form a reticulate or crossbanded pattern across the back. In some individuals, the gray pigment is widely scattered and "lichen-like." Melanistic, uniformly black individuals have been reported (Carr, 1940). The venter (underside) is dark gray to black with a scattering of gray spots or flecks (USFWS, 2015).

Taxonomy

The species was split into two distinct species in 2009, reticulated flatwoods salamander (Ambystoma bishopi) and frosted flatwoods salamander (Ambystoma cingulatum), based on findings of Pauley et al. (2007) (74 FR 6700, 2009) (USFWS, 2015). Listed Entity Taxonomy and nomenclature: The currently accepted classification for the reticulated flatwoods salamander is (Integrated Taxonomic Information System 2023): Phylum: Chordata Class: Amphibia Order: Caudata Family: Ambystomatidae Genus: Ambystoma Species: Ambystoma bishopi There are 33 species of Ambystoma found in North America (IUCN 2018). Seventeen species are found exclusively in Mexico, eight are endemic to the U.S., eight are found in both the U.S. and Canada, and two species, Ambystoma mavortium and A. tigrinum, are found in all three countries (IUCN 2018). Pauly et al. (2007) demonstrated that flatwoods salamanders are polytypic with a major disjunction at the Apalachicola River in Florida. Based on mitochondrial DNA, morphology, and allozymes, Pauly et al. (2007) recognized two species of flatwoods salamanders – the frosted flatwoods salamander, Ambystoma cingulatum, to the east of the Apalachicola drainage, and the reticulated flatwoods salamander, A. bishopi, to the west. The ringed salamander, A. annulatum, is the closest phylogenetic relative of the flatwoods salamanders, with all three species grouping together in their own clade (Kraus 1988; Shaffer et al. 1991; Williams et al. 2013). In turn, this clade is the sister group to the tiger salamander clade (A. californiense, A. mexicanum, A. ordinarium, and A. tigrinum) (USFWS, 2023).

Historical Range

Historically A. bishopi occurred in Mobile, Baldwin, Covington, and Houston counties in Alabama, Escambia, Santa Rosa, Okaloosa, Walton, Holmes, Washington, Bay, Jackson, Calhoun, and Gulf counties in Florida, and Seminole, Decatur, Early, Miller, Baker, Dougherty, and Lee counties in Georgia (USFWS, 2015).

Current Range

In Alabama, the flatwoods salamander was historically known to occur in four southern counties (Wright, 1935; Mount, 1975; Mount, 1980; Jones et al., 1982). Despite more recent survey effort (Godwin, 1994, 2003), the last observation of the species (of what we now have determined is the reticulated flatwoods salamander) in Alabama was in Houston County in 1981 (Jones et al., 1982). In Georgia, A. bishopi was recently found in two wetlands on the Mayhaw Wildlife Management Area (John Jensen, pers. comm., 2015), Miller County. Prior to 2015, this species had not been detected in Georgia since 2001, but in some cases surveys were limited. In Florida, recent surveys have detected A. bishopi in Santa Rosa and Okaloosa Counties (Table 2). Within these counties, 16 breeding wetlands on EAFB have had at least one detection from 2010 to 2015, with most being occupied during multiple years within this time frame (Gorman et al., 2013, Haas et al., 2014a). Additionally, larvae were detected at one site on Hurlburt Field and one site on property owned by Santa Rosa County in 2014 (Haas et al., 2014b). Larvae were detected at Garcon Point in 2014 (Pierson Hill, FWC, pers. comm.) and, in 2015, larvae were detected at a breeding wetland at Yellow River Marsh Preserve State Park for the first time since 2006 (K. Enge, FWC, pers. comm., 2015). Lastly, A. bishopi was detected at one site on Naval Outlying Landing Field (NOLF) Holley in 2010 and another site in 2011, but no salamanders have been detected since 2011 (Kurt Buhlmann, UGA, pers. comm., 2018). Thus, currently, A. bishopi is only known from Santa Rosa and Okaloosa counties in Florida, and Miller County in Georgia (Table 2.2, Figure 2.3). As of the end of the 2014/15 breeding season, there were six known and currently occupied populations (based on unpublished data from Gorman and Haas, Virginia Tech 2014, K. Enge, FFWC, K. Buhlmann, UGA, and J. Jenson, GADNR). The Mayhaw WMA site, the wetland in which larvae were found in 2001, did not yield any detections, but two other wetlands within the same population did. The two detections in 2015 were from wetlands never previously known to be occupied. These two wetlands are considered separate populations (John Jensen, GADNR, pers. comm. 2017). It is important to note that 11 of the 20 populations (described in 74 FR 6700) are on private land, and nine on public land. However, compared to those included in the 2009 final rule, 3-4 populations (33-45%) on public lands have not had detection in recent years (Table 2.2). (USFWS, 2020)

Critical Habitat Designated

Yes; 3/12/2009.

Legal Description

On February 10, 2009, the U.S. Fish and Wildlife Service (Service), finalized the listing under the Endangered Species Act of 1973, as amended (Act), of the currently threatened flatwoods salamander (Ambystoma cingulatum) into two distinct species: Frosted flatwoods salamander (Ambystoma cingulatum) and reticulated flatwoods salamander (Ambystoma bishopi) due to a recognized taxonomic reclassification; determined endangered status for the reticulated flatwoods salamander; retained threatened status for the frosted flatwoods salamander; and designated critical habitat for the frosted flatwoods salamander and the reticulated flatwoods salamander. In total, approximately 27,423 acres (ac) (11,100 hectares (ha)) in 35 units or subunits fall within the boundaries of the critical habitat designation; 22,970 ac (9,297 ha) of critical habitat is designated for the frosted flatwoods salamander and 4,453 ac (1,803 ha) for the reticulated flatwoods salamander. This area is a reduction of 3,205 ac (977 ha) from the proposed designation; 162 ac (66 ha) less for the frosted flatwoods salamander and 3,043 ac (928 ha) less for the reticulated flatwoods salamander.

Critical Habitat Designation

8 units, some of which are divided into subunits (for a total of 16 units and subunits), are designated as critical habitat.

Unit RFS–1: Unit RFS–1 encompasses 687 ac (278 ha) in Santa Rosa County, Florida. Within this unit, 466 ac (189 ha) consist of State land in the Garcon Point Water Management Area managed by the Northwest Florida Water Management District (NWFLWMD) and in the Yellow River Marsh State Buffer Preserve (YRMSBP); 221 ac (89 ha) are in private ownership. Unit RFS–1 is bisected by Hwy. 191 and occurs within an extensive wet prairie. Since the majority of this unit, which was occupied at the time of listing, is owned by NWFLWMD and YRMSBP, it is likely protected from most agricultural and urban development. Threats to reticulated flatwoods salamander habitat that may require special management of the PCEs include potential fire suppression and potential hydrologic changes resulting from the adjacent highway that could alter the ecological functioning of the breeding pond and surrounding terrestrial habitat. Ditches associated with highways can drain water from a site and result in ponds with shorter hydroperiods and drier terrestrial habitat. Alternatively, ditches can connect isolated wetlands with permanent water sites that increase the hydroperiod of ponds and facilitate the introduction of predaceous fish into breeding ponds. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Unit RFS–2: Unit RFS–2 is comprised of two subunits encompassing 324 ac (131 ha) in Santa Rosa County, Florida. Within this unit, which was occupied at the time of listing, there are 162 ac (66 ha) on State land managed by NWFLWMD and Blackwater River State Forest (BRSF); and 162 ac (66 ha) are in private ownership. Subunit A Unit RFS–2, Subunit A encompasses 162 ac (66 ha) on private land in Santa Rosa County, Florida. This subunit is located northeast of Milton, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include agricultural and urban development, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, potential hydrological alterations to the habitat, and the potential for fire suppression. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit B Unit RFS–2, Subunit B encompasses 162 ac (66 ha) in Santa Rosa County, Florida. Within this unit, there are 32 ac (13 ha) on State land managed by NWFLWMD and 130 ac (53 ha) on State land managed by BRSF. This subunit is located south of Interstate 10 and near the Santa Rosa-Okaloosa County border. A small county road bisects the unit and a power line crosses the eastern edge of the breeding pond. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the belowground soil structure, and potential hydrologic changes resulting from the road and power line that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Unit RFS–3: Unit RFS–3 is comprised of two subunits encompassing 205 ac (83 ha) in Santa Rosa County, Florida. Within this unit, which was occupied at the time of listing, 180 ac (73 ha) are on private land and 25 ac (10 ha) are on property owned by the Santa Rosa County School Board. Subunit A Unit RFS–3, Subunit A encompasses 148 ac (60 ha) on private land in Santa Rosa County, Florida. This subunit is located near a rapidly developing section of Federal Hwy. 98 between Navarre and Gulf Breeze, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soils structure, potential hydrologic changes resulting from the highway that could alter the ecology of the breeding pond and surrounding terrestrial habitat, and potential habitat destruction due to urban and commercial development nearby. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit B Unit RFS–3, Subunit B encompasses 57 ac (23 ha) in Santa Rosa County, Florida. This subunit is located near a rapidly developing section of U.S. Hwy. 98 between Navarre and Gulf Breeze, Florida. Within this subunit, 32 ac (13 ha) are on private land and 25 ac (10 ha) are on property owned by the Santa Rosa County School Board. Threats to the reticulated flatwoods salamander habitat that may require special management of the existing PCEs include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soils structure, potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat, and future habitat destruction due to urban and commercial development. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Unit RFS–6: Unit RFS–6 is composed of two subunits encompassing 375 ac (152 ha) in Walton and Washington Counties, Florida. Within this unit (which was occupied at the time of listing), 213 ac (86 ha) are on private land in Walton County, Florida, and 162 ac (66 ha) are located on Pine Log State Forest (managed by the State of Florida's Division of Forestry) in Washington County, Florida. Subunit A Unit RFS–6, Subunit A encompasses 213 ac (86 ha) on private land in Walton County, Florida. This subunit is bisected by State Hwy. 81 near Bruce, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat, and future habitat destruction due to urban and commercial development. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit B Unit RFS–6, Subunit B encompasses 162 ac (66 ha) on Pine Log State Forest (managed by the State of Florida's Division of Forestry) in Washington County, Florida. Since the lands located within this subunit are owned by the State of Florida, they are likely protected from direct agricultural and urban development; however, threats remain to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs. They include the potential for fire suppression and potential detrimental alterations in forestry practices that could destroy the below-ground soil structure. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Unit RFS–7: Unit RFS–7, which was occupied at the time of listing, is comprised of two subunits encompassing 327 ac (132 ha) on private land in Holmes and Washington Counties, Florida. Subunit A Unit RFS–7, Subunit A encompasses 162 ac (66 ha) on private land in Holmes County, Florida. This subunit is located approximately 2 mi (3.2 km) east of State Hwy. 79 and approximately 5.5 mi (8.8 km) north of Bonifay, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture into the unit, potential detrimental alterations in forestry practices that could destroy the belowground soil structure, and potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit B Unit RFS–7, Subunit B encompasses 165 ac (67 ha) on private land in Washington County, Florida. This subunit is located less than a mile (1.6 km) northwest of State Hwy. 79 and approximately 4 mi (6.4 km) west of Vernon, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture into the unit, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Unit RFS–8: Unit RFS–8, which was occupied at the time of listing, is composed of three subunits encompassing 712 ac (288 ha) on private land in Jackson County, Florida. Subunit A Unit RFS–8, Subunit A encompasses 110 ac (45 ha) on private land in western Jackson County, Florida near the Jackson-Washington County line. This subunit is located just south of U.S. Hwy. 90 and west of State Hwy. 231 approximately 10 mi (16 km) west of Marianna, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture and residential development into the unit, potential detrimental alterations in forestry practices that could destroy the belowground soil structure, and potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit B Unit RFS–8, Subunit B encompasses 358 ac (145 ha) on private land in Jackson County, Florida. This subunit is located just east of State Hwy. 71 and south of U.S. Hwy. 90, between Old Spanish Trail and the CSX railroad. This locality is approximately 4 mi (6.4 km) southeast of Marianna, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture and residential development into the unit, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit C Unit RFS–8, Subunit C encompasses 244 ac (99 ha) on private land in Jackson County, Florida. This currently occupied subunit is bisected by State Hwy. 275 south of Interstate 10 near Wolf Slough. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture and residential development into the unit, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Unit RFS–9: Unit RFS–9, which was occupied at the time of listing, is comprised of two subunits encompassing 1,039 ac (421 ha) on private land in Calhoun County, Florida. Subunit A Unit RFS–9, Subunit A encompasses 162 ac (66 ha) on private land in Calhoun County, Florida. This subunit is bisected by an unnamed road near Broad Branch, is approximately 2.5 mi (4 km) west of State Hwy. 73, and is approximately 4 mi (6.4 km) west of Kinard, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture and residential development into the unit, potential detrimental alterations in forestry practices that could destroy the belowground soil structure, and potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit B Unit RFS–9, Subunit B encompasses 877 ac (355 ha) on private land in Calhoun County, Florida. This subunit is bisected by an unnamed road running east of and parallel to State Hwy. 71, and is located approximately 13 mi (20.8 km) south of Scotts Ferry, Florida. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture and residential development into the unit, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Unit RFS–10: Unit RFS–10, which was occupied at the time of listing, is comprised of two subunits encompassing 784 ac (317 ha) in Baker and Miller counties, Georgia. Within RFS–10, 162 ac (66 ha) are located on Mayhaw Wildlife Management Area (managed by the State of Georgia) in Miller County, Georgia, and 622 ac (252 ha) are located on private land adjacent to, and running south of, State Highway 200 in southwestern Baker County, Georgia. Subunit A Unit RFS–10, Subunit A encompasses 162 ac (66 ha) on Mayhaw Wildlife Management Area (managed by the State of Georgia) in Miller County, Georgia. Since this subunit is owned by the State of Georgia, it is likely protected from most agricultural and urban development (Ozier 2008). Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes. Subunit B Unit RFS–10, Subunit B encompasses 622 ac (252 ha) on private land adjacent to, and south of, State Highway 200 in southwestern Baker County, Georgia. Threats to the reticulated flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple reticulated flatwoods salamander life processes.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Calhoun, Holmes, Jackson, Santa Rosa, Walton, and Washington Counties in Florida; and Baker and Miller Counties in Georgia. The primary constituent elements of critical habitat for the reticulated flatwoods salamander are the habitat components that provide:

(i) Breeding habitat. Small (generally less than 1 to 10 ac (less than 0.4 to 4.0 ha)), acidic, depressional standing bodies of freshwater (wetlands) that: (A) Are seasonally flooded by rainfall in late fall or early winter and dry in late spring or early summer; (B) Are geographically isolated from other water bodies; (C) Occur within pine flatwoodssavanna communities; (D) Are dominated by grasses and grass-like species in the ground layer and overstories of pond-cypress, blackgum, and slash pine; (E) Have a relatively open canopy, necessary to maintain the herbaceous component that serves as cover for flatwoods salamander larvae and their aquatic invertebrate prey; and (F) Typically have a burrowing crayfish fauna, but, due to periodic drying, the breeding ponds typically lack large, predatory fish (for example, Lepomis (sunfish), Micropterus (bass), Amia calva (bowfin)).

(ii) Non-breeding habitat. Upland pine flatwoods-savanna habitat that is open, mesic woodland maintained by frequent fires and that: (A) Is within 1,500 ft (457 m) of adjacent and accessible breeding ponds; (B) Contains crayfish burrows or other underground habitat that the flatwoods salamander depends upon for food, shelter, and protection from the elements and predation; (C) Has an organic hardpan in the soil profile, which inhibits subsurface water penetration and typically results in moist soils with water often at or near the surface under normal conditions; and (D) Often has wiregrasses as the dominant grasses in the abundant herbaceous ground cover, which supports the rich herbivorous invertebrates that serve as a food source for the reticulated flatwoods salamander.

(iii) Dispersal habitat. Upland habitat areas between nonbreeding and breeding habitat that allows for salamander movement between such sites and that is characterized by: (A) A mix of vegetation types representing a transition between wetland and upland vegetation (ecotone); (B) An open canopy and abundant native herbaceous species; (C) Moist soils as described in paragraph (2)(ii); and (D) Subsurface structure, such as deep litter cover or burrows that provide shelter for salamanders during seasonal movements.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

Special management of the PCEs for the frosted flatwoods salamander and the reticulated flatwoods salamander and their habitat may be required for the following threats: Direct and indirect impacts of land use conversions, primarily urban development and conversion to agriculture and pine plantations; stump removal and other soil-disturbing activities which destroy the belowground structure within forest soils; fire suppression and low fire frequencies; wetland destruction and degradation; and random effects of drought or floods.

Life History

Food/Nutrient Resources

Food Source

Larvae: Aquatic invertebrates: zooplankton, crustaceans

Juvenile: Herbivorous invertebrates

Adult: Invertebrates

Competition

Larvae: Fish

Food/Nutrient Narrative

Larvae: Larval flatwoods salamanders most likely prey on a variety of aquatic invertebrates and perhaps small vertebrates such as other amphibian larvae (Palis and Means 2005, p. 608). Data from a recent study of larval food habits found that freshwater crustaceans dominated stomach contents of preserved, wildcaught individuals from Florida and South Carolina (Whiles et al. 2004, p. 208). This indicates a preference for freshwater crustaceans or perhaps is an indication that these invertebrates are the most abundant or most easily captured prey in breeding ponds. Larvae hide amid inundated graminaceous vegetation by day, but will enter the water column at night (J. Palis, pers. obs.). Wetland water quality is important to maintain the aquatic invertebrate fauna eaten by larval salamanders. The presence of predatory fish has a marked effect on invertebrate communities and alters prey availability for larval salamanders with the potential for negative effects on larval fitness and survival (Semlitsch 1987, p. 481).

Juvenile: Post-larval salamanders eat small invertebrates that share their underground habit.

Adult: Wiregrasses support the herbivorous invertebrates that serve as a food source for the flatwoods salamander. The invertebrate community serves as a food source for flatwoods salamander adults. Records exist of earthworms that have been found in the stomachs of dissected adult salamanders (Goin 1950, p. 314). Individuals are seldom seen except during the breeding season. Small numbers of post-larval salamanders continue to be active on the surface during the winter months (Palis, unpubl. data).

Reproductive Strategy

Adult: Oviparity, colonial, R-selected

Lifespan

Adult: At least 8 years

Breeding Season

Adult: September - December

Key Resources Needed for Breeding

Egg: Enough rainfall to inundate eggs (NatureServe, 2015)

Larvae: Enough rainfall to result in pond flooding

Adult: Rainfall sufficient to result in pond flooding, acidic wetlands (pH 3.6-5.6), herbaceous vegetation

Reproduction Narrative

Egg: Egg development from deposition to hatching occurs in approximately 2 weeks, but eggs do not hatch until they are inundated (Palis 1995, pp. 352, 353). The eggs develop to hatching size within three weeks (Anderson and Williamson 1976) (NatureServe, 2015).

Larvae: The larval period lasts for 11 to 18 weeks (Palis 1995a). If rainfall is insufficient to result in adequate pond flooding, larvae may die before metamorphosis.

Juvenile: In captivity, adult size can be reached within one year (Means 1972). Preliminary field data, however, suggest that full size is not attained until the third or fourth year in the wild (Palis, unpubl. data). Although not much bigger than metamorphs, males attain sexual maturity in their first year (Palis 1997). Females, however, do not sexually mature until at least two years old (Palis and Jensen 1995, Palis 1997).

Adult: Breeding wetlands are located within mesic (moderate moisture) to intermediate mesic longleaf pine (Pinus palustris)-dominated flatwoods/savanna communities where adults and metamorphosed juveniles spend the rest of their life outside of the breeding season. Breeding occurs in acidic (pH 3.6-5.6 (Palis, unpubl. data)), tannin-stained ephemeral wetlands (swamps or graminoid-dominated depressions) that range in size from 0.02 to 9.5 ha, and are usually not more than 0.5 m deep (Palis, unpubl. data). Breeding sites are small (generally less than 1 to 10 acres (ac) (less than 0.4 to 4.0 hectares (ha)), acidic, depressional standing bodies of fresh water (wetlands) that: (a) Are seasonally flooded by rainfall in late fall or early winter and dry in late spring or early summer; (b) Are geographically isolated from other water bodies; (c) Occur within pine flatwoods savanna communities; (d) Are dominated by grasses and grass-like species in the ground layer and overstories of pond-cypress, blackgum, and slash pine; (e) Have a relatively open canopy, necessary to maintain the herbaceous component that serves as cover for flatwoods salamander larvae and their aquatic invertebrate prey; and (f) Typically have a burrowing crayfish fauna, but, due to periodic drying, the breeding ponds typically lack large, predatory fish (for example, Lepomis (sunfish), Micropterus (bass), Amia calva (bowfin)). Breeding occurs from late September to December when ponds flood due to rainy weather associated with cold fronts. If rainfall is insufficient to result in adequate pond flooding, breeding may not occur or, if larvae do develop, they may die before metamorphosis. As adults, flatwoods salamanders migrate to ephemeral (seasonally-flooded) wetlands to breed in the fall, where females lay eggs singly on bare mineral soil in small depressions that later fill with water (Anderson and Williamson 1976; Palis 1995a, 1997). Flatwoods salamanders breed and deposit eggs in wetlands that are not yet inundated with water (Anderson and Williamson 1972, Hill 2013, Powell et al. 2013, Gorman et al. 2014). Adults select areas of complex and diverse stands of herbaceous vegetation within breeding wetlands for egg deposition. In this microhabitat, eggs are typically located in small depressions that likely minimize desiccation of developing embryos in the otherwise dry wetland. Individual females lay up to 225 eggs (Ashton 1992) singly or in small clusters, with larger individuals producing more eggs than smaller ones (Anderson and Williamson 1976). Generation length is presumed to be about 8 years.Other types of suboptimal habitat, such as roadside ditches and borrow pits that have the physical and biotic characteristics of natural breeding sites may be used by flatwoods salamanders, especially when located near natural breeding ponds (Anderson and Williamson, 1976; Palis, 1995b; Stevenson, 1999; Gorman and Haas, unpubl. data).

Habitat Type

Egg: Freshwater: lacustrine, palustrine (NatureServe, 2015)

Larvae: Freshwater: lacustrine, palustrine

Juvenile: Freshwater: lacustrine, palustrine; Terrestrial: forest; fossorial

Adult: Freshwater: lacustrine, palustrine; Terrestrial: forest; fossorial

Habitat Vegetation or Surface Water Classification

Egg: Ephemeral wetland, pond, riparian (USFWS, 2015)

Larvae: Ephemeral wetland, pond, riparian

Juvenile: Freshwater: ephemeral wetland, pond, riparian; Terrestrial: mesic longleaf pine-dominated flatwoods/savanna communities with herbaceous groundcover

Adult: Freshwater: ephemeral wetland, pond, riparian; Terrestrial: mesic longleaf pine-dominated flatwoods/savanna communities with herbaceous groundcover

Dependencies on Specific Environmental Elements

Juvenile: Moist soils, periodic fires

Adult: Moist soils, periodic fires

Geographic or Habitat Restraints or Barriers

Adult: Roads (see Threats)

Spatial Arrangements of the Population

Adult: Isolated populations scattered across the historical range

Environmental Specificity

Egg: Narrow (NatureServe, 2015)

Larvae: Narrow

Juvenile: Narrow

Adult: Narrow

Tolerance Ranges/Thresholds

Egg: Moderate (inferred from USFWS, 2015)

Larvae: Moderate

Juvenile: Moderate

Adult: Moderate

Site Fidelity

Juvenile: High

Adult: High

Dependency on Other Individuals or Species for Habitat

Juvenile: Crayfish (Procambarus), wiregrass (Aristida stricta [= A. beyrichiana])

Adult: Crayfish (Procambarus), wiregrass (Aristida stricta [= A. beyrichiana])

Habitat Narrative

Egg: Eggs are deposited in wetlands that are not yet inundated with water (Anderson and Williamson 1972, Hill 2013, Powell et al. 2013, Gorman et al. 2014). Adults select areas of complex and diverse stands of herbaceous vegetation within breeding wetlands for egg deposition. In this microhabitat, eggs are typically located in small depressions that likely minimize desiccation of developing embryos in the otherwise dry wetland (USFWS, 2015).

Larvae: Larvae develop in wetlands located within mesic (moderate moisture) to intermediate mesic longleaf pine (Pinus palustris)-dominated flatwoods/savanna communities. Larval flatwoods salamanders occur in acidic (pH 3.4 to 5.6), tannin-stained ephemeral wetlands (swamps or marshes) that typically range in size from < 1 to 10 acres, but may exceed 30 ac. (Palis, 1997; Safer, 2001). Water depth fluctuates greatly, but is usually 0.5 meters (m) (Palis, 1997) in areas where larval salamanders are found. At wetland sites, developing larval salamanders hide in submerged herbaceous vegetation during the day (Palis and Means 2005, p. 608) as protection from predators. Thus, an abundant herbaceous community in these ponds is important for cover.

Juvenile: Post-larval salamanders occupy upland flatwoods sites where they live underground in crayfish burrows (typically genus Procambarus), root channels, or burrows of their own making (Goin 1950, p. 311; Neill 1951, p. 765; Mount 1975, pp. 98–99; Ashton and Ashton 2005, pp. 63, 65, 68–71). The occurrence of these belowground habitats is dependent upon protection of the soil structure within flatwoods salamander terrestrial sites. Flatwoods salamander larval habitats represent high quality conditions. However, populations persist in less than ideal habitat which may differ from what is presented below. Juveniles and adults are highly fossorial and spend much of their time in crayfish burrows or root channels until they reach sexual maturity (1 year for males; 1-2 years for females) and return to wetlands to breed during the fall months (Petranka, 1998; Powell et al., 2015; Brooks et al., 2019b). (USFWS, 2021)

Adult: Salamanders require upland pine flatwoods-savanna habitat that are open, mesic woodland maintained by frequent fires and that: (a) Is within 1,500 ft (457 m) of adjacent and accessible breeding ponds; (b) Contains crayfish burrows or other underground habitat that the flatwoods salamander depends upon for food, shelter, and protection from the elements and predation; (c) Has an organic hardpan in the soil profile, which inhibits subsurface water penetration and typically results in moist soils with water often at or near the surface under normal conditions; and (d) Often have wiregrasses as the dominant grasses in abundant herbaceous ground cover, which supports the herbivorous invertebrates that serve as a food source for the flatwoods salamander.The groundcover of the longleaf pine flatwoods/savanna ecosystem is typically dominated by wiregrass (Aristida stricta [= A. beyrichiana] Kesler et al., 2003), along with a highly diverse suite of grasses and forbs in the herbaceous groundcover. Adult salamanders occupy upland flatwoods sites where they live underground in crayfish burrows, root channels, or burrows of their own making (Goin 1950, p. 311; Neill 1951, p. 765; Mount 1975, pp. 98–99; Ashton and Ashton 2005, pp. 63, 65, 68–71). Longleaf pine flatwoods/savannas are characterized by low flat topography and relatively poorly drained, acidic, sandy soil that becomes seasonally saturated. In the past, this ecosystem was characterized by open pine woodlands maintained by frequent fires. Currently, A. bishopi occurs in isolated populations scattered across the historical range in remnants of suitable habitat. Other types of suboptimal habitat, such as roadside ditches and borrow pits that have the physical and biotic characteristics of natural breeding sites may be used by flatwoods salamanders, especially when located near natural breeding ponds (Anderson and Williamson, 1976; Palis, 1995b; Stevenson, 1999; Gorman and Haas, unpubl. data).Flatwoods salamander adult habitats represent high quality conditions. This species has a narrow environmental specificity because it depends on a relatively scarce set of habitats, substrates, food types, or other abiotic and/or biotic factors within the overall range. However, populations persist in less than ideal habitat which may differ from what is presented above. See Reproduction Narrative for breeding habitat.

Dispersal/Migration

Motility/Mobility

Larvae: Low

Juvenile: Low

Adult: Low

Dispersal

Juvenile: Low

Adult: Low (1-2 km)

Dispersal/Migration Narrative

Juvenile: Juveniles normally disperse from ponds shortly after metamorphosing, but may stay near ponds during seasonal droughts (Palis 1997). Metamorphs emigrate from their natal ponds during the months of March and April (J. Palis, pers. obs.).

Adult: As adults, flatwoods salamanders migrate to ephemeral (seasonally-flooded) wetlands to breed in the fall. Individual salamanders probably do not disperse more than 1-2 km within a generation (Semlitsch 2008; Peterman et al. 2015). Migrations to breeding sites occur at night in conjunction with rains and passing cold fronts from mid-fall through early winter (Means 1972, Anderson and Williamson 1976; Palis, unpubl. data). Salamanders migrate up to hundreds of meters between breeding and nonbreeding habitats; Ashton (1992) mentioned movements of over 1,700 meters.Salamanders require upland habitat areas between non-breeding and breeding habitat that allow for movement between such sites and that is characterized by: (a) A mix of vegetation types representing a transition between wetland and upland vegetation (ecotone); (b) An open canopy and abundant native herbaceous species; (c) Moist soils; and (d) Subsurface structure, such as that created by deep litter cover or burrows, which provides shelter for salamanders during seasonal movements.

Population Information and Trends

Population Trends:

Decreasing

Species Trends:

Decreasing

Resiliency:

Resiliency, assessed at the population level, describes the ability of a population to withstand stochastic disturbance events. Like many amphibians that breed in ephemeral wetlands, flatwoods salamanders exhibit dramatic fluctuations in abundance across years. Specific environmental conditions are required for successful recruitment; drought years result in catastrophic reproductive failure. To discern long-term trends from natural fluctuations, a stochastic Integral Projection Model (IPM) was constructed from 10 years of drift fence data obtained at two breeding wetlands on Eglin AFB. A population viability analysis (PVA) was conducted, whereby simulated populations were projected into the future and extinction risks under various scenarios were calculated (George Brooks, Virginia Tech, 2019, unpublished data). Owing to the stochastic nature of recruitment, extinction risk was high for a single population. Thus, the species will need 101 resilient metapopulations distributed across its range to persist into the future and avoid extinction. As we consider the future viability of the species, more metapopulations with high resiliency distributed across the known range are associated with higher overall viability. For the reticulated flatwoods salamander, metapopulations were delineated by occupied breeding wetlands (i.e., ponds) buffered by a 1500 foot (approximately 500 m) radius of upland habitat in the 2009 critical habitat designation (74 FR 6700). In this document, we follow that definition of a population although we discuss additional advancements in the understanding of flatwoods salamander populations. In addition to the PVA, species' resiliency was assessed based on breeding wetland occupancy and according to 6 resiliency categories describing habitat quality: (1) extent of woody vegetation in understory of upland habitat; (2) quality and composition of the wetland basin overstory; (3) presence and composition of the wetland midstory vegetation; (4) type of wetland understory vegetation and presence of organic duff/peat layer in basin; (5) adequacy of wetland hydroperiod for completion of metamorphosis; and (6) burn frequency/burn season for the compartment in which breeding sites are located. We discuss each of these factors. (USFWS, 2020)

Representation:

Representation characterizes a species adaptive potential by assessing geographic, genetic, ecological, and niche variability. The reticulated flatwoods salamander historically occurred within the western Coastal Plain of the Florida panhandle, extreme southwestern Georgia, and extreme southeastern Alabama (Palis and Means, 2005). The species is currently represented in three separate metapopulations capable of at least short term sustainability. Two of these metapopulations are within Eglin Air Force Base (EAFB) and the other at Escribano Point Wildlife Management Area, outside the western boundary of Eglin, along the eastern coast of Pensacola Bay, Florida. One population at Hurlburt field re-discovered in February 2020 after finding no larvae since 2015, and one population re-discovered in 2018 at Yellow River Marsh Preserve State Park, and one population at Garcon River Water Management Area, but has been at least 2 years since the last detection of animals there. One very small, intermittent population exists on Mayhaw Wildlife Management Area in Southwestern Georgia. No current populations are known to remain in Alabama. The RMUs were derived by dividing the range of the species into more manageable units, and assure better distribution of recovered populations across the range, by establishing 34 metapopulation targets in each of the RMUs. This would help prevent potentially clumping too many metapopulations into a confined geographic area within the range. (USFWS, 2020)

Redundancy:

Redundancy describes the ability of the species to withstand catastrophic disturbance events. A PVA conducted for this species revealed a high probability of local extirpation under a business as usual scenario (George Brooks, Virginia Tech, 2019, unpublished data). Multiple independent populations, exhibiting asynchronous dynamics, will be required to secure long-term viability of the species and avoid regional extinction. For the reticulated flatwoods salamander, we considered the distribution of the species remaining on the landscape. We also considered flood models (e.g. SLOSH, etc.) for potential sea level rise to get an indication of threat for extant populations near the Gulf Coast. Roughly 34 metapopulations per each of the 3 Recovery Management Units (RMUs) is necessary to provide redundancy across the historic range; 101 resilient metapopulations in total will be required across the historic range to ensure the risk of extinction is low enough to allow the species to persist into the foreseeable future. (USFWS, 2020)

Number of Populations:

4 (USFWS, 2023)

Population Size:

>1,400 (USFWS, 2023)

Resistance to Disease:

Unknown

Population Narrative:

Recovery Management Unit 1- This unit currently no known/current populations as the vast majority occur in RMU 2 (Eglin AFB, Hurlburt Field, and Escribano Point WMA). However, there are areas of private ownership that have not been surveyed in decades. It is possible that remnant populations do occur on some private lands that are currently unavailable to survey. There are new efforts to prepare some private lands for potential translocation. Those plans are currently in development. There are historic sites on private land for which access and future plans are currently being negotiated. Recovery Management Unit 2- This unit contains the three resilient populations and will be the source for the great majority of recovery and reintroduction/translocation efforts aimed at recovering populations in RMU 1 and RMU 2 in the future. Precise population numbers are difficult to accurately convey as annual counts can be misleading if weather is not conducive to successful breeding years. As mentioned in the recovery plan, drought during breeding seasons seems to be more frequent, resulting in reduced breeding success or outright seasonal failure. The better description is trend information which seems to be holding steady or slightly increasing during this review period with several ponds having had larvae detected that were not detected prior to this 5-year review period. Recovery Management Unit 3 – As is the case with RMU 1, this unit has only 1 semi-resilient population at Mehaw WMA in southern Georgia. This population is intermittently present depending on the season, and currently only presence/absence surveys are conducted. Overall, there is great variety in the abundance of A. bishopi. Ongoing studies (T. Gorman pers. comm. 2015) show two breeding ponds that had over 700 individuals. However, in breeding ponds outside of Eglin, abundance was not documented, as the goal was simply to determine presence/absence (USFWS, 2023).

Threats and Stressors

Stressor: Fire suppression (USFWS, 2015)
Exposure: Degradation of longleaf pine habitat.
Response: Habitat becomes less suitable.
Consequence:
Narrative: Fire suppression at many sites has led to greater canopy closure in the overstory of both the flatwoods uplands and ephemeral ponds (Bishop and Haas 2005, Gorman et al. 2009, Gorman et al. 2013) and the shrub layers of both habitats have similarly increased (Gorman et al. 2013). This has resulted in a lower cover of herbaceous groundcover that is less diverse. In the absence or paucity of growing-season fire, slash and/or pond pine may become dominant over longleaf pine in the flatwoods uplands. Further, the ecotone between the breeding wetland and associated flatwoods may be obscured or nonexistent, replaced with a dense layer of shrubs, such as titi, fetterbush, and dog hobble (Leucothoe spp.) due to fire suppression or exclusion (Gorman et al. 2013) (USFWS, 2015).

Stressor: Habitat conversion (USFWS, 2015)
Exposure: Fragmentation of the longleaf pine ecosystem.
Response: Populations become isolated.
Consequence: Survival of the remaining flatwoods salamander populations is threatened.

Narrative: Fragmentation of the longleaf pine ecosystem, resulting from habitat conversion, threatens the survival of the remaining flatwoods salamander populations. Large tracts of intact longleaf pine flatwoods habitat are fragmented by roads and pine plantations. Most flatwoods salamander populations are widely separated from each other by unsuitable habitat. Studies have shown that the loss of fragmented populations is common, and recolonization is critical for their regional survival (Fahrig and Merriam, 1994; Burkey, 1995). Amphibian populations may be unable to recolonize areas after local extinctions due to their physiological constraints, relatively low mobility, and site fidelity (Blaustein et al., 1994). Land use conversions to urban development and agriculture eliminated large acreages of pine flatwoods in the past (Schultz, 1983; Stout and Marion, 1993; Outcalt and Sheffield, 1996; Outcalt, 1997). Urbanization and agriculture resulted in the destruction of flatwoods salamander localities in Mobile and Baldwin counties, Alabama; Jackson and Washington counties, Florida; and Berrien, Chatham, Early, and Effingham counties, Georgia. State forest inventories completed between 1989 and 1995 indicated that flatwoods losses through land use conversion were still occurring (Outcalt, 1997). Urbanization, especially in the panhandle of Florida and around major cities, is reducing the available pine forest habitat. Wear and Greis (2002) identified conversion of forests to urban land uses as the most significant threat to southern forests. These authors predicted that the South could lose about 12 million forest acres (about 8% of its current forest land) to urbanization between 1992 and 2020 (USFWS, 2015).

Stressor: Road construction (USFWS, 2015)
Exposure: Habitat fragmentation and destruction.
Response: Migration routes and dispersal is disrupted. Salamanders may cross roads.
Consequence: Decreased breeding success, mortality from vehicles
Narrative: Road construction in the last two decades destroyed an historic breeding pond in Escambia County, Florida. Roads also contribute to habitat fragmentation by isolating blocks of remaining contiguous habitat. They may disrupt migration routes and dispersal of individuals to and from breeding sites. In addition, vehicles may also cause the death of flatwoods salamanders during migrations across roads (Means, 1996). Road construction is also a recurring threat in the remaining flatwoods salamander habitats on Eglin AFB and Hurlburt Field. Roads can cause disruptions to groundwater and sheet flow, and have serious direct and indirect impacts on the breeding ponds (USFWS, 2015).

Stressor: Forestry management (USFWS, 2015)
Exposure: Site hydrology is disrupted native herbaceous groundcover is eliminated.
Response: Invertebrate community is reduced and subterranean voids are nagatively impacted
Consequence: Species food source is reduced; species gets trapped or killed
Narrative: Forestry management which includes intensive site preparation may adversely affect flatwoods salamanders both directly and indirectly (Means et al., 1996). Bedding (a technique in which a small ridge of surface soil is elevated as a planting bed) alters the surface soil layers, disrupts the site hydrology and often eliminates the native herbaceous groundcover. This can have a cascading effect of reducing the invertebrate community that serves as a food source for flatwoods salamander adults. Intensive site preparation also negatively impacts subterranean voids such as crayfish burrows and root channels that are the probable fossorial habitats of

terrestrial salamanders and may result in entombing, injuring, or crushing individuals (USFWS, 2015).

Stressor: Hydrological alterations (USFWS, 2015)
Exposure: Lowered water levels and shortened hydroperiods at breeding sites.
Response: Recruitment is reduced
Consequence:
Narrative: Flatwoods salamander breeding sites have also been degraded or altered. The number and diversity of these small wetlands have been reduced by alterations in hydrology, agricultural and urban development, incompatible silvicultural practices, shrub encroachment, dumping in or filling of ponds, conversion of wetlands to fish ponds, domestic animal grazing, and soil disturbance (Vickers et al., 1985; Ashton, 1992). Hydrological alterations, such as those resulting from ditches created to drain flatwoods sites or fire breaks and plow lines, for example, represent one of the most serious threats to flatwoods salamander breeding sites. Lowered water levels and shortened hydroperiods at these sites may prevent successful flatwoods salamander recruitment (USFWS, 2015).

Stressor: Off-road vehicle use (USFWS, 2015)
Exposure: Wetland habitat is degraded
Response:
Consequence: Direct mortality from ORVs
Narrative: Off-road vehicle (ORV) use within flatwoods salamander breeding ponds and their margins severely degrades wetland habitat. Continued use of sites by ORVs can completely degrade the integrity of breeding sites by killing herbaceous vegetation and rutting the substrate, which can alter hydrology. There is also the potential for direct injury and/or mortality of flatwoods salamanders by ORVs at breeding sites (USFWS, 2015).

Stressor: Ranaviruses, Chytrid fungus (USFWS, 2015)
Exposure: Unknown
Response: Not assessed
Consequence: Not assessed
Narrative: Ranaviruses in the family Iridoviridae and chytrid fungus may be other potential threats, although the susceptibility of the reticulated flatwoods salamander to these diseases is unknown. Ranaviruses have been responsible for die-offs of tiger salamanders throughout western North America and spotted salamanders (A. maculatum) in Maine (Daszak, et al. 1999). The chytrid fungus (Batrachochytrium dendrobatidis, or Bd), which causes chytridiomycosis in many amphibians, has been discovered and associated with mass mortality in tiger salamanders in southern Arizona and California, and the Santa Cruz long-toed salamander (A. macrodactylum croceum) (Vredenburg and Summers, 2001; Davidson, et al. 2003; Padgett-Flohr and Longcore, 2005). This chytrid fungus has been found at an A. bishopi breeding wetland on Eglin Air Force Base and at a site near occupied breeding wetlands (USFWS, 2015).

Stressor: Predation (USFWS, 2015)

Exposure: Seasonally ponded wetland breeding sites are changed to, or connected to, more permanent wetlands inhabited by fishes that are not typically found in temporary wetlands.
Response:
Consequence:
Narrative: Exposure to increased predation by fish is a potential threat to the reticulated flatwoods salamanders when isolated, seasonally ponded wetland breeding sites are changed to, or connected to, more permanent wetlands inhabited by fishes that are not typically found in temporary wetlands. Wetlands/ponds may be modified specifically to serve as fish ponds or sites may be altered because of drainage ditches, firebreaks, or vehicle tracks which can all provide avenues for fish to enter the wetlands from other water bodies. Studies of other ambystomatid species have demonstrated a decline in larval survival in the presence of predatory fish (Semlitsch, 1987; 1988) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)
Exposure: Red imported fire ants have been seen in areas disturbed by the installation of drift fences at known breeding sites (T. Gorman, pers. comm., 2015).
Response:
Consequence: Unknown
Narrative: Red imported fire ants (Solenopsis invicta) are potential predators of reticulated flatwoods salamanders, especially in disturbed areas. This species has been seen in areas disturbed by the installation of drift fences at known breeding sites (T. Gorman, pers. comm., 2015). Controlling fire ants in areas with a high degree of disturbance can be accomplished by using hot water rather than pesticides (Tschinkel and King 2007), so on a small scale fire ants can be controlled around breeding sites. Further study on the effects of fire ants on flatwoods salamanders is recommended because the severity and magnitude, as well as the long term effect of fire ants on reticulated flatwoods salamander populations is currently unknown (USFWS, 2015)

Stressor: Rooting by feral swine (USFWS, 2015)
Exposure: Negative impacts on breeding sites.
Response:
Consequence:
Narrative: Nonindigenous feral swine can significantly impact reticulated flatwoods salamander breeding sites through rooting, so intensive approaches (e.g., control measures and fencing) may be needed to avoid degradation to occupied sites and sites going through restoration.

Stressor: Invasive plants (USFWS, 2015)
Exposure: Native vegetation is displaced.
Response:
Consequence:
Narrative: Invasive plant species such as cogongrass (Imperata cylindrica) threaten to further degrade existing habitat. Cogongrass, a perennial grass native to Southeast Asia, is one of the leading threats to the ecological integrity of native herbaceous flora, including that in the longleaf pine ecosystem (Jose et al. 2002). Reticulated flatwoods salamander habitat management plans

will need to address threats posed by invasive plants and develop strategies to control them. It has been documented that cogongrass can displace most of the existing vegetation except large trees. Especially threatening to the reticulated flatwoods salamander if the ability of cogongrass to outcompete wiregrass (Scientific name), a key vegetative component of reticulated flatwoods salamander habitat.

Stressor: Climate change (USFWS, 2015)
Exposure: Sea level rise, altered precipiation patterns, increased temperatures
Response:
Consequence:
Narrative: Climate change, especially in combination with other stressors, is a daunting challenge for the persistence of amphibians (Walls et al. 2013). Sea level rise is becoming and will likely continue to increase as a threat to the extant populations of the flatwoods salamanders (both species). Most of the remaining relatively resilient populations occur in very low lying areas within a short distance of the coast. These populations are already vulnerable to high tide storm-influenced saltwater intrusion, and these threats will likely increase as sea level rise from global climate change continues. Climate change models predict the occurrence of more variable patterns of precipitation in the future, with longer droughts and larger (but fewer) rainfall events, in addition to increased temperatures (HeislerWhite et al. 2008; Lucas et al. 2008). Increases in the occurrence of drought and heavy precipitation events are known to be impacting a variety of amphibians, including those that breed in ephemeral wetlands (Walls et al. 2013). In addition to rainfall amounts, the timing of precipitation events is an important stimulus for reproduction in many pond-breeding amphibians (Walls et al. 2013). Thus, climate change may have an impact on reticulated flatwoods salamanders by altering the timing of fall and winter rains, as well as creating drier winters than historically would have occurred (Chandler 2015).

Stressor: Small population sizes (USFWS, 2015)
Exposure:
Response: Populations are more susceptible to stochastic events
Consequence: Negative impact on populations.
Narrative: Small population sizes, especially concentrated in small areas, are more susceptible to stochastic events that could negatively impact the entire population. Examples include salt water intrusion from storm surge (for those areas near enough to the coastline, which is the case for the majority of currently occupied bishopi ponds) extended drought, introduced contaminants, fire exclusion, among others (USFWS, 2015).

Stressor: Pesticides and herbicides (USFWS, 2015)
Exposure: Permeable eggs and skin readily absorb substances from the surrounding aquatic or terrestrial environment (Duellman and Trueb, 1986); alteration of density and species composition of vegetation surrounding a breeding site.
Response: Delayed metamorphosis, paralysis, reduced growth rates, and mortality (Bishop, 1992); The number of potential sites for egg deposition, larval development, or shelter for migrating salamanders is reduced.
Consequence:

Narrative: Pesticides and herbicides may pose a threat to amphibians such as the reticulated flatwoods salamander, because their permeable eggs and skin readily absorb substances from the surrounding aquatic or terrestrial environment (Duellman and Trueb, 1986). Negative effects on amphibians may include delayed metamorphosis, paralysis, reduced growth rates, and mortality (Bishop, 1992). Herbicides used near reticulated Flatwoods salamander breeding ponds may alter the density and species composition of vegetation surrounding a breeding site and reduce the number of potential sites for egg deposition, larval development, or shelter for migrating salamanders. However, the potential for negative effects from pesticide and herbicide use can be reduced by following label directions for application and avoiding aerial spraying over areas adjacent to breeding ponds (Tatum, 2004). Aerial spraying of herbicides over outdoor ponds has been shown to reduce zooplankton diversity, a food source for larval reticulated flatwoods salamanders and cause very high (68-100 percent) mortality in tadpoles and juvenile frogs (Relyes 2005). Additionally, herbicides, if used according to the label and used in specific applications, may aid in restoration of upland and wetland habitat that have been altered by fire suppression and/or exclusion (USFWS, 2015).

Stressor: Crayfish harvest (NatureServe, 2015)
Exposure: Larvae are incidentally collected and either used as bait or not returned to the water.
Response:
Consequence: Larve die.
Narrative: Larvae are threatened in some wetlands by the harvest of crayfish as bait. Bait harvesters drag large hardware cloth buckets through inundated vegetation, dump the contents of the bucket on the ground, and then sort out the crayfish. Flatwoods salamander larvae taken in this manner are left to die or are collected as bait (J. Palis, pers. obs.) (NatureServe, 2015).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor: Pet Trade (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The pet trade still deals in wild caught amphibians and rarity drives up the value and price (Factor B). Because extremely low numbers of animals are being found, even relatively intensive dip netting surveys has the possibility of a negative effect on some smaller populations. This may continue to be a threat if regulatory mechanisms are not protective. At this time disease is currently unknown in natural populations of reticulated flatwoods salamanders, however there are disease concerns (Factor C). There are no existing regulatory mechanisms for the protection of the upland habitats where reticulated flatwoods salamanders spend most of their lives (Factor D). Section 404 of the Clean Water Act (CWA) is the primary Federal law that has the potential to provide some protection for the wetland breeding sites of the reticulated flatwoods salamander;

however, isolated wetlands are no longer covered under these protections (Service 2020). At the State and local levels, regulatory mechanisms are limited. Therefore, regulatory mechanisms are currently inadequate to prevent the threats the species currently faces (USFWS, 2023).

Stressor: Lack of regulatory mechanisms (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: There are no existing regulatory mechanisms for the protection of the upland habitats where reticulated flatwoods salamanders spend most of their lives (Factor D). Section 404 of the Clean Water Act (CWA) is the primary Federal law that has the potential to provide some protection for the wetland breeding sites of the reticulated flatwoods salamander; however, isolated wetlands are no longer covered under these protections (Service 2020). At the State and local levels, regulatory mechanisms are limited. Therefore, regulatory mechanisms are currently inadequate to prevent the threats the species currently faces (USFWS, 2023).

Recovery

Reclassification Criteria:
Information not available-at present, this species does not have an approved recovery plan.

Recovery Priority Number: 2

Delisting Criteria:
(1) At least 101 resilient metapopulations exhibit a stable or increasing trend are extant or reestablished as evidenced by natural recruitment, and multiple age classes. The delisting criteria were developed based on a population viability analysis (George Brooks, Virginia Tech, 2019, pers. comm.) and the distribution of currently and previously occupied wetlands on Eglin Air Force Base (EAFB) (George Brooks and Nick Caruso, Virginia Tech, 2019, unpublished data)." Greater detail of the development process is found in section 3.4 of the accompanying Species Status Assessment. (2) Approximately one third of the 101 (roughly 34) resilient metapopulations are present in each of the three Recovery Management Units (RMUs; Figure 1) that represent the spatial distribution of historic range: RMU 1 (Western Complex), RMU 2 (Eglin Complex), and RMU 3 (Eastern Complex). The precise number in each RMU is dependent on habitat suitability and availability, but an approximate equal distribution will allow for sufficient redundancy across the historic range. A resilient metapopulation describes the ability of a species to withstand stochastic disturbance. It is positively related to population size and growth rate and may be influenced by connectivity among populations. Generally speaking, populations need abundant individuals within habitat patches of adequate area and quality to maintain survival and reproduction in spite of disturbance. This definition of a metapopulation is based on Brooks et al. (2019b) who indicated that wetlands within 1.5 km of other occupied wetlands were most likely to be occupied and genetic data (Wendt 2017) confirmed the small scale of connectivity (<1 km). Resilient metapopulations in most cases are defined as those with multi-generation demographic stability as indicated by regular evidence of breeding and stable adult

population size, or increasing effective population size (Ne), encompassing a number of occupied wetlands supported by appropriately managed upland and wetland habitats that are not separated by barriers or great dispersal distances. Management agreements or plans with landowners supporting each population are in place to ensure habitat management occurs. (3) Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future. Breeding and adjacent upland habitats within the resilient metapopulations are protected long-term though management agreements, public ownership, or other means, in sufficient quantity and quality to support growing populations. When the major threats to this species have been significantly reduced or eliminated as to no longer pose a threat to its continued survival. Lack of regular lightning season fire to maintain suitable breeding and upland habitats, feral swine, disruptions to hydrology including ditching and addition of impervious surfaces, forestry operations that result in substantial soil disturbance, road construction or increased traffic near breeding wetlands, invasive plants, disease, improper or overuse of pesticides and herbicides, effects of climate change on wetland hydrology and upland soil moisture and temperature, and unnatural presence of predatory fish in breeding ponds, are all threats that must be ameliorated to the greatest extent possible. (USFWS, 2021)

Recovery Actions:

- Population Management and captive propagation
- Habitat restoration
- Research and monitoring
- Most species of the genus Ambystoma have not been bred successfully in captivity, but it is necessary to try to work out captive methods in case it becomes an option of last resort to prevent extinction. If these techniques are successful it is deemed the most likely approach to acquire sufficient numbers of salamanders to conduct any real recovery efforts beyond habitat recovery
- Management of breeding wetlands for this species should include a suite of management actions that increase the cover of herbaceous vegetation (Gorman et al. 2014).
- To increase effective burning of flatwoods salamander habitat, land managers should diversify burning strategies (Bishop and Haas 2005). Other options may include burning uplands during the dormant season and return in the growing season to burn wetlands when they are dry (Gorman et al. 2009).
- Mechanical treatments can be coupled with fire to restore sites that have become too overgrown for fire alone to restore the site (Gorman et al. 2013).
- Further study on the effects of fire ants on flatwoods salamanders is recommended because the severity and magnitude, as well as the long term effect of fire ants on reticulated flatwoods salamander populations is currently unknown.
- Recovery priority number (RPN) should be revised from 5 to 2. An RPN of 2 indicates this is a species with high threat yet high recovery potential.
- Improvement of access and communication with private land owners is needed. Eleven populations were known from private lands, but limited data is available from these populations. Outreach and education are vital to securing the trust of private land owners.
- Greater expansion of survey efforts to include more areas where habitat is suitable but no known populations exist, including greater documentation of areas we do not believe continue to support populations, and why.

- Monitoring programs need to be refined so that data will be compatible among all participating agencies and to develop a better understanding of the current status of the species with particular emphasis on private lands and other populations that have not been sampled as intensively.
- Capture-mark-recapture studies that provide information on vital rates (e.g. individual growth and survival) and demographic parameters of populations are needed to develop a Population Viability Analysis (PVA), which is essential for recovery planning. (Walls et al 2015).
- Head starting, “assisted metamorphosis”, and captive populations are recommended to increase larvae survival to the metamorph stage and to help increase numbers of individuals more rapidly than is possible under current natural circumstances. (O’Donnell et al. 2015; Walls et al. 2015).
- Ensure adequate, high quality habitat is available to support resilient reticulated flatwoods salamander populations. Increase the number of resilient reticulated flatwoods salamander populations to the extent possible of its historic range, within the three RMUs. Improve knowledge needed to increase the number of resilient reticulated flatwoods salamander populations through research and adaptive management. Estimated acquisition of habitat in private sector. Research needs and data gaps (USFWS, 2021)

Conservation Measures and Best Management Practices:

- The future of reticulated flatwoods salamanders is dependent on wetland management. While both sea level rise and increasing temperatures due to climate change are predicted to decrease the number and resiliency of populations by 2100, the choice of management scenario has profound impacts on the number of breeding wetlands and salamander populations in both the short and long-term. If species-specific wetland management (regularly burning of breeding wetlands when they are dry) is not conducted, most active breeding wetlands will become inactive by the Year 2050. However, it is not enough to simply actively manage the breeding wetlands that are currently occupied, as sea level rise and associated marsh migration are projected to result in the loss of currently active breeding wetlands at Escribano Point and Garcon Point WMAs under half of the climate change scenarios by the Year 2100. Climate changes in temperature and precipitation extremes (floods and droughts) will also negatively impact all populations under all but the lowest emissions scenario. To avoid further population declines and ensure that populations are as resilient as possible in the face of anticipated climate changes, land managers will need to engage in and maximize the active restoration of potentially suitable breeding wetlands to offset anticipated breeding wetland losses to sea level rise and other climate changes. Wetland restoration efforts should be primarily focused on inland areas with potentially suitable habitat in the range of the species, which are not anticipated to be affected by sea level rise in the next 80 years. Similarly, long-term protection (via acquisition or easements) should focus on this portion of the species range. Currently, many managers face challenges or lack the resources to maintain all active breeding wetlands or restore additional wetlands. Therefore, efforts should be made to remove barriers to and provide support for wetland restoration and management on occupied and potentially suitable properties. In addition to wetland restoration efforts, salamander translocations to restored wetlands may be necessary if salamanders fail to colonize restored wetlands. (USFWS, 2020)
- RECOMMENDED FUTURE ACTIVITIES x Ensure adequate, high quality habitat availability to support viable reticulated flatwoods salamander populations. x Employ regular prescribed fire to restore and maintain adequate breeding and upland habitat. x Use hand crews or heavy mechanical removal to restore fire excluded or poor condition breeding ponds. x Invest in small fire and hand clearing teams

to assist and fill gaps for land managers in meeting fire and mechanical restoration goals. x Use herbicides selectively to remove hardwoods and non-native vegetation from breeding and upland habitats. x Purchase optimum boundary properties adjacent to Eglin AFB, known as Creets Landing. x Increase the size and number of reticulated flatwoods salamander populations to the extent possible of its historic range, within 3 Recovery Management Units. x Use assisted metamorphosis (headstarting) to strengthen extant but suboptimal populations. x Continue development and implementation of a vigorous captive breeding program. x Use translocation from suitable donor ponds to restore breeding population throughout appropriate connected pond complexes. x Use reintroductions from captive bred or salvaged animals to repopulate extirpated areas with suitable habitat once appropriate methodologies have been developed. x Promote reticulated flatwoods salamander conservation through education and outreach programs. x Identify research needs and close data gaps. Especially, to determine frequency and seasonality needed to improve salamander habitat (USFWS, 2023).

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SPECIES ACCOUNT: *Ambystoma californiense* (California tiger Salamander (Central California))

Species Taxonomic and Listing Information

Commonly-used Acronym: CTS

Listing Status: Threatened; 8/4/2004 (69 FR 47212).

Physical Description

The California tiger salamander is a large, stocky terrestrial salamander with a broad, rounded snout. Adults average 16 to 24 centimeters (6 to 9.5 inches [in.]) in length, and have random white or yellowish spots or bars against a black body. Their small eyes, which have black irises, protrude from their heads. Males can be distinguished from females, especially during the breeding season, by their swollen cloacae (a common chamber into which the intestinal, urinary, and reproductive canals discharge), more developed tail fins, and larger overall size (68 FR 28648). The larvae are aquatic; range in size from 11.5 to 14.2 millimeters (0.45 to 0.55 in.) in total length; are yellowish gray in color; and have a broad fat head, large, feathery external gills, and broad dorsal fins that extend well onto the back (68 FR 28648).

Taxonomy

Six unique populations consisting of three discrete DPSs have been identified in California; although each DPS is genetically differentiated and geographically isolated; in California, all California tiger salamanders are treated as Ambystoma californiense.

Historical Range

Historically, California tiger salamanders were endemic to the San Joaquin-Sacramento river valleys, bordering foothills, and coastal valleys of Central California. Although the historical distribution of California tiger salamanders is not known in detail, their current distribution suggests that they may have been continuously distributed along the low-elevation grassland-oak woodland plant communities of the valleys and foothills. In this area, the species is known from sites on the Central Valley floor near sea level, up to a maximum elevation of roughly 1,200 meters (m) (3,940 feet [ft.]) in the Coast Ranges and 500 m (1,640 ft.) in the Sierra Nevada foothills (USFWS 2014).

Current Range

The Central California tiger salamander is currently restricted to disjunct populations that form a ring along the foothills of the Central Valley and Inner Coast Range (Figure 1) (Service 2017a, p. iv) within the following counties: Alameda, Amador, Calaveras, Contra Costa, Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, Sacramento, San Benito, San Mateo, San Joaquin, San Luis Obispo, Santa Clara, Santa Cruz, Stanislaus, Solano, Tulare, Tuolumne, and Yolo (Service 2014, p. 13). In addition, genetic studies have shown that within the Central California DPS there is genetic differentiation between the following four sub-groups that corresponds with the geographic distribution of those groups: (1) Southern San Joaquin Valley; (2) Central Valley; (3)

Bay Area; and (4) Central Coast Range (Shaffer et al. 2004, pp. 3039–3040; Shaffer et al. 2013, p. 5). The spatial distribution for the Central California tiger salamander has not changed significantly since the time of listing (Service 2004, p. 47214; Service 2014, p. 13; Service 2017a, p. I-2) and traditional surveys continue throughout portions of the species range. A new eDNA assay developed by Kieran et al. (2020) offers another survey method to detect California tiger salamanders and could help increase our understanding of their distribution within Central California (USFWS 2023).

Critical Habitat Designated

Yes; 8/23/2005.

Legal Description

On August 23, 2005, the U.S. Fish and Wildlife Service (Service), designated critical habitat for the Central population of the California tiger salamander (Ambystoma californiense) pursuant to the Endangered Species Act of 1973, as amended (70 FR 49380 - 49458). In total, approximately 199,109 acres (ac) (80,576 hectares (ha)) fall within the boundaries of the critical habitat designation. The critical habitat is located within 19 counties in California.

Critical Habitat Designation

The critical habitat designation for Ambystoma californiense includes 31 units totaling 199,109 acres in four geographic regions in California. The four regions containing critical habitat are: (1) The Central Valley Region; (2) the Southern San Joaquin Valley Region; (3) the East Bay Region (including Santa Clara Valley area); and (4) the Central Coast Region.

Central Valley Geographic Region: The Central Valley Geographic Region is generally found in an area from northern Yolo County south and southeast to the northern half of Madera County, including eastern Solano and Contra Costa counties. It is 4.9 million ac (1.9 million ha) in size. Within the Central Valley Geographic Region we are designating 12 critical habitat units for the Central population of the California tiger salamander that total approximately 97,045 ac (39,273 ha). The 12 critical habitat units contain PCEs and include a total of 44 extant occurrences of CTS. The 12 units occur in four of 17 vernal pool regions within California. These four regions are Solano-Colusa, Southeastern Sacramento Valley, Southern Sierra Foothills, and San Joaquin Valley. The units are distributed across the Region and represent the varying habitats and environmental conditions available to the California tiger salamander within the area. A fundamental concept in conservation biology is that species that are protected across their ranges have lower chances of extinction (Soule and Simberloff 1986; Noss et al. 2002). By including units across the geographic range of the species within this region the Service is conserving the diversity of the species and its habitat across its range. Special management requirements for these units include management of erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat and alter upland refugia and dispersal habitat, and activities such as road development that may result in barriers to dispersal.

Unit 1, Dunnigan Creek Unit, Yolo County: This unit is the only unit in Yolo County, encompasses approximately 2,730 acres (1,105 ha). This unit contains all three of the PCEs. Three extant occurrences of the species have been documented within this unit. Unit 1 is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographical Region. Unit 1 represents the northern portion of the range and the represents the northern portion of the Solano-Colusa vernal pool region. Unit 1 is roughly bordered by Interstate 5 on the east, Bird Creek on the south, and Buckeye Creek on the north and west. Land ownership is private. Threats that require special management considerations for this unit include agricultural land conversion and the introduction of predators such as mosquito fish into seasonal wetlands for the control of mosquitoes.

Unit 2, Jepson Prairie Unit, Solano County: This unit encompasses approximately 5,699 ac (2,306 ha), and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 2 represents the northwestern portion of the species' distribution and represents the southern end of Solano-Colusa vernal pool region in Solano County. This unit contains all three of the PCEs and four extant occurrences of the species in one aggregation. Unit 2 generally is located south of Dixon, west of State Route 113, north of Creed Road, and east of Travis Air Force Base. This unit is mostly privately owned but also includes some California Department of Fish and Game lands. Threats that require special management considerations for this unit include loss and destruction of occupied habitat due to agricultural land conversion.

Unit 3, Southeastern Sacramento Unit, Sacramento County: This unit encompasses approximately 9,966 ac (4,033 ha), is the only unit in Sacramento County, and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 3 represents the northern-central portion of the range of the species, the southern portion of the Southeastern Sacramento Valley vernal pool region, and is only one of a few occupied areas in the Sacramento Valley. This unit contains all three of the PCEs. A cluster of eight extant occurrences has been documented in this unit. Unit 3 generally is bordered on the south by the Sacramento and San Joaquin County border dividing line, Laguna Creek on the north, the Sacramento and Amador County border dividing line on the east, and Alta Mesa Road on the west. Land ownership is private. Threats that require special management considerations for this unit include road construction, agricultural land conversion, urban development, and predators such as bullfrogs. Development and agricultural land conversion could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity. Aquatic predators such as bullfrogs require special management because they can impair breeding success.

Unit 4, Northeastern San Joaquin Unit, and Amador Counties: This unit encompasses approximately 9,603 ac (3,886 ha), is the only one in San Joaquin and Amador counties, and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 4 is the second unit in the Southeastern Sacramento Valley vernal pool region. This unit contains all three of the PCEs and five extant occurrences in one aggregation. Unit 4 roughly is found over an area south of the San Joaquin and Sacramento county dividing line, east of Day Creek Road, north of Liberty Road, and west of Comanche and Jackson Valley Roads. Land ownership is private. Threats that require special management considerations for this unit include developments and associated road construction that could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 5, Indian Creek Unit, Calaveras County: This unit encompasses appropriately 3,128 ac (1,266 ha). This unit is essential to the conservation of the CTS because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 5 represents the northeastern portion of the range and the Southeastern Sacramento Valley vernal pool region. Four extant occurrences of the species have been documented in this unit. It contains all three PCEs and generally is bordered by State Route 26 on the south and east, Warren Road on the west, and State Route 12 on the north. Land ownership is private. Threats that require special management considerations for this unit include urban developments, agricultural land conversions, and associated infrastructure including road construction that could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 6, Rock Creek Unit, Calaveras, San Joaquin, and Stanislaus Counties: This 23,491 ac (9,506 ha) unit is essential to the conservation of the Central population of the California tiger salamander because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 6 contains all three of the PCEs and represents the northern end of the Southern Sierra Foothills vernal pool region and a portion of the eastcentral portion of the San Joaquin Valley. This unit contains five extant occurrences of the species in one aggregation. This unit is approximately located west of San Joaquin County Road J6, north of Sonora Road, east of Stanislaus County Road J12, and south of the Calaveras River. Land ownership is private. Threats that require special management considerations for this unit include urban developments, agricultural land conversions, and associated infrastructure including road construction, which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 7, Rodden Lake Unit, Stanislaus County: This unit contains approximately 562 ac (227 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 7 is located within the northern end of the Southern Sierra Foothill vernal pool region in the eastern San Joaquin Valley, the only unit near the Stanislaus River. Three extant occurrences of the Central CTS have been documented within this unit. This unit is roughly bounded by Horseshoe Road on the east, Frankenheimer Road on the north, Twenty Eight Mile Road on the west, and the Stanislaus River of the south. Land ownership is private. Threats that require special management considerations for this unit include urban developments, agricultural land conversions, and associated infrastructure including road construction, which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 8, La Grange Ridge Unit, Stanislaus and Merced Counties: This unit contains approximately 4,013 ac (1,624 ha) and is essential for the conservation of the Central CTS because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 8 occurs within the northeastern area of the 2,167,907 ac (877,352 ha) Southern Sierra Foothills vernal pool region and represents the east central portion of the species' distribution within the Central Valley Geographic Region. It contains five extant occurrences of the species and all three of the PCEs. This unit is roughly defined as west of Cardoza Ridge, east of Los Cerritos Road, south of State Route 132, and north of Fields Road. Land ownership is private. Threats that require special management considerations for this unit include Threats that require special management considerations for this unit include urban developments, agricultural land conversions, and associated infrastructure including road construction that could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 9, Fahrens Creek Unit, Merced County: This unit contains 17,799 ac (7,203 ha) and is essential for the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 9 represents the 2,167,907 ac (877,352 ha) South Sierra Foothills vernal pool region in Merced County, the central portion of the species' distribution in the eastern San Joaquin Valley, and the south-eastern portion of the species' distribution in the Central Valley Geographic Region. Twenty extant occurrences of the species are documented in this unit. This unit is located generally northeast from Merced, east of the Merced and Mariposa county dividing line, north of Bear Creek, and south of the Merced River. Land ownership of the unit is private. Threats that require special management considerations for this unit urban developments, agricultural land conversions, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 10, Miles Creek Unit, Merced County: This unit contains approximately 10,585 ac (4,284 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 10 is the only other unit that occurs within the Southern Sierra Foothill vernal pool region in Merced County and represents the central portion of the species' distribution in the eastern San

Joaquin Valley and the south-eastern portion of the species' distribution in the Central Valley Geographic Region. Nine extant occurrences have been documented within this unit, which is located generally east of Owens Lake in Mariposa County, west of Cunningham Road in Merced County, south of South Bear Creek Road in Merced County, and north of Childs Avenue. Land ownership is private. Threats that require special management considerations for this unit include urban developments, agricultural land conversions, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 11, Rabbit Hill Unit, Madera County: This unit contains 8,291 ac (3,355 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Valley Geographic Region. Unit 11 represents the Sierra Foothills vernal pool region in Madera County and is the southernmost unit within the Central Valley Geographic Region. This unit contains all three of the primary constituent elements, including vernal pools and upland dispersal habitats that support six extant occurrences of the species. Unit 11 is generally located west of Hensley Lake, south of Knowles Junction, west of the Daulton Mine, and north of the Fresno River. Land ownership is private. Threats that require special management considerations for this unit include urban developments, agricultural land conversions, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 18, Doolan Canyon Unit, Alameda County: This unit contains approximately 1,178 ac (477 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species in the Central Valley Geographic Region. Unit 18 represents the 485,120 ac (196,328 ha) Livermore vernal pool region and the western portion of the Central Valley Geographic Region. Two extant occurrences of the species are found in this unit. Unit 18 is south of the Contra Costa County line near Collier Canyon Road on the east and the south, and the City of Dublin on the west. Land ownership is private. Threats that require special management considerations for this unit include urban developments, agricultural land conversions, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Southern San Joaquin Valley Geographic Region: The Southern San Joaquin Valley Geographic Region contains approximately 1.4 million ac (566,580 ha) and is found from the southern half of Madera County south to northeastern Kings County and northwestern Tulare County. Within this Geographic Region the Service designated four critical habitat units that total approximately 20,293 ac (8,212 ha). The four critical habitat units contain approximately 20 known extant occurrences the Central population of the California tiger salamander. The critical habitat units represent the San Joaquin Valley and Southern Sierra Foothills vernal pool regions in the southern

San Joaquin Valley. It is critical to conserve the CTS within a range of habitat types to capture the geographic, ecological, and genetic variability found in nature. Protecting a variety of occupied habitats and ecologic conditions will increase the ability of the species to survive random environmental (e.g. predators), natural (e.g. disease), demographic (e.g. low recruitment) or genetic (e.g. inbreeding) events. The critical habitat units of the Southern San Joaquin Valley Geographical Region are essential to the conservation of the California tiger salamander because these units represent the range of geographic, genetic, and ecological variation found in nature and they contain the PCEs that support essential functions including, but not limited to, breeding, metamorphosing, dispersing, feeding, sheltering, and aestivating. Special management requirements for these units include management of erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Units 1a and 1b, Millerton Unit, Madera County: This 6,811 ac (2,756 ha) unit is comprised of two sub-units; Unit 1a (3,808 ac (1,541 ha)) and Unit 1b (3,003 ac (1,215 ha)). This unit is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species in the Southern San Joaquin Geographic Region. Unit 1 represents the Southern Sierra Foothills vernal pool region, one of two differing vernal pool regions in the Southern San Joaquin Geographic Region, and the southeastern portion of the species' distribution in the San Joaquin Valley. Unit 1 is the only unit within this vernal pool region in Madera County. The two subunits contain nine extant occurrences of the species. These subunits are located west of State Highway 41 and generally north of the San Joaquin River. The eastern boundary is approximately the western side of Millerton Lake, and the northern boundary is south of Berry Hill along O'Neal Road. Land ownership is private. Threats that require special management considerations for this unit include urban development, agricultural conversion, and associated infrastructure, including road construction, which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 2, Northeast Fresno, Fresno County: This unit is approximately 4,961 ac (2,008 ha) and is essential for the conservation of the Central population of the California tiger salamander because it is needed to maintain the current geographic and ecological distribution of the species in the Southern San Joaquin Geographic Region. Unit 2 represent the Southern Sierra Foothills vernal pool region within Fresno County, the northern end of the Southern San Joaquin Geographic Region, and the southern portion of the species' distribution in the San Joaquin Valley. This unit contains all three of the PCEs and 6 extant occurrence records This unit is located northeast of Fresno, southwest of Millerton Lake, east of Friant Road, and generally west of Academy. Land ownership is private. Threats that require special management considerations for this unit include urban development, agricultural conversion, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Units 3a and 3b, Hills Valley Unit, Fresno and Tulare Counties: This 4,181 ac (1,692 ha) unit is comprised of the two subunits Unit 3a (1,626 ac (658 ha)) and Unit 3b (2,553 ac (1,033 ha)). This unit is essential to the conservation of the Central population of the California tiger salamander because it is needed to maintain the current geographic and ecological distribution of the species in the Southern San Joaquin Geographic Region. The subunits comprising Unit 3 represent the foothills of northwest Tulare County, the Southern Sierra Foothills vernal pool region, and the southeastern portion of the species' distribution within the San Joaquin Valley. These subunits contain all three of the PCEs and five extant occurrences of the species. This unit is located south of State Highway 180, generally west of George Smith and San Creek Roads, north of Curtis Mountain, and east of Cove Road. Land ownership is private. Threats that require special management considerations for this unit include urban development, agricultural conversion, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 5, Cottonwood Creek Unit, Tulare County: Unit 5 is approximately 4,342 ac (1,757 ha) and represents a significant area at the very southernmost portion of the range of the Central population of the California tiger salamander. This unit was originally called unit 5A in the proposed designation. This unit is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Southern San Joaquin Geographic Region. Unit 5 represents a lowelevation vernal pool complex within the San Joaquin Valley vernal pool region. Four extant occurrences have been documented within this unit, which is roughly bordered by County Road J36 on the north, Dinuba Road on the east, Avenue 352 on the south, and County Road 112 on the west. Land ownership is mostly private. Threats that require special management considerations for this unit include urban development, agricultural conversion, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

East Bay Geographic Region: The East Bay Geographic Region is found in Alameda County, south to Santa Benito and Santa Clara counties, and west to the eastern portions of San Joaquin and Merced Counties. The East Bay Region contains 2.4 million ac (971,280 ha) and has approximately 24,045 ac (9,731 ha) of critical habitat. Within the East Bay Geographic Region The Service designated 14 critical habitat units for the California tiger salamander that contain a number of extant occurrences of the Central population of the California tiger salamander. The 14 critical habitat units within the Bay Area Geographic Region occur in the Livermore, Central Coast, and San Joaquin vernal pool regions. Special management requirements for these units include management of erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal. It is critical to conserve the Central population of the California tiger salamander within the range of habitat types to capture the geographic and genetic variability found in nature. Protecting a variety of occupied habitats and conditions will increase the ability of the species to survive random environmental (e.g. predators), natural (e.g. disease), demographic (e.g. low recruitment), or genetic (e.g. inbreeding) events. The critical habitat units within the East Bay Geographic Region are essential to the conservation of the Central population of the California tiger salamander because these units collectively maintain the geographic, genetic, and genetic variability that currently exists within the range of the species. Some of the designated units are in pristine condition as indicated by the best scientific and commercial data, and habitat quality was another factor which the Service considered in our determination of what habitat is essential.

Unit 3, Alameda Creek Unit, Santa Clara County: This unit contains 619 ac (251 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 3 represents the north-central portion of the Bay Area Geographic Region and the northwestern Livermore vernal pool region. This unit contains all three of the PCEs and three extant occurrences. Unit 3 generally is located north of Calaveras Reservoir, east of Sugar Butte, west of Fremont, and south of Livermore. Land ownership is a mixture of county parks and private lands. Threats that require special management considerations for this unit include urban development, agricultural conversion, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity. Feral pigs and bullfrogs may require special management because can impair breeding success.

Unit 5, Poverty Ridge Unit, Santa Clara County: This unit is approximately 2,814 ac (1,139 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 5 represents the north-central portion of the Bay Area Geographic Unit and the southern end of the Livermore vernal pool region. It contains all three of the PCEs and six extant occurrences of the species. This unit is generally located west of Alum Rock, south of the Alameda and Contra Costa Counties dividing line, west of Kincaid Road, and north of Master Hill. Land ownership is private. Threats include conversion of grazing land to housing and commercial development.

Unit 6, Smith Creek Unit, Santa Clara County: This unit is approximately 7,976 ac (3,228 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 6 represents the north-central part of the range of the species within the Bay Area Geographic region and the northern range of the Central Coast vernal pool region. This unit contains all three of the PCEs and 10 extant occurrences of the species. Unit 6 is generally located west of Sugarloaf Mountain, south of Packard Ridge, east of Masters Hill, and north of Panochita Hill. This unit contains county, private, and University of California-owned lands. Threats that require special management considerations include urban development, agricultural conversion, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 7, San Felipe Creek Unit, Santa Clara County: This unit is approximately 9,080 ac (3,675 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 7 represents the center of the Bay Area Geographic Region and the north-central part of the Central Coast vernal pool region. It contains all three of the PCEs and four extant occurrences of the species. Unit 7 is generally located in west of Silver Creek, south of Panochita Hill, east of Bollinger Mountain, and north of Morgan Hill. Land ownership is private. Threats that require special management considerations include urban development, agricultural conversion, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity.

Unit 8, Laurel Hill Unit, Santa Clara County: This unit is approximately 2,535 ac (1,026 ha) and is essential for the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 8 represents the northwestern portion of the species’ range in the Bay Area Geographic Region and the northwestern area of the Central Coast vernal pool region on the western side of the Santa Clara Valley. This unit contains all three of the PCEs and three extant occurrences. Unit 8 generally is located east of Morgan Hill, south of San Jose, west of the Santa Cruz Mountains, and north of Croy Ridge. Land ownership is private. Threats that require special management considerations for this unit include urban development and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity. Bullfrogs present in aquatic habitat may require special management because they can impair breeding success.

Unit 9, Cebata Flat Unit, Santa Clara County: This unit contains approximately 2,934 ac (1,187 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the East Bay Geographic Area. Unit 9 represents the center of the Bay Area Geographic Region and the central area of the Central Coast vernal pool region. It contains all three of the PCEs and three extant occurrences of the species. Unit 9 is generally located west of Gilroy, south of Henry Coe State Park, east of Lake Mountain, and north of Canada Road. Land ownership is private. Threats that require special management considerations for this unit include urban development, and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity. Bullfrogs present in aquatic habitat may require special management because they can impair breeding success.

Units 10a and 10b, Lions Peak Unit, Santa Clara County: This unit is comprised of 892 ac (360 ha) in two subunits: (Unit 10a (194 ac (79 ha) and Unit 10b (698 ac (282 ha). It is essential for the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 10 represents only the second unit on the west side of the Santa Clara Valley within the center of the Bay Area Geographic Region and the center of the Central Coast vernal pool region. It contains all three of the PCEs and six extant occurrences of the species. Unit 10 is generally found east of State Highway 101, south of Morgan Hill, north of Hecker Pass Highway, and west of Uvas Reservoir. Land ownership is private. Threats that require special management considerations for this unit include urban development and associated infrastructure including road construction which could destroy or degrade aquatic habitat essential for breeding and rearing; destroy, degrade, or fragment upland habitat essential for growth, feeding, resting, and aestivation; or destroy, degrade, or fragment habitat essential for dispersal and connectivity. Bullfrogs present in aquatic habitat may require special management because they can impair breeding success.

Unit 11, Braen Canyon Unit, Santa Clara County: This unit is comprised of 6,991 ac (2,829 ha) of habitat and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 11 represents the eastern central portion of the species range within the Bay Area Geographic Region and the central portion of the Central Coast vernal pool region. It contains all three of the PCEs and five extant occurrences of the species. Unit 11 is found in southern Santa Clara County generally west of Gilroy, south of Kelly Lake, east of Pacheco Lake, and north of Jamison Road. Land ownership is private. Threats that may require special management include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Unit 12, San Felipe Unit, Santa Clara and San Benito Counties: This unit is comprised of 6,642 ac (2,688 ha) of habitat and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 12 represents part of the center of the distribution within the Bay Area Geographic Region and the southernmost portion of Santa Clara County, northern San Benito County, and center of the Central Coast vernal pool region. It contains all three of the PCEs and 10 extant occurrences of the species. Unit 12 generally is found west of Camadero, south of Kickham Peak, east of San Joaquin Peak, and north of Dunneville. Land ownership is private. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Unit 13, Los Banos Unit, Merced County: This unit is comprised of 2,409 ac (975 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 13 represents a portion of the southeastern range of the species within the Bay Area Geographic Region and the San Joaquin Valley vernal pool region. It contains all three of the PCEs and three extant occurrences of the species. Unit 13 generally is located east of Los Banos Reservoir, north of Bullard Mountain, west of Cathedral Peak, and south of San Luis Reservoir State Recreation Area. Land ownership is private. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Unit 14, Landgon Unit, Merced County: This unit is comprised of 2,212 ac (895 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. Unit 14 represents the easternmost distribution of the species within the Bay Area Geographic Region and is the only other unit that occurs within the San Joaquin Valley vernal pool region. It contains all of the PCEs and three extant occurrences of the species. Unit 14 generally is found west of Sweeney Hill, south of Gasten Bide Road, and north of Ortigalita Peak. Land ownership is private. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Units 15A and 15B, Ana Creek Unit, San Benito County: This unit is approximately 3,165 ac (1,280 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Bay Area Geographic Region. The unit is comprised of two subunits, 15A (2,722 ac (1,102 ha)) and 15B (194 ac (79 ha)). These subunits represent the southwestern portion of the species' range within the Bay Area Geographic Region and in the southern Central Coast vernal pool region. They contain all three of the PCEs and nine extant occurrences of the species. Unit 15A and B are generally located west of Hollister, north of Tres Pinos, east of Cibo Peak, and south of Coyote Peak. Land ownership is private. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Unit 16, Bitterwater Unit, San Benito County: This unit is approximately 16,952 ac (6,860 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the East Bay Geographic Region. Unit 16 represents the southernmost range of the species within the Bay Area Geographic Region and the southern end of the Central Coast vernal pool region. It contains all three of the PCEs and nine extant occurrences of the species. Unit 16 generally is found south of Pinnacles, east of Hernandez Reservoir, north of Lonoak, and west of Murphy Flat. Land ownership is private. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Unit 17, Gloria Valley Unit, Monterey and San Benito Counties (Formerly Central Coast Region, Unit 4): This unit is comprised of 3,881 ac (1,571 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the East Bay Geographic Region. Unit 17 represents the northeastern portion of the range of the species within the Bay Area Geographic Region and the western area of the Central Coast vernal pool region. It contains all three of the PCEs and 10 extant occurrences of the species. Unit 17generally is located north of Soledad, east of the Pinnacles National Monument, south of Tres Pinos, and west of Gonzales. Land ownership is private. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Central Coast Geographic Region: The Central Coast Geographic Region is located from Monterey County to northeastern San Luis Obispo County and northwestern Tulare County. The Central Coast Geographic Region is 3.6 million ac (1.5 million ha) in size and contains two critical habitat units for the Central population of the California tiger salamander that total approximately 25,373 ac (10,268 ha). The critical habitat units within the Central Coast Geographic Region contain 14 extant occurrences of California tiger salamander that encompass a migration distance of 0.70 mi (1.1 km) from each cluster of known extant occurrences that compose the critical habitat units. Critical habitat is designated within the Central Coast, Livermore, and Carrizo vernal pool regions. Special management requirements for these units include management of erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal. It is essential to conserve the Central population of the California tiger salamander within the range of habitat types to capture the geographic and genetic variability found in nature. Protecting a variety of occupied habitats and conditions will increase the ability of the species to survive random environmental (e.g. predators), natural (e.g. disease), demographic (e.g. low recruitment) or genetic (e.g. inbreeding) events. The critical habitat units within the Central Coast Geographic Region are essential to the conservation of the Central population of the California tiger salamander because these units collectively maintain the geographic, genetic, and genetic variability that currently exists within the range of the species. Some of the designated units are in pristine condition as indicated by the best scientific and commercial data, and habitat quality was another factor the Service considered in the determination of what habitat is essential.

Unit 3, Haystack Hill Unit, Monterey County: This unit is comprised of 3,665 ac (1,483 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Coast Geographic Region. Unit 3 represents the center of the Central Coast Geographic Region and the northwestern area of the Central Coast vernal pool region. It contains all three of the PCEs and 10 extant occurrences of the species. Unit 3 generally is located north of Soledad, east of Paloma Ridge, west of Jamesberg, and south of Carmel Valley. Land ownership within this unit is a mixture of private and Hastings Natural History State Reserve. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Unit 6, Choice Valley, Kern and San Luis Obispo Counties: This unit is comprised of 9,233 ac (3,736 ha) and is essential to the conservation of the species because it is needed to maintain the current geographic and ecological distribution of the species within the Central Coast Geographic Region. Unit 6 represents the very southern extension of the species' range in the Central Coast Geographic Region and is the only unit within the Carrizo vernal pool region. It contains all three of the PCEs and four extant occurrences of the species. Unit 6 generally is located in an area north of the Carrisa Highway, east of Antelope Valley, south of Cottonwood, and west of Shandon. Land ownership is private. Threats include erosion and sedimentation, pesticide application, introduction of predators such as bullfrogs and mosquito fish, disturbance activities associated with development that may alter the hydrologic functioning of the aquatic habitat, upland disturbance activities that may alter upland refugia and dispersal habitat, and activities such as road development and widening that may develop barriers for dispersal.

Primary Constituent Elements/Physical or Biological Features

The PCEs of critical habitat for the Central population of the California tiger salamander (Ambystoma californiense) are the habitat components that provide:

(i) Standing bodies of fresh water (including natural and manmade (e.g., stock)) ponds, vernal pools, and other ephemeral or permanent water bodies which typically support inundation during winter rains and hold water for a minimum of 12 weeks in a year of average rainfall;

(ii) Upland habitats adjacent and accessible to and from breeding ponds that contain small mammal burrows or other underground habitat that CTS depend upon for food, shelter, and protection from the elements and predation; and

(iii) Accessible upland dispersal habitat between occupied locations that allow for movement between such sites.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one or more of the PCEs, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

The areas proposed for critical habitat may require special management considerations or protections due to the threats outlined below: (1) Introduction of non-native predators such as bullfrogs and fish can be significant threats to the California tiger salamander breeding ponds in Sonoma County; (2) Activities that could disturb aquatic breeding habitats during the breeding season, such as heavy equipment operation, ground disturbance, maintenance projects (e.g. pipelines, roads, powerlines), off-road travel or recreation; (3) Activities that impair the water quality of aquatic breeding habitat; (4) Activities that would reduce small mammal populations to the point that there is insufficient underground refugia used by California tiger salamander in Sonoma County for foraging, protection from predators, and shelter from the elements; (5) Activities that create barriers impassable for salamanders or increase mortality in upland habitat between extant occurrences in breeding habitat; and (6) Activities that disrupt vernal pool complexes' ability to support California tiger salamander breeding function.

Life History

Food/Nutrient Resources

Food Source

Larvae: Zooplankton, small crustaceans, and aquatic insects, moving toward larger prey such as the tadpoles of Sierran tree frog (Pseudacris sierra), western spadefoot toads (Spea hammondii), and California red-legged frogs (Rana draytonii) as they grow in size (USFWS 2014).

Adult: Invertebrate prey items found in adult salamander stomachs include aphids (Aphididae), wood cockroaches (Blattellidae), ground beetles (Carabidae), springtails (Collembola), centipedes (Cryptopidae, Lithobiidae, and Scolopendra), true weevils (Curculionidae), webspinners (Embioptera), wasps/bees/ants (Hymenoptera), woodlice (Isopoda), silverfish (Lepismatidae), wolf spiders (Lycosidae), owlet moths (Noctuidae), harvestmen (Opiliones), crickets (Rhaphidophoridae), scarab beetles (Scarabaeidae), and crane flies (Tipula) (USFWS 2014).

Competition

Larvae: Nonnative and hybrid tiger salamanders and western mosquitofish (Gambusia affinis) can outcompete larvae when they occur (USFWS 2014).

Food/Nutrient Narrative

Larvae: The California tiger salamander larvae is an opportunistic invertivore/carnivore, and is among the top aquatic predators in the seasonal pool ecosystems. The larvae prey on zooplankton, small crustaceans, and aquatic insects, moving toward larger prey such as the tadpoles of Sierran tree frog (Pseudacris sierra), western spadefoot toads (Spea hammondii), and California red-legged frogs (Rana draytonii) as they grow in size (USFWS 2014). The larvae often rest on the bottom in shallow water, but also may be found at different layers in the water column in deeper water. The young salamanders are wary; when approached by potential predators, they will dart into vegetation on the bottom of the pool (68 FR 28648). Typical competitors include nonnative and hybrid tiger salamanders and western mosquitofish (Gambusia affinis), which can outcompete larvae when they occur (USFWS 2014). Larvae feed for about 6 to 8 weeks after hatching, after which they switch to larger prey (USFWS 2014). The larval stage of the California tiger salamander usually lasts 3 to 6 months, with metamorphosis beginning in late spring or early summer (USFWS 2014). Larvae develop faster in smaller, more rapidly drying pools. The developmental period is prolonged in colder weather and in larger pools; larvae development (time from eggs laid to larvae leaving the pond) has been observed taking from 74 days to 94 days (USFWS 2014).

Adult: The California tiger salamander adult is an opportunistic invertivore/carnivore, foraging predominantly underground during the dry summer months. Invertebrate prey items found in adult salamander stomachs include aphids (Aphididae), wood cockroaches (Blattellidae), ground beetles (Carabidae), springtails (Collembola), centipedes (Cryptopidae, Lithobiidae, and Scolopendra), true weevils (Curculionidae), webspinners (Embioptera), wasps/bees/ants (Hymenoptera), woodlice (Isopoda), silverfish (Lepismatidae), wolf spiders (Lycosidae), owlet moths (Noctuidae), harvestmen (Opiliones), crickets (Rhaphidophoridae), scarab beetles (Scarabaeidae), and crane flies (Tipula). Most evidence suggests that California tiger salamanders remain active in their underground dwellings during the summer months, making frequent underground movements in burrow systems of less than 33 ft. (10 m), but otherwise remaining underground until the onset of rain and the winter months (USFWS 2014).

Reproductive Strategy

Adult: Substrate spawner.

Lifespan

Adult: Up to 10 years or more (USFWS 2014).

Dependency on Other Individuals or Species

Adult: Males typically arrive before the females, generally remaining in the ponds longer (average of 44.7 days) than females (average of 11.8 days) (USFWS 2014).

Breeding Season

Adult: Typically from November through April, although migrating adults can be observed as early as October and as late as May (USFWS 2014).

Key Resources Needed for Breeding

Adult: Females deposit their eggs in ephemeral/vernal or perennial water, attaching the eggs to twigs, grass stems, or other vegetation or debris (USFWS 2014).

Other Reproductive Information

Egg: Females attach their eggs singly or, in rare circumstances, in groups of two to four (68 FR 28648). California tiger salamander eggs hatch in 10 to 28 days; the amount of time for hatching is likely related to water temperatures (USFWS 2014).

Adult: The male deposits a spermatophore on the bottom of the pond, which the female picks up and uses to fertilize her eggs internally (USFWS 2014).

Reproduction Narrative

Egg: Females attach their eggs singly or, in rare circumstances, in groups of two to four (68 FR 28648). After deposition, California tiger salamander eggs hatch in 10 to 28 days; the amount of time for hatching is likely related to water temperatures (USFWS 2014).

Adult: With the onset of the breeding season, typically from November through April (although migrating adults can be observed as early as October and as late as May), adult salamander leave their refugia during rain and storm events in search of breeding ponds (e.g., ephemeral/vernal or perennial water). Males typically arrive before the females, generally remaining in the ponds longer (average of 44.7 days) than the females (average of 11.8 days). The male deposits a spermatophore on the bottom of the pond, which the female picks up and uses to fertilize her eggs internally. Females then attach their eggs to twigs, grass stems, or other vegetation or debris (USFWS 2014).Breeding adults are usually 1 (rare) to 2 years (typical), and up to 4 to 5 years of age; females breed an estimated 1.4 times in their lifetime (up to 10 years or more). Given that an estimated 8.5 young survive to metamorphosis per reproductive event, a female's reproductive capacity averages roughly 12 metamorphic offspring over its lifetime (USFWS 2014).

Habitat Type

Egg: See Adult life stage.

Larvae: See Adult life stage.

Adult: Grassland/herbaceous, savanna, woodland - hardwood (NatureServe 2015); for breeding, primarily inhabits annual grasslands and open woodlands of the foothills and valleys surrounding ephemeral/vernal pools (USFWS 2014).

Habitat Vegetation or Surface Water Classification

Egg: See Adult life stage.

Larvae: See Adult life stage.

Adult: Lacustrine Habitat(s): shallow water; Palustrine Habitat(s): herbaceous wetland, temporary pool surrounded by uplands characterized by annual grassland and oak woodland (NatureServe 2015).

Dependencies on Specific Environmental Elements

Egg: California tiger salamanders breed in deeper vernal pools and wetlands that have sufficiently long periods of inundation to prevent stranding/desiccation (USFWS 2014).

Adult: Deep, natural vernal pools and ponds with sufficient hydroperiod; livestock ponds and other modified ephemeral and permanent ponds surrounded by large tracts of land dominated by grassland, oak savanna, or oak woodland. Breeding pools typically have moderate to high levels of turbidity; California tiger salamanders rarely use ponds with clear water (USFWS 2014).

Geographic or Habitat Restraints or Barriers

Adult: Roads; wide, fast rivers; areas of intensive development dominated by buildings and pavement (NatureServe 2015).

Spatial Arrangements of the Population

Adult: Random

Environmental Specificity

Adult: Narrow/specialist or community with key requirements common (NatureServe 2015).

Tolerance Ranges/Thresholds

Larvae: Ponding duration is an important factor for breeding success. Wetlands must have a long enough ponding duration for California tiger salamander larvae to mature into juveniles capable of dispersing from the aquatic breeding site to suitable terrestrial habitat. This typically takes 3 months or more, and will vary depending on factors such as water temperature and the depth of the breeding ponds (USFWS 2014).

Site Fidelity

Adult: High; California tiger salamanders appear to have high site fidelity, returning to their natal pond as adults. After breeding, they commonly return to the same terrestrial habitat areas (USFWS 2014).

Dependency on Other Individuals or Species for Habitat

Adult: California tiger salamander populations are strongly correlated with small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae) (USFWS 2014).

Habitat Narrative

Egg: California tiger salamanders breed in deeper vernal pools and wetlands that have sufficiently long periods of inundation to prevent stranding/desiccation. Eggs are attached to a substrate such as twigs, grass stems, or other vegetation or debris (USFWS 2014).

Larvae: Ponding duration is an important factor for breeding success. Wetlands must have a long enough ponding duration for California tiger salamander larvae to mature into juveniles capable of dispersing from the aquatic breeding site to suitable terrestrial habitat. This typically takes 3 months or more, and will vary depending on factors such as water temperature and the depth of the breeding ponds (USFWS 2014).

Adult: California tiger salamander populations are strongly correlated with small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae). Adult California tiger salamanders spend roughly 90 percent of any given year underground. Most evidence suggests that California tiger salamanders remain active in their underground dwellings. California tiger salamanders appear to have high site fidelity, returning to their natal pond as adults. After breeding, they commonly return to the same terrestrial habitat areas (USFWS 2014).Although California tiger salamanders are adapted to natural vernal pools and ponds, they now frequently use livestock ponds and other modified ephemeral and permanent ponds surrounded by large tracts of land dominated by grassland, oak savanna, or oak woodland. California tiger salamanders breed in deeper vernal pools and wetlands that have sufficiently long periods of inundation. Breeding pools typically have moderate to high levels of turbidity; California tiger salamanders rarely use ponds with clear water. This species is not known to breed in streams or rivers; however, breeding populations have been reported in ditches that contain seasonal wetlands, and have been documented in sewage treatment ponds in Calaveras County. There has been a shift in habitat use from vernal pools on valley floors to livestock ponds and other artificial wetlands in the foothills (USFWS 2014).Geographic barriers include heavily traveled roads, especially at night during salamander breeding season, so that salamanders almost never successfully traverse the road; roads with a barrier that is impermeable to salamanders; wide, fast rivers; and areas of intensive development dominated by buildings and pavement (NatureServe 2015).

Dispersal/Migration

Motility/Mobility

Adult: Low due to dependency on aquatic habitat/moist environmental conditions, and seasonal weather conditions (USFWS 2014).

Dispersal

Adult: Peak periods for metamorphs to leave their natal ponds have been reported from May to July. Once metamorphosis occurs, juveniles often depart their natal ponds at night and enter into terrestrial habitat in search of underground burrows. Although wet conditions are more favorable for upland travel, metamorphs typically travel during dry weather because summer rain events seldom occur as metamorphosis is completed and ponds begin to dry. However, if a rain event does occur, it is likely that it will trigger a mass emergence from the natal pond

(USFWS 2014). The mean distance that juveniles travel before settling in a burrow is 26 m (85 ft.); dispersal into terrestrial habitat occurs randomly with respect to direction (USFWS 2014). Adults migrate up to about 2 kilometers (km) (1.25 miles [mi.]) between terrestrial habitat and breeding pond; rain storms precede major migrations to the breeding sites, with most migration on rainy nights (NatureServe 2015; USFWS 2014). The average dispersal distance is estimated to be 562 m (1,844 ft.). However, estimates suggest California tiger salamanders are physiologically capable of migrating up to 1.5 mi. (2.4 km) during a breeding season, and an estimated 95 percent of California tiger salamander populations are thought to occur within 1.86 km (1.16 mi.) of a breeding pond (USFWS 2014). The mean distance adults travel before settling into a burrow is 35.9 m (118 ft.).

Dependency on Other Individuals or Species for Dispersal

Adult: California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae) (USFWS 2014).

Dispersal/Migration Narrative

Larvae: See Adult life stage.

Adult: Peak periods for metamorphs to leave their natal ponds have been reported from May to July. Once metamorphosis occurs, juveniles often depart their natal ponds at night and enter into terrestrial habitat in search of underground burrows. Although wet conditions are more favorable for upland travel, metamorphs typically travel during dry weather because summer rain events seldom occur as metamorphosis is completed and ponds begin to dry. However, if a rain event does occur, it is likely that it will trigger a mass emergence from the natal pond (USFWS 2014). The mean distance that juveniles travel before settling in a burrow is 26 m (85 ft.); dispersal into terrestrial habitat occurs randomly with respect to direction (USFWS 2014).After breeding events, adults and juveniles disperse from the breeding pond in search of small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae), or in their absence (especially as recent metamorphs), soil cracks (USFWS 2014). The average dispersal distance is estimated to be 562 m (1,844 ft.). The mean distance adults travel before settling into a burrow is 35.9 m (118 ft.).During the breeding season, rain storms precede major migrations to breeding sites, with most migrations occurring on rainy nights. Adult California tiger salamanders migrate up to about 2 km (1.25 mi.) between terrestrial habitat and breeding pond (NatureServe 2015; USFWS 2014). However, estimates suggest California tiger salamanders are physiologically capable of migrating up to 1.5 mi. (2.4 km) during a breeding season, and an estimated 95 percent of California tiger salamander populations are thought to occur within 1.86 km (1.16 mi.) of a breeding pond (USFWS 2014).

Population Information and Trends

Population Trends:

Decreasing

Species Trends:

Decreasing

Population Growth Rate:

Slow

Number of Populations:

The Central California DPS of California tiger salamander includes four of the six known populations: the Bay Area, Central Valley, southern San Joaquin Valley, and the Central Coast Range (USFWS 2014).

Population Size:

The total adult population size is unknown, but certainly exceeds 10,000 and likely is at least several 10,000s (NatureServe 2015).

Resistance to Disease:

Low

Adaptability:

Low

Additional Population-level Information:

The correlation between declining California tiger salamander numbers and surrounding urban and agricultural land uses had been well documented; as of 2002, there was a 20.7 percent loss of known Central California DPS records as a result of habitat loss and degradation. However, because the species spends a majority of its life underground and may not breed every year (= low detectability), it is difficult to determine the exact number of California tiger salamander populations that have been lost due to habitat conversion (USFWS 2014).Although the number of individual extant occurrences of California tiger salamander (Central California DPS) have increased from 638 to 867 since the DPS was first listed in 2004, these do not necessarily correlate with an improvement in status or a reduction in threats to the California tiger salamander; many of these ponds (occurrences) are likely threatened by development, or may have already been destroyed or degraded as a result of development projects. The available data suggest that most populations consist of relatively small numbers of breeding adults; breeding populations in the range of a few pairs up to a few dozen pairs are common, and numbers above 100 breeding individuals are rare. As of 2012, general occurrence data derived from the California Natural Diversity Data Base indicate that there are 257 extant, 18 extirpated, and 12 possibly extirpated occurrences in the Bay Area population; 439 extant, 18 extirpated, and 17 possibly extirpated occurrences in the Central Valley population; 73 extant, 8 extirpated, and 7 possibly extirpated occurrences in the Southern Jan Joaquin Valley population; and 98 extant, 2 extirpated, and 2 possibly extirpated occurrences in the Central Coast Range population (USFWS 2014).

Population Narrative:

Both the California tiger salamander (Central California DPS) population levels and the overall California tiger salamander species are decreasing; the total adult population size is unknown, but certainly exceeds 10,000 and likely is at least several 10,000s (NatureServe 2015). The correlation between declining California tiger salamander numbers and surrounding urban and agricultural land uses has been well documented. As of 2002, there was a 20.7 percent loss of known Central California DPS records as a result of habitat loss and degradation. However, because the species spends a majority of its life underground and may not breed every year (= low detectability), it is difficult to determine the exact number of California tiger salamander populations that have been lost due to habitat conversion (USFWS 2014).Although the number of individual extant occurrences of California tiger salamander (Central California DPS) have increased from 638 to 867 since the DPS was first listed in 2004, these do not necessarily correlate with an improvement in status or a reduction in threats to the California tiger salamander; many of these ponds (occurrences) are likely threatened by development, or may have already been destroyed or degraded as a result of development projects. The available data suggest that most populations consist of relatively small numbers of breeding adults; breeding populations in the range of a few pairs up to a few dozen pairs are common, and numbers above 100 breeding individuals are rare. As of 2012, general occurrence data derived from the California Natural Diversity Data Base indicate that there are 257 extant, 18 extirpated, and 12 possibly extirpated occurrences in the Bay Area population; 439 extant, 18 extirpated, and 17 possibly extirpated occurrences in the Central Valley population; 73 extant, 8 extirpated, and 7 possibly extirpated occurrences in the Southern Jan Joaquin Valley population; and 98 extant, 2 extirpated, and 2 possibly extirpated occurrences in the Central Coast Range population (USFWS 2014). The total adult population size is unknown, but certainly exceeds 10,000 and likely is at least several 10,000s (NatureServe 2015).Given the species' comparatively widespread distribution across the landscape, their ecological diversity/variation across their range, and their sensitivity to environmental changes, the species shows a moderate resilience to withstand stochastic events, has a moderate representation to adapt to changing environmental conditions across the landscape, a moderate redundancy to withstand catastrophic events, a low resistance to disease, and low adaptability.

Threats and Stressors

Stressor: Urbanization
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation/fragmentation.
Consequence: Mortality/extirpation, habitat degradation/loss.
Narrative: Urban impacts include development activities such as building and maintenance of housing, commercial, and industrial developments; construction and widening of roads and highways; golf course construction and maintenance; landfill operation and expansion; operation of gravel mines and quarries; and dam building and inundation of habitat by reservoirs. Urbanization leads to direct and indirect loss of habitat for the California tiger salamander. Direct effects include the loss of suitable aquatic and terrestrial habitat through grading or other habitat modifications, such as flooding from reservoir expansion projects or the construction of solar power facilities. Indirect effects can be caused by many actions, including pond modifications that

favor exotic predators; ground squirrel eradication; habitat fragmentation from roads and urban areas; increases in contaminated run-off from urbanized areas; and increases in native species, such as raccoons (Procyon lotor), that may be artificially abundant in association with urban development (USFWS 2014).

Stressor: Land conversion to intensive agriculture
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation/predation, habitat degradation.
Consequence: Mortality/extirpation; decrease or elimination of population; habitat degradation/loss.
Narrative: Agricultural impacts include the conversion of native habitat by discing and deep-ripping; and cultivation, planting, and maintenance of row crops, orchards, and vineyards. Conversion of grasslands to intensive agricultural uses, such as vineyards, orchards, and row crops, has led to the direct loss of Central California tiger salamander populations. Some less intensive agriculture uses (such as irrigated pasture) may still provide areas for California tiger salamanders to persist; however, even less intensive forms of agricultural use often lead to the alteration of wetlands and upland habitat which will result in less favorable conditions for California tiger salamanders. For example, if vernal pool grasslands are converted to irrigated pasture for cattle grazing, the repetitive flooding of the grasslands throughout the summer months decreases the abundance of burrowing mammals such as ground squirrels, thereby reducing the number of available burrows for California tiger salamanders. Suitable habitat adjacent to intensive agricultural uses may also be impacted. Aquatic breeding habitat may be affected by changes to hydrology (e.g. changing seasonal wetlands to perennial wetlands), increases in sediment inputs, increases in harmful contaminants, changes in predator and prey assemblages, and other alterations. Upland habitat may be impacted by the loss of small mammal burrows resulting from ground squirrel or gopher eradication programs, fragmentation from roads, and changes in available forage. All of these factors will result in less favorable conditions for California tiger salamanders, and may decrease or eliminate populations (USFWS 2014).

Stressor: Disease
Exposure: Direct/indirect
Response: Increased molt frequency.
Consequence: Reduced fitness and increased energy requirements.
Narrative: For example, ranavirus diseases such as Ambystoma tigrinum virus (ATV) and regina ranavirus (RRV) are known to cause die-offs of other Ambystoma species, and although not yet documented to occur in California tiger salamander in the Central California DPS, such diseases are lethal to the species in experimental conditions. If introduced (i.e. by way of nonnative tiger salamanders sold as fishing bait), such diseases could spread from a single pond to an entire metapopulation (USFWS 2014). California tiger salamanders are also susceptible to infection by Chytrid fungus (Batrachochytrium dedrobatidis), which causes infected individuals to molt (slough) their entire skin every 2 to 3 days (rather than the typical once every 1 to 2 weeks); this may help prevent mortality, but also requires more energy and reduces individual fitness (USFWS 2014).

Stressor: Predation
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation and predation, reduced breeding.
Consequence: Mortality/extirpation, reduced fitness.
Narrative: In addition to native predators (amphibians, snakes, turtles, birds, and small mammals), nonnative and exotic predators include bullfrogs (Rana catesbeiana); nonnative and hybrid tiger salamanders; western mosquitofish (Gambusia affinis) and other introduced fishes like largemouth bass (Micropterus salmoides) and blue gill (Lepomis macrochirus); nonnative crayfish species (Pacifastacus, Oronectes, and Procambarus sp.), all of which can prey on either the larval or adult (or both) stages of the California tiger salamander (USFWS 2014). Other predators include invertebrate species like giant water bugs (Belostomatidae), predacious diving beetles (Dytiscidae), water scorpions (Nepidae), and dragonfly nymphs (Anisoptera), all of which prey on larvae; in some cases, their very presence can preclude California tiger salamanders from successfully breeding (USFWS 2014).

Stressor: Inadequacy of existing regulatory mechanisms
Exposure: Direct/indirect
Response:
Consequence: Mortality/extirpation, habitat degradation/loss.
Narrative: The primary cause of the decline of the Central California tiger salamander is the loss, degradation, and fragmentation of habitat that results from human activities. There are several state and federal laws and regulations that are pertinent to the protection of Central California tiger salamanders; however, federal, state, and local laws have not been sufficient to prevent past and ongoing losses of the California tiger salamander and its habitat (USFWS 2014).

Stressor: Hybridization with nonnative tiger salamanders
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, increased competition, habitat degradation, greater susceptibility to hybridization, shift in habitat.
Consequence: Mortality/extirpation, higher predation, reduction in population numbers, habitat degradation/loss, decreased reproductive success, higher fitness, reduced genetic purity, shift in habitat.
Narrative: The California tiger salamander Central California DPS has been heavily affected by hybridization. The large-scale introduction of barred tiger salamander was first reported in the Salinas Valley about 60 years ago, when many tens of thousands of barred tiger salamander (Ambystoma mavortium) were introduced in support of the bass-bait industry. Barred tiger salamanders have since been hybridizing with native California tiger salamanders, and have spread from the original source populations out across the Salinas Valley and coast range portion of the range of the species. Barred tiger salamanders were also introduced to two ponds near the North Fork Pacheco Creek in Santa Clara County in the early 1980s, and at three additional locations in Merced County. The hybrids are able to produce viable and fertile offspring, whose hybrid offspring have higher survival rates than either pure California tiger salamanders or pure barred tiger salamander; ultimately, this results in higher fitness, but reduced genetic purity.

Furthermore, hybrids appear to thrive and dominate in perennial ponds because they can breed earlier, attain larger sizes, produce more eggs, and persist in a paedomorph form (an intermediate sexually mature, post-larval stage), during which time they can successfully cannibalize native California tiger salamanders (USFWS 2014).

Stressor: Contaminants
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation, increased levels of nitrogen, hydrocarbons, and other contaminants.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, increase susceptibility to parasites and bacteria, altered rates of metamorphosis, increase in growth abnormalities, reduced fitness.
Narrative: Sources of chemical pollution that may adversely affect California tiger salamander (Central California DPS) include hydrocarbon and other contaminants from oil production and road runoff; the application of chemicals for agricultural production and urban/suburban landscape maintenance; and increased nitrogen levels in aquatic habitats. Amphibians in general are extremely sensitive to contaminants, due to their highly permeable skin. Exposure to pesticides can increase their susceptibility to parasitic or bacterial infections, alter their rates of metamorphosis, lead to growth abnormalities, reduce their overall fitness, and lead to increased mortality (USFWS 2014).

Stressor: Rodent and vector control programs
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation, increased mortality of burrowing mammals, predation on embryo and larval stages, increased predation on invertebrate prey base.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, reduction in small mammal population numbers, reduction invertebrate prey base, increased competition with predators.
Narrative: 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 potential threat to California tiger salamanders. Eradication techniques include the application of poisoned grains; fumigant rodenticide; gases (including aluminum phosphide, carbon monoxide, and methyl bromide) introduced into burrows through cartridges, pellets, and other methods; and combustible gas injected into burrow complexes and then ignited. Other rodent control measures include habitat modifications such as deep ripping of rodent burrow areas or use of flood irrigation. All of these techniques can both directly and indirectly result in mortality of California tiger salamanders. Fumigants applied to burrows could result in direct mortality of California tiger salamanders, including crushing or entombing salamanders. Although some methods may avoid direct mortality of salamanders, they will decrease ground squirrel and pocket gopher populations, which will in turn decrease the amount of available burrow habitat (USFWS 2014). Through vector control programs, mosquitofish introduced into wetlands by mosquito abatement agencies or ranchers introduces a nonnative predator that will predate not only on California tiger salamanders embryos and larvae, but also on the available invertebrate

prey base, making it possible that mosquitofish may outcompete the salamander larvae for food. Other effects of vector control include the application of insecticides like methoprene, which has been shown to have direct and indirect effects on growth and survival of larval amphibians; and the bacterium Bacillus thuringiensis israeli (Bti), which if effective could reduce the density of available invertebrate prey (USFWS 2014).

Stressor: Climate change
Exposure: Indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation, greater susceptibility to hybridization, shorter hydroperiods, temperature fluctuations, increased exposure to UV light, increased exposure to disease.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, decreased reproductive success, reduced period of standing water, increased stranding of larvae/embryos, variance in temperature extremes, altered predator/prey relationships, increased incidence of diseases.
Narrative: The distribution of the California tiger salamander (Central California DPS) spans a considerable range in climatic conditions (including annual variation), and it is uncertain how the various sub-populations of the Central California tiger salamander might differ in their responses to climate change. Although the life history strategy is adapted to inconsistent environmental conditions, climate change could result in even more erratic weather patterns, to which California tiger salamanders cannot adapt quickly enough. During drought, ponds may not persist long enough for larvae to transform, and temperature extremes or fluctuations in water levels during the breeding season may kill large numbers of embryos. Presumably, the longevity of adult California tiger salamanders is sufficient to ensure local population survival through all but the longest droughts. However, if long-term droughts become the norm in the future, this will have significant implications for California tiger salamanders, because they depend on these ponds for breeding (USFWS 2014). Changes in climatic conditions could have other significant implications for California tiger salamanders, including altered prey/predator relationships; increased effects from ultraviolet radiation; and increased effects from diseases such as chytrid fungus and ATV. All of these changes in environmental conditions could have significant impacts on local populations of California tiger salamander. Because of the isolated and fragmented distribution of this species, this may lead to further population extirpations. In addition, climate change will likely result in warmer air temperatures in California, and this may serve as an advantage for hybrid tiger salamanders, which are able to disperse longer distances and have better endurance than native California tiger salamanders at higher air temperatures (USFWS 2014).

Recovery

Reclassification Criteria:
Reclassification criteria for this species have not been developed.

Recovery Priority Number: 3C

Delisting Criteria:

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range Recovery criteria A/1 through A/4, below, will ameliorate or eliminate the threat of habitat loss to an extent that it is no longer a threat to Central California tiger salamander populations. This will be accomplished through the preservation (in fee title or easement) of high quality habitat. Requirements for preserves described in criteria A/1through A/4 are described below (i.e, if the preserve meets these requirements then the habitat is considered high quality). Number of preserves. The number of preserves required within each recovery unit is provided in recovery criteria A/1 through A/4. The required number of preserves within each recovery unit may change as additional surveys are completed in areas that have not been well surveyed. Preserve Size. Minimum preserve size is 3,398 acres (1,375.1 hectares) (see Justification for recovery criteria in Appendix B). Breeding Habitat - Each 3,398-acre area (the minimum preserve size) of protected habitat will have at least four ponds. Although it is possible for a preserve with three breeding ponds that cover 4.1 acres to maintain a population size of 132 individuals (see criteria E/6), an additional pond will ensure some resiliency to stochastic events (see Justification for recovery criteria in Appendix B). The ponds should also have variation in ponding to ensure some ponds are able to fill during variable environmental conditions. If more ponds are available, a smaller surface area is required. See Table 1 for a description of pond sizes expected to result in sustainable Central California tiger salamander populations. Upland Habitat – Upland habitat will contain at least one moderately-sized burrowing mammal colony [as defined by having at least 50 active burrow entrances within a 656-foot (200-meter) radius] that occurs within the average dispersal distance of the salamander [1,844 feet (562 meters) (Searcy and Shaffer 2011)] of each breeding pond. There are 12 management units within the Central Valley recovery unit. each preserve needs to meet the minimum preserve size (3,398 acres). Jepson Prairie 4 Preserves. Required Total Area Preserved 13,592 acres Dunnigan Hills 4 Preserves. Required Total Area Preserved 13,592 acres Concord/Livermore 5 Preserves. Required Total Area Preserved 16,990 acres Central Valley West Side 2 Preserves. Required Total Area Preserved 6,796 acres San Luis NWR/Sandy Mush 5 Preserves. Required Total Area Preserved 16,990 acres Rancho Seco 5 Preserves. Required Total Area Preserved 16,990 acres Lockeford 4 Preserves. Required Total Area Preserved 13,592 acres Farmington 5 Preserves. Required Total Area Preserved 16,990 acres Oakdale/Waterford 5 Preserves. Required Total Area Preserved 16,990 acres Hickman/Snelling 4 Preserves. Required Total Area Preserved 13,592 acres Merced 5 Preserves. Required Total Area Preserved 16,990 acres Le Grand/Raymond 5 Preserves. Required Total Area Preserved 16,990 acres A/2 Protection of sufficient high quality habitat within all management units of the southern San Joaquin Valley recovery unit to ensure sustainable Central California tiger salamander populations. There are three management units within the San Joaquin Valley recovery unit. Table 3 specifies the target number of preserves for this recovery unit and their distribution by management unit. In addition, each preserve needs to meet the minimum preserve size (3,398 acres), as well as breeding and upland habitat characteristics described in the introduction for Factor A. A/3 Protection of sufficient high quality habitat within all management units of the Bay Area recovery unit to ensure sustainable Central California tiger salamander populations. There are six management units within the Bay Area recovery unit. Table 4 specifies the target number of preserves for this recovery unit and their distribution by management unit. In addition, each preserve needs to meet the minimum preserve size (3,398 acres), as well as breeding and upland habitat characteristics described in the introduction for Factor A. A/4 Protection of sufficient high quality habitat within all management units of the Central Coast Range recovery unit to ensure sustainable Central California tiger salamander populations. There are six management units within the Central Coast Range recovery unit. Table 5 specifies the target number of preserves for this recovery unit and their distribution by management unit. In addition, each preserve needs to meet the minimum preserve size (3,398 acres), as well as breeding and upland habitat characteristics described in the introduction for Factor A (USFWS, 2017).

Recovery Actions:

- Reduce Road Mortality: Coordinate with transportation agencies to incorporate wildlife tunnels in design plans for new roads and road improvement projects to decrease Central California tiger salamander road mortality (USFWS, 2017).
- Reduce road mortality. Upgrade existing roads to include wildlife tunnels to decrease Central California tiger salamander road mortality (USFWS, 2017).
- Reduce the risk of introduction of diseases (e.g., ranaviruses, chytrid fungi, or other pathogens) within preserves. Monitor breeding sites to detect disease outbreaks. Monitoring should be conducted during the breeding season to detect rapid die-offs of larvae, which may be the result of ranavirus, chytrid or other pathogens (USFWS, 2017).
- Reduce the risk of introduction of diseases (e.g., ranaviruses, chytrid fungi, or other pathogens) within preserves. Determine the cause of die-offs. If a rapid die-off is detected, tests for ranaviruses, chytrid fungi, or other pathogens should be conducted immediately. Land managers should coordinate with the Service and CDFW to determine the appropriate next steps (USFWS, 2017).
- Reduce the risk of introduction of diseases (e.g., ranaviruses, chytrid fungi, or other pathogens) within preserves. Develop contingency plans. Contingency plans should be incorporated into all management plans to ensure that a population infected with a ranavirus, chytrid fungus, or other pathogen is quickly isolated and the disease does not spread to uncontaminated populations (USFWS, 2017).
- Reduce the risk of introduction of diseases (e.g., ranaviruses, chytrid fungi, or other pathogens) within preserves. Develop measures to sterilize field equipment to minimize disease transmission (USFWS, 2017).
- Reduce levels of non-native predator species within preserves. Reduce populations of non-native predators to a level where they are determined to not decrease Central California tiger salamander populations (USFWS, 2017).
- Reduce levels of non-native predator species within preserves. Identify sites within each preserve that require non-native predator eradication or control. 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 (see action 1.2.2 for a description of optimal breeding habitat to reduce non-native predators) (USFWS, 2017).
- Reduce levels of non-native predator species within preserves. Prohibit introduction of fish species to breeding habitat or within any aquatic system that has the potential to convey non-native fish to breeding habitat (USFWS, 2017).
- Develop and implement adaptive management and monitoring plans for protected habitat counted toward recovery. All preserves (as described in recovery criteria A/1 through A/4) should have management and monitoring plans. These plans should specifically target management and monitoring of Central California tiger salamander breeding and upland

habitat to maintain habitat suitability in perpetuity. The plans may include, but are not limited to, actions to identify and reduce: harmful contaminants, non-native predator species, road mortality, and non-native tiger salamanders and hybrids. Management plans should describe grazing management and disease prevention strategies. Plans should be updated based on feedback from land managers and adaptive to climate change and other variables (USFWS, 2017).

- Develop and implement adaptive management and monitoring plans for protected habitat counted toward recovery. Secure funding in perpetuity for habitat management and monitoring either through an endowment or other funding mechanism (USFWS, 2017).
- Develop and implement adaptive management and monitoring plans for protected habitat counted toward recovery. Management plans should be developed to ensure high quality upland and breeding habitat is available for the Central California tiger salamander in perpetuity (USFWS, 2017).
- Monitor trends to gain a better understanding of population health, trends in habitat loss, and other information that will help to guide conservation planning for the Central California tiger salamander. 1. Establish and maintain a database that tracks the amount of incidental take authorized through section 7 and 10 of the Act. 2. Monitor habitat land use change. Utilize GIS land use cover data to determine amount of suitable habitat that has been lost. 3. Survey lands for Central California tiger salamander in areas that have not been well surveyed. The following management units have not been well surveyed: Dunnigan Hills, Central Valley West Side, Farmington, Oakdale/Waterford, Northeast Diablo Range, and Southeast Diablo. Other areas will likely require surveys as well. 4. Conduct population viability analyses for Central California tiger salamander metapopulations throughout the range of the DPS. Population viability analyses are tools that can identify populations in need of recovery actions, as opposed to those that may be viable over the long-term without intervention. 5. Research should be conducted to determine the effectiveness of standard avoidance and minimization measures (e.g., exclusion fencing, burrow excavation, and seasonal work windows) to ensure the most successful measures are being used during implementation of projects that may impact Central California tiger salamanders and their habitat. 6. Conduct research on the effects of contaminants. 6.1. Conduct investigations on effects of contaminants on Central California tiger salamander (or a surrogate salamander species if determined appropriate). 6.2. Conduct research that determines which pesticides and other contaminants are commonly used on agriculture lands within the range of the Central California tiger salamander. 6.3. Conduct research on the effects of mosquito abatement chemicals on Central California tiger salamander populations. 7. Conduct genetic research. 7.1. Monitor projects designed to increase native species genomes and limit hybridization. These studies should occur within a variety of geographic areas (e.g., Salinas Valley floor, foothill areas to the north and east of Salinas Valley, and Bay Area) to determine the most effective strategies in various geographic areas. 7.2. Conduct focused research on SI alleles to determine how each non-native gene is physically expressed and the subsequent ecological impact of these genes. 7.3. Conduct landscape genomic research and climate change modeling to identify genetic variability that may provide resiliency to climate change and identify areas of climate refugia. 8. Conduct research on small burrowing mammal communities. 8.1. Conduct research to determine burrow requirements for Central California tiger salamander populations (i.e., what burrow densities are optimal for Central California tiger salamanders, and how many small burrowing mammals are required to maintain these densities?). 8.2. Conduct research to determine optimum grazing regimes to increase small mammal burrowing communities (USFWS, 2017).

- Develop and implement participation plans for each Recovery Unit. Participation plans will assist in the realization of recovery goals by facilitating commitments from participating agencies and stakeholders to implement recovery actions, where feasible (USFWS, 2017).
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Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Central California tiger salamander. Some of these recommendations have already been discussed in the previous 5-year review (Service 2014, p. 44- 45) and remain valid. Conservation and Management of Habitat Actively manage California tiger salamander habitats, including maintenance of appropriate vegetation conditions and ponding duration as appropriate, and removal and/or control of nonnative predators (See Ford et al. 2013 for considerations when managing rangelands to benefit California tiger salamanders). Restore or create ephemeral ponds to enhance existing Central California tiger salamander populations and restore degraded upland habitats adjacent to known breeding sites. Maintaining, restoring, or creating a breeding pond will have the most benefit to the local population if the pond is already occupied or is near an existing population for colonization, and as far as possible from predator and hybrid tiger salamander source-areas. California's variable weather can make a given pond vary in habitat quality from year to year, so having ponds with different characteristics (size, depth, vegetation, etc.) increases the odds that at least one pond will be suitable in a given year and have good reproductive output. Natural vernal pools and wetland features that mimic vernal pool hydrology appear to favor reproductive success for native Central California tiger salamanders. Therefore, habitat management strategies should focus on preserving natural vernal pools and ensuring that livestock ponds and other constructed wetlands resemble the hydrology of natural vernal pools as much as possible. This should help to limit hybridization, and possibly assimilation, with non-native tiger salamanders (Service 2014, p. 37). Work with conservation partners to increase awareness of the potential incidental adverse impacts to Central California tiger salamanders and other native species associated with ground squirrel (Otospermophilus beecheyi) eradication efforts. Encourage public and private livestock pond management practices consistent with Central California tiger salamander conservation as described in the Special Rule Exempting Routine Ranching Activities (Service 2004). Outlying populations in the northern and southern areas of the Central California tiger salamander’s range, as well as populations at elevation extremes, may provide potentially significant genetic diversity in terms of the species’ ability to adapt to different climate change scenarios. These outlying populations should be a focus of study and conservation efforts (Service 2014, p. 45). Central California tiger salamanders can exhibit high fluctuation in population numbers and may not breed in an individual pool every year. Surveys conducted in a proposed project area that include multiple potential breeding pools may only detect Central California tiger salamander larvae in some of the pools, or even in none of the pools (e.g., in years with low rainfall when the species does not successfully breed). There is a high likelihood that pools that contained no Central California tiger salamander larvae at the time of the surveys could provide suitable breeding habitat in future years when conditions are more favorable. This should be taken into consideration when analyzing the potential effects of a proposed project on the species. Strategy to address non-native tiger salamanders Guidance has been developed in cooperation with the California Department of Fish and Wildlife and other agencies, academics, and involved stakeholders to address the issue of hybridization with non-native tiger salamanders in different portions of the Central California tiger salamander’s range (Service in litt. 2017). This guidance should be utilized to address the threat of hybridization with non-native salamanders throughout the Central California tiger salamander's range. Specific objectives outlined in the guidance include: 1) maintaining or restoring locally adapted California tiger salamander alleles, and 2) maintaining or restoring historical ecological functions provided by non-hybridized California tiger salamanders. Decrease mortality from road crossings Investigate use and effectiveness of wildlife crossing structures and/or tunnels designed for Central California tiger salamanders in circumstances where road-kill mortality due to migration to/from breeding ponds is significant. Ranaviruses and other diseases A nationwide amphibian survey by Waddle et al. (2020) did not detect any salamander chytrid fungus (Batrachochytrium salamandrivorans, Bsal) and asserts Bsal is highly unlikely to occur in the U.S. However, monitoring and preventing the spread of ranaviruses and other diseases in Central California tiger salamander populations will ensure early detection and implementation of management practices to reduce threats of widespread disease transmission. Assess recovery criteria To continue tracking progress towards meeting recovery criteria, we need additional information about the species and its habitat. Information needs include: • An updated GIS layer of Central California tiger salamander conservation lands; • Copies of easements and management plans to ensure management specifically for, or land-use compatibility with, the Central California tiger salamander; • An updated GIS layer of vernal pools and wetlands throughout the species' range; • Research to determine current metapopulation abundances across the range of Central California tiger salamander and monitor status and trend in all protected populations counted towards recovery; and • Population viability analyses specific to Central California tiger salamander metapopulations throughout the range with a focus on probability of persistence (USFWS, 2023).

Additional Threshold Information:

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SPECIES ACCOUNT: *Ambystoma californiense* (California tiger Salamander (Santa Barbara))

Species Taxonomic and Listing Information

Commonly-used Acronym: CTS

Listing Status: Endangered

Physical Description

The California tiger salamander is a large, stocky terrestrial salamander with a broad, rounded snout. Adults average 16 to 24 centimeters (cm) (6 to 9.5 inches [in.]) in length, and have random white or yellowish spots or bars against a black body. Their small eyes, which have black irises, protrude from their heads. Males can be distinguished from females, especially during the breeding season, by their swollen cloacae (a common chamber into which the intestinal, urinary, and reproductive canals discharge), more developed tail fins, and larger overall size (68 FR 28648). The larvae are aquatic; range in size from 11.5 to 14.2 millimeters (0.45 to 0.55 in.) in total length; are yellowish gray in color; and have a broad fat head, large, feathery external gills, and broad dorsal fins that extend well onto the back (68 FR 28648).

Taxonomy

Six unique populations consisting of three discrete DPSs have been identified in California; although each DPS is genetically differentiated and geographically isolated; in California, all California tiger salamanders are treated as Ambystoma californiense. 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 nonnative 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 (USFWS, 2022).

Historical Range

Historically, California tiger salamanders were endemic to the San Joaquin-Sacramento river valleys, bordering foothills, and coastal valleys of Central California. Although the historical distribution of California tiger salamanders is not known in detail, their current distribution suggests that they may have been continuously distributed along the low-elevation grassland-oak woodland plant communities of the valleys and foothills. In this area, the Santa Barbara DPS is found in low-elevation vernal pools and seasonal ponds and associated grassland, oak savannah, and coastal scrub plant communities of the Santa Maria, Los Alamos, and Santa Rita valleys in northwestern Santa Barbara County (generally under 475 meters (m) (1,500 feet [ft.]) (USFWS 2009).

Current Range

The California tiger salamander (Santa Barbara DPS) is the only population of California tiger salamanders west of the outer Coast Ranges, and it is the southernmost population of the species (USFWS 2009). 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) (USFWS 2009). The California tiger salamander (Santa Barbara DPS) is found in six metapopulations in Santa Barbara County: West Santa Maria/Orcutt, East Santa Maria, West Los Alamos, East Los Alamos, Purisima Hills, and Santa Rita Valley (USFWS 2009). Each of these metapopulations are separated by more than 2.2 kilometers (km) (1.3 miles [mi.]) (the furthest distance California tiger salamanders have been found from a breeding pond) or by U.S. Highway 101 (USFWS 2009).

Critical Habitat Designated

Yes; 12/27/2004.

Legal Description

On November 24, 2004, the U.S. Fish and Wildlife Service (Service), designated critical habitat for the Santa Barbara County population of California tiger salamander (Ambystoma californiense) (referred to here as California tiger salamander or CTS in Santa Barbara County) under the Endangered Species Act of 1973, as amended (Act). In total, approximately 11,180 acres (ac) (4,523 hectares (ha)) fall within the boundaries of the critical habitat designation. A total of 2,740 ac (1,109 ha) of privately-owned was excluded lands from this final critical habitat designation.
On August 31, 2011, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for the Sonoma County distinct population segment of the California tiger salamander (Ambystoma californiense) (Sonoma California tiger salamander) under the Endangered Species Act of 1973, as amended (Act). In total, approximately 47,383 acres (19,175 hectares) of land was designated as revised critical habitat for the Sonoma California tiger salamander.

Critical Habitat Designation

The six areas designated as critical habitat are: (1) Western Santa Maria/Orcutt; (2) eastern Santa Maria; (3) western Los Alamos/Careaga; (4) eastern Los Alamos; (5) Purisima Hills; and (6) Santa Rita Valley.

Unit 1: Western Santa Maria/Orcutt Modifications were made to this unit as a result of a revised mapping methodology, which resulted in more accurately showing the boundary of this unit. This modification resulted in the reduction from 4,349 ac (1,760 ha) to 4,135 ac (1,673 ha). Unit 1 consists of 4,135 ac (1,673 ha) west and southwest of the city of Santa Maria, mostly in unincorporated areas of the County and the community of Orcutt. This area encompasses the known California tiger salamander breeding sites extending from the Casmalia Hills on the south to the Santa Maria Airport on the north and from west of Black Road eastward to Highway 135. This unit makes up 26 percent of the total area we have identified as containing the PCEs for the species and as being essential to the conservation of the species in Santa Barbara County. The unit contains 12 known California tiger salamander breeding ponds and several water bodies that are suitable for breeding California tiger salamanders but that have never been surveyed. The 12 known breeding ponds in this unit constitute approximately 26 percent of the known breeding ponds (46) in Santa Barbara County. Of even greater significance, Unit 1 contains 7 (approximately 37 percent) of the 19 natural vernal ponds that occur in Santa Barbara County. These natural ponds occur on the Orcutt Dune Sheet, which contains soils that are unique to the Santa Maria Valley. The Orcutt Dune Sheet is an ancient, windblown sand deposit that covers the southern one-half to two-thirds of the Santa Maria Valley (Hunt 1993). All natural California tiger salamander breeding sites occurring on the sheet are classified as dunal or deflation pools and ponds, a type of California tiger salamander breeding pond occurring only within the two units within the Santa Maria Valley. The five remaining known ponds occur along the base of the Casmalia Hills, just off the southwestern edge of the Orcutt Dune Sheet. Population growth and the concomitant residential and commercial development are the greatest threat to California tiger salamanders within this unit. The city of Santa Maria currently sustains a population of 82,148 people and is anticipated to reach a population of 110,800 people by 2020, with an annual growth rate of 1.8 percent (Santa Barbara County Association of Governments 2002). Annexations to further development are proposed in the remaining California tiger salamander habitat (Marc Bierdzinski, Santa Maria Community Development Department, pers. comm. 2003). The city of Santa Maria is the fastest growing city in Santa Barbara County, with a 26 percent increase in population in the 1990s (16,000 new residents). Santa Barbara County's population is projected to grow by at least 160,000 people in the next 30 years (Santa Barbara County Planning and Development 2002). Depending on housing densities, the county may need over 15,000 ac (6,070 ha) of residentially zoned land on which to build homes to meet this goal (Santa Barbara County Planning and Development 2002). All of the urban areas in the county except Santa Maria and Orcutt have nearly exhausted land zoned for residential development. The California Department of Housing and Community Development expects the county and cities to set aside land for over 17,500 homes in the next seven years (Santa Barbara County Planning and Development 2002). Approximately 3,600 ac (1,457 ha) of prime agricultural land has been annexed to meet the increase in population. Prime farmland east and west of Santa Maria currently designated by the City of Santa Maria as ''No Urban Development Areas'' are expected to face increasing pressure to develop as the city exhausts land available for development around 2010 (Santa Barbara County Planning and Development 2002). Several development projects have been proposed within Unit 1. The Santa Maria Airport District proposes to build a 400-ac (162-ha) research park and golf course just south of the airport on a parcel with three known California tiger salamander breeding ponds (Rincon 2002). The Orcutt Community Plan identifies

Key Site 22 as a site for 60 percent buildout to a maximum of 3,000 units of dwellings (Santa Barbara County 2002). This site lies entirely within the critical habitat unit. Additional proposed development projects include Union Valley Parkway (City of Santa Maria 2003) and expansion of the Laguna County Sanitation District's wastewater treatment plan. In the West Santa Maria subpopulation, 78 percent of California tiger salamander upland habitat has been lost or separated from breeding ponds by fragmentation. Three large development projects (Mahoney Ranch, Key Site 22, and the Santa Maria Airport Research Park and Golf Course) threaten most of the remaining habitat. The Santa Maria Airport has worked with the Service to develop a plan that will minimize impacts to the California tiger salamander; however, one of the most productive ponds, the easternmost pond on the Santa Maria Airport property, will be permanently isolated from all other ponds on a 120-acre (49-ha) reserve once the Santa Maria Airport Research Park goes forward (Service files). A number of smaller development projects (Laguna Sanitation District Expansion, construction of three administrative buildings on Foster Road, Union Valley Parkway) also threaten to further reduce the available upland habitat and fragment the breeding ponds from each other. This unit is essential to the conservation of the California tiger salamander because it contains 37 percent of the natural vernal pools for this Santa Barbara population. It is critical for the conservation of the species to conserve the California tiger salamander within a range of habitat types as protecting a variety of habitat conditions will increase the ability of the species to survive stochastic events. This unit requires special management to continue efforts to protect PCEs essential for the conservation of California tiger salamanders. In particular, one pond is known to have introduced fish, another is subject to berm failure, and bullfrogs breed in close proximity to a third site. Managing these ponds to maintain the existing PCEs is essential for the conservation of the California tiger salamander. Addressing the removal of upland habitat (PCE 2) and dispersal habitat (PCE 3) due to building pressures through special management or protection is essential for the conservation of the California tiger salamander.

Unit 2: Eastern Santa Maria Modifications were made to this unit as a result of a revised mapping methodology, which resulted in more accurately showing the boundary of this unit. This modification resulted in the reduction from 2,985 ac (1,208 ha) to 2,909 ac (1,177 ha). This unit covers a portion of the eastern half of the Orcutt Dune Sheet, but is separated from the western Santa Maria Valley unit by a broad area of urban and agricultural development, including State Highways 135 and 101. The unit is 2,909 ac (1,177 ha) in size and is bordered by State Highway 101 on the west, the Solomon Hills on the south, the Sisquoc River on the east, and the Santa Maria River floodplain on the north. This unit makes up 26 percent of the total area we have identified as containing the PCEs for the species and as being essential to the conservation of the species in Santa Barbara County. The unit contains 4 known California tiger salamander breeding ponds and additional water bodies that are suitable for breeding California tiger salamanders but that have never been surveyed. The four known breeding ponds in Unit 2 are natural vernal pools. Therefore, Unit 2 represents approximately 21 percent of the natural vernal pools used for California tiger salamander breeding in Santa Barbara County (19 natural vernal ponds total). The four of the known breeding ponds in Unit 2 have had substantial alterations to the surrounding upland habitats, and substantial fragmentation of the habitat between breeding ponds has occurred. This unit contains primary constituent elements essential to the conservation of the

California tiger salamander in Santa Barbara County because it contains 21 percent of the natural vernal pools (PCE 1) in the Santa Barbara County population. It is critical for the conservation of the species to conserve the California tiger salamander within a range of habitat types as protecting a variety of habitat conditions will increase the ability of the species to survive stochastic events. At least 10 additional ponds that appear suitable for California tiger salamander breeding exist within the unit. As mentioned in the discussion under Unit 1, the Santa Maria Valley is quickly growing, and both Unit 1 and Unit 2 are facing increasing pressure due to development. Some proposed projects further threaten the remaining California tiger salamander habitat, including the 2000-ac (809-ha) Bradley Ranch proposed development project (John L. Wallace & Associates 2002), scattered low-density residential development, two soil remediation projects, and the construction of a radio tower. Additionally, Unit 2 has also experienced some loss of California tiger salamander habitat due to illegallyconducted ground disturbing activities.

Unit 3: Western Los Alamos/Careaga Part of this unit was excluded from this final critical habitat designation because this area is actively managed for the protection and enhancement of California tiger salamander habitat (refer to Exclusions Under Section 4(b)(2) of the Act). This modification resulted in the reduction from 2,181 ac (882 ha) to 1,451 ac (587 ha). This unit consists of 1,451 ac (587 ha) to the west of Highway 101, bordered on the west by the Careaga Divide. Four ponds within this unit have been documented as breeding habitat by California tiger salamanders. Several other agricultural impoundments are located within dispersal distance of the California tiger salamander breeding ponds in the western Los Alamos Valley. These human-made ponds may also be used by California tiger salamanders for breeding. In contrast to the dunal or deflation ponds found in the two units to the north within the Santa Maria Valley, the natural breeding ponds within the Western Los Alamos/Careaga Unit are found in structural basin ponds. These ponds occur in the valleys or depressions along the axes of the synclines. The natural ponds within the unit occur along the axis of the Los Alamos Syncline and an unnamed syncline occurring parallel to and west of the Los Alamos Syncline. This unit contains primary constituent elements essential to the conservation of the California tiger salamander because it contains some of the highest-quality natural California tiger salamander breeding pools remaining in the County. The Careaga Divide pond, located on the western side of the unit, is one of the most unique and pristine vernal ponds (PCE 1) where California tiger salamanders breed. The wetland is unique in that it is enclosed on two sides by extensive, dense coast live oak woodland, and by coastal sage scrub and grasslands. The unit also provides large blocks of continuous unfragmented upland habitat with few known sources of mortality, all occurring within a working rangeland landscape (PCE 2 and 3). The unit requires special management in the form of fish removal from at least one pond and sediment control at three ponds (PCE 1). This unit also requires protection and special management to reduce other threats, including berm failure and vineyard development proposals that could reduce aquatic, upland refugia and dispersal habitats (PCEs 1, 2 and 3). The current surrounding land use is cattle grazing.

Unit 4: Eastern Los Alamos Part of this unit was excluded from this final critical habitat designation because this area is actively managed for the protection and enhancement of California tiger salamander habitat (refer to Exclusions Under Section 4(b)(2) of the Act section below). This modification resulted in the reduction from 1,302 ac (527 ha) to 90 ac (36 ha). This unit consists of two separate parcels, one 27 ac (10.9 ha) parcel and one 63.7 ac (25.8 ha) parcel, for a total of 90 ac (36 ha). This unit is located south of Highway 101 and southeast of the town of Los Alamos. This population is currently comprised of four known California tiger salamander breeding ponds; however, the property on which these four ponds are located has been excluded from this designation due to a conservation strategy that the landowners have created to enhance existing and create additional California tiger salamander aquatic habitat. Given the small number of known breeding populations, the acreage remaining in this final designation contains primary constituent elements essential for the conservation of the California tiger salamander, because, despite its location adjacent to State Highway 101, it provides essential upland habitat. In addition, the acreage remaining within this unit is essential to support a self-sustaining population of California tiger salamanders. Furthermore, the populations within this unit constitute the easternmost location of the species in Santa Barbara County. It is critical for the conservation of the species to conserve the California tiger salamander within the range of habitat types where it is found in nature. Protecting a variety of habitat conditions will increase the ability of the species to survive stochastic events. The unit requires special management to address the threats of road mortality and upland habitat loss.

Unit 5: Purisima Hills Part of this unit was excluded from this final critical habitat designation because this area is actively managed for the protection and enhancement of California tiger salamander habitat (refer to Exclusions Under Section 4(b)(2) of the Act section). This modification resulted in the reduction from 2,359 ac (955 ha) to 1,957 ac (792 ha). Unit 5 consists of 1,957 ac (792 ha) along the crest and south slope of the west-central portion of the Purisima Hills. The unit encompasses 14 of the 16 documented breeding ponds in the subpopulation. The portion of the Purisima Hills that contains suitable habitat lies upon the lower Careaga Formation, bounded to the eastsoutheast by outcrops of Sisquoc Formation, and bounded to the westnorthwest by badlands topography of sandier horizons within the upper Careaga Formation. Neither the Sisquoc nor the upper Careaga formations will retain water in unlined ponds (PCE 1); thus, ponds require special management in the form of artificial lining with materials such as clay or butyl rubber sheeting. Pond elevations range from 500 to 1400 ft (152 to 427 m). The documented breeding localities are all stock ponds, most of which were constructed in the mid to late 1950s (Thomas Silva, Sr., pers. comm. 2001); of these, only one may have been based on a preexisting natural depression. This unit contains the primary constituent elements essential for the conservation of the California tiger salamander. Although the occupied ponds in this unit are human made and thus require frequent maintenance, the unit is the most remote of all the units and has the fewest documented threats. Because of the steepness of the topography, conversion to farmland or high-intensity development is not feasible. However, the Service is aware of a recent proposal to develop ranchette-style houses throughout this unit within California tiger salamander dispersal distance of known ponds (Service files). The Service has not received a final proposal. The unit is unique in that it contains habitat unlike the other 5 units; it is steeper terrain and is more densely vegetated than all other units. This location contains the only known California tiger salamander breeding ponds completely surrounded by coastal sage chaparral vegetation. Few other locations in Santa Barbara County are within chaparral or mixed chaparral habitats. The Purisima Hills Unit is also essential in that it provides a linkage between the Santa Rita Valley Unit to the southwest and the Western Los Alamos/Careaga Unit to the north.

Although many of the units may be permanently separated from each other by urban development and State Highway 101, these three units still likely retain some connectivity. Several stockponds that have never been surveyed lie between the units; genetic exchange between the two critical habitat units. The unit requires special management to address threats of habitat loss.

Unit 6: Santa Rita Valley Modifications were made to this unit to exclude an area on the edge of the unit that does not contain the primary constituent elements. This area was included in the proposed designation as a result of a mapping error. This modification resulted in the reduction from 744 ac (301 ha) to 638 ac (258 ha). This 638-ac (258-ha) unit constitutes the southernmost locality for California tiger salamanders in Santa Barbara County. The unit is bisected by Highway 246, a heavily traveled thoroughfare between the towns of Buellton and Lompoc. Two confirmed breeding locations (representing three ponds) lie in the Santa Rita Valley. However, one of these is a human-made pond isolated from other units and is not included within the boundaries of critical habitat. The other confirmed breeding locality consists of two hydrobasins within 50 ft (15 m) of one another and adjacent to Highway 246. Adult California tiger salamanders were often found dead on roads after rain events during the 1980s. Three ponds on a neighboring property to the east and two ponds on the south side of Highway 246 likely formed a complex with this pond in the past. However, the ponds to the east were degraded by introduced fish and vineyards, while Highway 246 forms a substantial barrier to the southern ponds. The ponds south of Highway 246 have never been surveyed for California tiger salamanders. Although one landowner reported finding a California tiger salamander in a water pump in 2000, we have been unable to obtain permission to conduct surveys to confirm or refute this record. The known ponds are based on natural features developed on an active syncline in the Careaga Formation east of the Santa Rita-Drum Canyon divide along the north side of California Highway 246. The ponds are natural but have been excavated so that the smaller pond appears to retain water year round. This unit contains primary constituent elements essential to the conservation of the California tiger salamander because it constitutes the only extant subpopulation remaining within the Santa Rita Valley. As stated previously, given the small number of remaining breeding locations, all six units contain primary constituent elements that are essential. In addition, due to the numbers of salamanders found dead on the roads in the 1980s, the ponds were likely productive in the past. Highway 246 constitutes the main threat to the breeding location.

A single unit is designated as critical habitat for the Sonoma California tiger salamander; Santa Rosa Plain Unit:

This unit is located on the Santa Rosa Plain in central Sonoma County and contains approximately 47,383 ac (19,175 ha), which includes 745 ac (301 ha) of State lands, 744 ac (301 ha) of city lands, 498 ac (202 ha) of county lands, 9 ac (4 ha) of individually owned tribal trust land, and 45,387 ac (18,367 ha) of private lands. No Federal lands are included in this proposed unit. The unit is partially bordered on the west by the generalized eastern boundary of the 100- year Laguna de Santa Rosa floodplain, on the southwest by Hensley Road, on the south by Pepper Road (northwest of Petaluma), on the east generally by and near Petaluma Hill Road or by the urban centers of Santa Rosa and Rohnert Park, and on the north by the Town of Windsor. This unit is characterized by vernal pools, seasonal wetlands, and associated grassland habitat. This unit contains the physical and biological features essential to the conservation of the Sonoma California tiger salamander, and is within the geographical area occupied at the time of listing. The critical habitat unit supports vernal pool complexes and manmade ponds that are currently known to support breeding Sonoma California tiger salamanders (PCE 1), upland habitats with underground refugia (PCE 2), and upland dispersal habitat allowing movement between occupied sites (PCE 3). A segment of the 100-year floodplain that is located between the Stony Point Conservation Area (near Wilfred Avenue) and the Northwest Cotati Conservation Area (near Nahmens Road) is included within the final designation to prevent fragmentation of the northern and southern breeding concentrations within the unit, by allowing for potential dispersal and genetic exchange. The physical and biological features essential to the conservation of the Sonoma California tiger salamander may require special management considerations or protection to minimize impacts from nonnative predators on otherwise suitable breeding habitat, disturbance of aquatic breeding habitats, activities that impair the water quality of aquatic breeding habitat, activities that reduce underground refugia, creation of impassable barriers, and disruption of vernal pool complex processes (see Special Management Considerations or Protections section above). Primary threats to the Sonoma California tiger salamander include habitat destruction, degradation, and fragmentation. Secondary threats include predation and competition from introduced exotic species, possible commercial overutilization, disease, hybridization with nonnative salamanders, various chemical contaminants, road-crossing mortality, and rodent control operations. The Sonoma California tiger salamander is also vulnerable to chance environmental or demographic events (to which small populations are particularly vulnerable). The combination of the Sonoma California tiger salamander biology and its specific habitat requirements makes this animal highly susceptible to random events, such as drought or disease. Such events are not usually a concern until the number of breeding sites, refugia habitat, or geographic distribution become severely limited, as is the case with the Sonoma California tiger salamander. General land use in the unit includes urban and rural development, which has taken place for over 100 years in this area. For the past 25 years, urban growth has encroached into areas inhabited by the Sonoma California tiger salamander. Voters in the cities of Cotati, Rohnert Park, and Santa Rosa have established urban growth boundaries for their communities. This is intended to accomplish the goal of city-centered growth, resulting in rural and agricultural land uses being maintained between the urbanized areas. Therefore, it can be reasonably expected that rural land uses will continue into the foreseeable future. There are also acreages of publicly owned property and preserves located in the Santa Rosa Plain, which will further protect against development. Some of the areas within these urban growth boundaries, however, include lands inhabited by Sonoma California tiger salamanders. Agricultural practices, including discing, have also disturbed seasonal wetlands and upland habitat on the Santa Rosa Plain. However, some agricultural practices, such as grazed pasture, have protected habitat from intensive development.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Santa Barbara County, California. The primary constituent elements (PCEs) of critical habitat for the California tiger salamander in Santa Barbara County are the habitat components that provide:

(i) Standing bodies of fresh water, including natural and man-made (e.g., stock) ponds, vernal pools, and dune ponds, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a sufficient length of time (i.e., 12 weeks) necessary for the species to complete the aquatic portion of its life cycle (PCE 1).

(ii) Barrier-free uplands adjacent to breeding ponds that contain small mammal burrows, including but not limited to burrows created by the California ground squirrel (Spermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae). Small mammals are essential in creating the underground habitat that adult California tiger salamanders depend upon for food, shelter, and protection from the elements and predation (PCE 2).

(iii) Upland areas between breeding locations (PCE 1) and areas with small mammal burrows (PCE 2) that allow for dispersal among such sites (PCE 3).

The critical habitat unit is designated for Sonoma County, CA. Within these areas, the primary constituent elements of the physical and biological features essential to the conservation of the California tiger salamander in Sonoma County consist of three components:

(i) Standing bodies of fresh water (including natural and manmade (e.g., stock)) ponds, vernal pools, and other ephemeral or permanent water bodies) that typically support inundation during winter and early spring, and hold water for a minimum of 12 consecutive weeks in a year of average rainfall.

(ii) Upland habitats adjacent to and accessible from breeding ponds that contain small mammal burrows or other underground refugia that the species depends upon for food, shelter, and protection from the elements and predation.

(iii) Accessible upland dispersal habitat between locations occupied by the species that allow for movement between such sites.

Special Management Considerations or Protections

Critical habitat does not include existing features and structures, such as buildings, aqueducts, airports, roads and their rights of way, and other developed areas not containing one or more of the primary constituent elements.

Areas in need of management for the California tiger salamander include not only the immediate locations where the species may be present at a particular point in time, but additional areas adjacent to these that are essential to provide for normal population fluctuations that may occur in response to natural and unpredictable events. The California tiger salamander are dependent upon habitat components beyond the immediate areas where individuals of the species occur at any given time, because these areas are important in maintaining ecological processes such as hydrology, expansion of distribution, recolonization, and maintenance of natural predator-prey relationships, all of which are essential for the conservation of the species.

The areas proposed for critical habitat may require special management considerations or protections due to the threats outlined below: (1) Non-native and introduced predators such as bullfrogs and fish. (2) Disturbance of aquatic breeding habitats during the breeding season. (3) Sedimentation and erosion into water bodies. (4) Contamination by chemicals such as those used for agricultural purposes. (5) Habitat loss due to construction of barriers or elimination of small mammal burrows.

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

Within the single unit proposed as critical habitat in this final designation, the features essential to the conservation of the Sonoma California tiger salamander may require special management considerations or protection to ameliorate the threats outlined below: 1. Activities that would threaten the suitability of Sonoma California tiger salamander breeding ponds, such as introduction of nonnative predators, including nonnative bullfrogs and nonnative fish; 2. Activities that could disturb or disrupt the hydrology of aquatic breeding habitat, such as heavy equipment operation (e.g., bulldozers or deep ripping), ground disturbance (e.g., discing), maintenance projects (e.g., pipelines, roads, power lines), land conversion to vineyards, off-road travel, or recreation; 3. Activities that impair the water quality of aquatic breeding habitat (e.g., pesticides, increased nitrogen input through recycled water or dairy operations); 4. Activities that would reduce small mammal populations or their burrows to the point that there are insufficient underground refugia, which are used by Sonoma California tiger salamanders for foraging, protection from predators, and shelter from the elements (e.g., discing, deep ripping, land conversion to vineyards, rodent control in existing vineyards); and 5. Activities that create barriers impassable by salamanders, or those activities that increase mortality in upland dispersal habitat between extant breeding occurrences.

In the case of the Sonoma California tiger salamander, natural repopulation of sites where the Sonoma California tiger salamander has been extirpated is likely not possible without human assistance and landowner cooperation. Examples of such proactive activities that benefit the Sonoma California tiger salamander include enhancement or creation of breeding ponds and control of nonnative predators. These are the types of proactive, voluntary conservation efforts that are necessary to prevent the extinction and promote the recovery of many other species as well (Wilcove and Lee 2004, p. 639; Shogren et al. 1999, p. 1260; Wilcove and Chen 1998, p. 1407; Wilcove et al. 1996, pp. 3–5).

Life History

Food/Nutrient Resources

Food Source

Larvae: Zooplankton, small crustaceans, and aquatic insects, moving toward larger prey such as the tadpoles of Sierran tree frog (Pseudacris sierra), western spadefoot toads (Spea hammondii), and California red-legged frogs (Rana draytonii) as they grow in size (USFWS 2014).

Adult: Invertebrate prey items found in adult salamander stomachs include aphids (Aphididae), wood cockroaches (Blattellidae), ground beetles (Carabidae), springtails (Collembola), centipedes (Cryptopidae, Lithobiidae, and Scolopendra), true weevils (Curculionidae), webspinners (Embioptera), wasps/bees/ants (Hymenoptera), woodlice (Isopoda), silverfish (Lepismatidae), wolf spiders (Lycosidae), owlet moths (Noctuidae), harvestmen (Opiliones), crickets (Rhaphidophoridae), scarab beetles (Scarabaeidae), and crane flies (Tipula) (USFWS 2014).

Competition

Larvae: Nonnative and hybrid tiger salamanders and western mosquitofish (Gambusia affinis) can outcompete larvae when they occur (USFWS 2014).

Food/Nutrient Narrative

Larvae: The California tiger salamander larvae is an opportunistic invertivore/carnivore, and is among the top aquatic predators in the seasonal pool ecosystems. The larvae prey on zooplankton, small crustaceans, and aquatic insects, moving toward larger prey such as the tadpoles of Sierran tree frog (Pseudacris sierra), western spadefoot toads (Spea hammondii), and California red-legged frogs (Rana draytonii) as they grow in size (USFWS 2014). The larvae often rest on the bottom in shallow water, but also may be found at different layers in the water column in deeper water. The young salamanders are wary; when approached by potential predators, they will dart into vegetation on the bottom of the pool (68 FR 28648). Typical competitors include nonnative and hybrid tiger salamanders and western mosquitofish (Gambusia affinis), which can outcompete larvae when they occur (USFWS 2014). Larvae feed for about 6 to 8 weeks after hatching, after which they switch to larger prey (USFWS 2014). The larval stage of the California tiger salamander usually lasts 3 to 6 months, with metamorphosis beginning in late spring or early summer (USFWS 2014). Larvae develop faster in smaller, more rapidly drying pools. The developmental period is prolonged in colder weather and in larger pools; larvae development (time from eggs laid to larvae leaving the pond) has been observed taking from 74 days to 94 days (USFWS 2014).

Adult: The California tiger salamander adult is an opportunistic invertivore/carnivore, foraging predominantly underground during the dry summer months. Invertebrate prey items found in adult salamander stomachs include aphids (Aphididae), wood cockroaches (Blattellidae), ground beetles (Carabidae), springtails (Collembola), centipedes (Cryptopidae, Lithobiidae, and Scolopendra), true weevils (Curculionidae), webspinners (Embioptera), wasps/bees/ants (Hymenoptera), woodlice (Isopoda), silverfish (Lepismatidae), wolf spiders (Lycosidae), owlet moths (Noctuidae), harvestmen (Opiliones), crickets (Rhaphidophoridae), scarab beetles (Scarabaeidae), and crane flies (Tipula). Most evidence suggests that California tiger salamanders remain active in their underground dwellings during the summer months, making frequent underground movements in burrow systems of less than 33 ft. (10 m), but otherwise remaining underground until the onset of rain and the winter months (USFWS 2014).

Reproductive Strategy

Adult: Substrate spawner.

Lifespan

Adult: Up to 10 years or more (USFWS 2014).

Dependency on Other Individuals or Species

Adult: Males typically arrive before the females, generally remaining in the ponds longer (average of 44.7 days) than females (average of 11.8 days) (USFWS 2014).

Breeding Season

Adult: Typically from November through April, although migrating adults can be observed as early as October and as late as May (USFWS 2014).

Key Resources Needed for Breeding

Adult: Females deposit their eggs in ephemeral/vernal or perennial water, attaching the eggs to twigs, grass stems, or other vegetation or debris (USFWS 2014).

Other Reproductive Information

Egg: Females attach their eggs singly or, in rare circumstances, in groups of two to four (68 FR 28648). California tiger salamander eggs hatch in 10 to 28 days; the amount of time for hatching is likely related to water temperatures (USFWS 2014).

Adult: The male deposits a spermatophore (a capsule or mass containing spermatozoa) on the bottom of the pond, which the female picks up and uses to fertilize her eggs internally (USFWS 2014).

Reproduction Narrative

Egg: Females attach their eggs singly or, in rare circumstances, in groups of two to four (68 FR 28648). After deposition, California tiger salamander eggs hatch in 10 to 28 days; the amount of time for hatching is likely related to water temperatures (USFWS 2014).

Adult: With the onset of the breeding season, typically from November through April (although migrating adults can be observed as early as October and as late as May), adult salamander leave their refugia during rain and storm events in search of breeding ponds (e.g., ephemeral/vernal or perennial water). Males typically arrive before the females, generally remaining in the ponds longer (average of 44.7 days) than the females (average of 11.8 days). The male deposits a spermatophore on the bottom of the pond, which the female picks up and uses to fertilize her eggs internally. Females then attach their eggs to twigs, grass stems, or other vegetation or debris (USFWS 2014).Breeding adults are usually 1 (rare) to 2 years (typical), and up to 4 to 5 years of age; females breed an estimated 1.4 times in their lifetime (up to 10 years or more). Given that an estimated 8.5 young survive to metamorphosis per reproductive event, a female's reproductive capacity averages roughly 12 metamorphic offspring over its lifetime (USFWS 2014).

Habitat Type

Egg: See Adult life stage.

Larvae: See Adult life stage.

Adult: Grassland/herbaceous, savanna, woodland - hardwood (NatureServe 2015); Primarily inhabits annual grasslands and open woodlands of the foothills and valleys surrounding ephemeral/vernal pools for breeding (USFWS 2014).

Habitat Vegetation or Surface Water Classification

Egg: See Adult life stage.

Larvae: See Adult life stage.

Adult: Lacustrine Habitat(s): shallow water; Palustrine Habitat(s): herbaceous wetland, temporary pool surrounded by uplands characterized by annual grassland and oak woodland (NatureServe 2015). In the Santa Barbara region, other natural sites where the Santa Barbara DPS is particularly found include (sand) dunal or deflational pools and ponds in once extensive sandy terraces; isolated fold and fault sag ponds in ridges or valleys; and fluvial ponds of varying origins in intermittent drainages in or along the margins of terraces (USFWS 2009).

Dependencies on Specific Environmental Elements

Egg: California tiger salamanders breed in deeper vernal pools and wetlands that have sufficiently long periods of inundation to prevent stranding/desiccation (USFWS 2014).

Adult: Deep, natural vernal pools and ponds with sufficient hydroperiod; livestock ponds and other modified ephemeral and permanent ponds surrounded by large tracts of land dominated by grassland, oak savanna, or oak woodland. Breeding pools typically have moderate to high levels of turbidity; California tiger salamanders rarely use ponds with clear water (USFWS 2014).

Geographic or Habitat Restraints or Barriers

Adult: Roads; wide, fast rivers; and areas of intensive development dominated by buildings and pavement (NatureServe 2015). In the Santa Barbara DPS, the heavily traveled U.S. Highway 101 creates a barrier to salamander dispersal; a few culverts exist that run under the highway and may allow for some dispersal between the Los Alamos metapopulations (USFWS 2009).

Spatial Arrangements of the Population

Adult: Random

Environmental Specificity

Adult: Narrow/specialist or community with key requirements common (NatureServe 2015).

Tolerance Ranges/Thresholds

Larvae: Ponding duration is an important factor for breeding success. Wetlands must have a long enough ponding duration for California tiger salamander larvae to mature into juveniles capable of dispersing from the aquatic breeding site to suitable terrestrial habitat. This typically takes 3 months or more, and will vary depending on factors such as water temperature and the depth of the breeding ponds (USFWS 2014).

Site Fidelity

Adult: High; California tiger salamanders appear to have high site fidelity, returning to their natal pond as adults. After breeding, they commonly return to the same terrestrial habitat areas (USFWS 2014).

Dependency on Other Individuals or Species for Habitat

Adult: California tiger salamander populations are strongly correlated with small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae) (USFWS 2014).

Habitat Narrative

Egg: California tiger salamanders breed in deeper vernal pools and wetlands that have sufficiently long periods of inundation to prevent stranding/desiccation. Eggs are attached to a substrate such as twigs, grass stems, or other vegetation or debris (USFWS 2014).

Larvae: Ponding duration is an important factor for breeding success. Wetlands must have a long enough ponding duration for California tiger salamander larvae to mature into juveniles capable of dispersing from the aquatic breeding site to suitable terrestrial habitat. This typically takes 3 months or more, and will vary depending on factors such as water temperature and the depth of the breeding ponds (USFWS 2014).

Adult: California tiger salamander populations are strongly correlated with small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae). Adult California tiger salamanders spend roughly 90 percent of any given year underground. Most evidence suggests that California tiger salamanders remain active in their underground dwellings. California tiger salamanders appear to have high site fidelity, returning to their natal pond as adults. After breeding, they commonly return to the same terrestrial habitat areas (USFWS 2014).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 (USFWS, 2022)

Dispersal/Migration

Motility/Mobility

Adult: Low due to dependency on aquatic habitat/moist environmental conditions, and seasonal weather conditions (USFWS 2014).

Dispersal

Adult: Peak periods for metamorphs to leave their natal ponds have been reported from May to July. Once metamorphosis occurs, juveniles often depart their natal ponds at night and enter into terrestrial habitat in search of underground burrows. Although wet conditions are more favorable for upland travel, metamorphs typically travel during dry weather because summer rain events seldom occur as metamorphosis is completed and ponds begin to dry. However, if a rain event does occur, it is likely that it will trigger a mass emergence from the natal pond (USFWS 2014). The mean distance that juveniles travel before settling in a burrow is 26 m (85 ft.); dispersal into terrestrial habitat occurs randomly with respect to direction (USFWS 2014). Migrates up to about 2 km (1.25 mi.) between terrestrial habitat and breeding pond; rain storms precede major migrations to the breeding sites, with most migration on rainy nights (NatureServe 2015; USFWS 2014). The average dispersal distance is estimated to be 562 m (1,844 ft.). However, estimates suggest California tiger salamanders are physiologically capable of migrating up to 1.5 mi. (2.4 km) during a breeding season, and an estimated 95 percent of California tiger salamander populations are thought to occur within 1.86 km (1.16 mi.) of a breeding pond (USFWS 2014). The mean distance adults travel before settling into a burrow is 35.9 m (118 ft.).

Dependency on Other Individuals or Species for Dispersal

Adult: California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae) (USFWS 2014).

Dispersal/Migration Narrative

Larvae: See Adult life stage.

Adult: Peak periods for metamorphs to leave their natal ponds have been reported from May to July. Once metamorphosis occurs, juveniles often depart their natal ponds at night and enter into terrestrial habitat in search of underground burrows. Although wet conditions are more favorable for upland travel, metamorphs typically travel during dry weather because summer rain events seldom occur as metamorphosis is completed and ponds begin to dry. However, if a rain event does occur, it is likely that it will trigger a mass emergence from the natal pond (USFWS 2014). The mean distance that juveniles travel before settling in a burrow is 26 m (85 ft.); dispersal into terrestrial habitat occurs randomly with respect to direction (USFWS 2014).After breeding events, adults and juveniles disperse from the breeding pond in search of small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta’s pocket gopher (Thommomys bottae), or in their absence (especially as recent metamorphs), soil cracks (USFWS 2014). The average dispersal distance is estimated to be 562 m (1,844 ft.). The mean distance adults travel before settling into a burrow is 35.9 m (118 ft.).During the breeding season, rain storms precede major migrations to breeding sites, with most migrations occurring on rainy nights. Adult California tiger salamanders migrate up to about 2 km (1.25 mi.) between terrestrial habitat and breeding pond (NatureServe 2015; USFWS 2014). However, estimates suggest California tiger salamanders are physiologically capable of migrating up to 2.4 km (1.5 mi.) during a breeding season, and an estimated 95 percent of California tiger salamander populations are thought to occur within 1.86 km (1.16 mi.) of a breeding pond (USFWS 2014).

Population Information and Trends

Population Trends:

Decreasing; five of the six existing habitat complexes supporting this population suffered moderate to severe levels of habitat destruction or degradation between 1996 and 2000 (NatureServe 2015).

Species Trends:

Decreasing

Population Growth Rate:

Slow

Number of Populations:

The Santa Barbara DPS of California tiger salamander represents one of the six known populations (USFWS 2009; USFWS 2014).

Population Size:

The total adult population size is unknown, but certainly exceeds 10,000 and likely is at least several 10,000s (NatureServe 2015).

Resistance to Disease:

Low

Adaptability:

Low

Additional Population-level Information:

The correlation between declining California tiger salamander numbers and surrounding urban and agricultural land uses had been well documented; as of 2009, there are approximately 60 known extant tiger salamander breeding ponds in Santa Barbara County (USFWS 2009; USFWS 2015), distributed across the six metapopulations. However, because the species spends a majority of its life underground and may not breed every year (= low detectability), it is difficult to determine the exact number of California tiger salamander populations that have been lost due to habitat conversion (USFWS 2014).Although the number of individual extant occurrences of California tiger salamander (Santa Barbara DPS) have increased since the DPS was emergency listed in 2000, these do not necessarily correlate with an improvement in status or a reduction in threats to the California tiger salamander; many of these ponds (occurrences) are likely threatened by development, or may have already been destroyed or degraded as a result of development projects. The available data suggest that most populations consist of relatively small numbers of breeding adults; breeding populations in the range of a few pairs up to a few dozen pairs are common, and numbers above 100 breeding individuals are rare. As of 2009, the West Santa Maria/Orcutt metapopulation contains 15 extant known breeding ponds, and comprises two vernal pool complexes and a few isolated ponds; the East Santa Maria metapopulation comprises six extant known breeding ponds, four of which comprise a vernal pool complex and two of which are isolated; the West Los Alamos metapopulation contains 11 known breeding ponds spread throughout three vernal pool complexes and two isolated ponds; the East Los Alamos metapopulation comprises four breeding ponds within one vernal pool complex; the Purisima Hills metapopulation contains 18 breeding ponds within a vernal pool complex and one isolated pond; the Santa Rita Valley metapopulation contains five known breeding ponds (USFWS 2009). 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 (USFWS, 2022).

Population Narrative:

Both the California tiger salamander (Santa Barbara DPS) population levels and the overall California tiger salamander species are decreasing; five of the six existing habitat complexes supporting this population suffered moderate to severe levels of habitat destruction or degradation between 1996 and 2000 (NatureServe 2015). Although the total adult population size at the species complex level (all DPSs) is unknown, it certainly exceeds 10,000 and likely is at least several tens of thousands (NatureServe 2015). The correlation between declining California tiger salamander numbers and surrounding urban and agricultural land uses had been well documented. As of 2009, there are approximately 60 known extant tiger salamander breeding ponds in Santa Barbara County (USFWS 2009; USFWS 2015), distributed across the six metapopulations. However, because the species spends a majority of its life underground and may not breed every year (resulting in low detectability), it is difficult to determine the exact number of California tiger salamander populations that have been lost due to habitat conversion (USFWS 2014).Although the number of individual extant occurrences of California tiger salamander (Santa Barbara DPS) have increased since the DPS was emergency listed in 2000, these do not necessarily correlate with an improvement in status or a reduction in threats to the California tiger salamander; many of these ponds (occurrences) are likely threatened by development, or may have already been destroyed or degraded as a result of development projects. The available data suggest that most populations consist of relatively small numbers of breeding adults; breeding populations in the range of a few pairs up to a few dozen pairs are common, and numbers above 100 breeding individuals are rare. As of 2009, the West Santa Maria/Orcutt metapopulation contains 15 extant known breeding ponds, and comprises two vernal pool complexes and a few isolated ponds; the East Santa Maria metapopulation comprises six extant known breeding ponds, four of which comprise a vernal pool complex and two of which are isolated; the West Los Alamos metapopulation contains 11 known breeding ponds spread throughout three vernal pool complexes and two isolated ponds; the East Los Alamos metapopulation comprises four breeding ponds within one vernal pool complex; the Purisima Hills metapopulation contains 18 breeding ponds within a vernal pool complex and one isolated pond; the Santa Rita Valley metapopulation contains five known breeding ponds (USFWS 2009).Given the species' comparatively limited, fragmented, and isolated distribution across the landscape, their ecological diversity/variation across their range, and their sensitivity to environmental changes, the species shows a low resilience to withstand stochastic events, has a low representation to adapt to changing environmental conditions across the landscape, a low redundancy to withstand catastrophic events, a low resistance to disease, and low adaptability.

Threats and Stressors

Stressor: Urbanization
Exposure: Direct/indirect

Response: Higher susceptibility to mortality/extirpation, habitat degradation/fragmentation.
Consequence: Mortality/extirpation, habitat degradation/loss.
Narrative: Urban impacts include development activities such as building and maintenance of housing, commercial, and industrial developments; construction and widening of roads and highways; golf course construction and maintenance; landfill operation and expansion; operation of gravel mines and quarries; and dam building and inundation of habitat by reservoirs. Urbanization leads to direct and indirect loss of habitat for the California tiger salamander. Direct effects include the loss of suitable aquatic and terrestrial habitat through grading or other habitat modifications, such as flooding from reservoir expansion projects or the construction of solar power facilities. Indirect effects can be caused by many actions, including pond modifications that favor exotic predators; ground squirrel eradication; habitat fragmentation from roads and urban areas; increases in contaminated run-off from urbanized areas; and increases in native species, such as raccoons (Procyon lotor), that may be artificially abundant in association with urban development (USFWS 2009; USFWS 2015).

Stressor: Land conversion to intensive agriculture
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation/predation, habitat degradation.
Consequence: Mortality/extirpation; decrease or elimination of population; habitat degradation/loss.
Narrative: Agricultural impacts include the conversion of native habitat by discing and deep-ripping; and cultivation, planting, and maintenance of row crops, orchards, and vineyards. Conversion of grasslands to intensive agricultural uses, such as vineyards, orchards, and row crops, has led to the direct loss of Central California tiger salamander populations. Some less intensive agriculture uses (such as irrigated pasture) may still provide areas for California tiger salamanders to persist; however, even less intensive forms of agricultural use often lead to the alteration of wetlands and upland habitat which will result in less favorable conditions for California tiger salamanders. For example, if vernal pool grasslands are converted to irrigated pasture for cattle grazing, the repetitive flooding of the grasslands throughout the summer months decreases the abundance of burrowing mammals such as ground squirrels, thereby reducing the number of available burrows for California tiger salamanders. Suitable habitat adjacent to intensive agricultural uses may also be impacted. Aquatic breeding habitat may be affected by changes to hydrology (e.g. changing seasonal wetlands to perennial wetlands), increases in sediment inputs, increases in harmful contaminants, changes in predator and prey assemblages, and other alterations. Upland habitat may be impacted by the loss of small mammal burrows resulting from ground squirrel or gopher eradication programs, fragmentation from roads, and changes in available forage. All of these factors will result in less favorable conditions for California tiger salamanders, and may decrease or eliminate populations (USFWS 2009; USFWS 2015).

Stressor: Disease
Exposure: Direct/indirect
Response: Increased molt frequency.
Consequence: Reduced fitness and increased energy requirements.

Narrative: 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 (USFWS 2015). For example, diseases such as Ambystoma tigrinum virus (ATV) and regina ranavirus (RRV) are known to cause die-offs of other Ambystoma species, and although not yet documented to occur in California tiger salamander in the Central California DPS, such diseases are lethal to the species in experimental conditions. If introduced (i.e. by way of nonnative tiger salamanders sold as fishing bait), such diseases could spread from a single pond to an entire metapopulation (USFWS 2009; USFWS 2015). California tiger salamanders are also susceptible to infection by Chytrid fungus (Batrachochytrium dedrobatidis), which causes infected individuals to molt (slough) their entire skin every 2 to 3 days (rather than the typical once every 1 to 2 weeks); this may help prevent mortality, but also requires more energy and reduces individual fitness (USFWS 2009; USFWS 2015).

Stressor: Predation
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation and predation, reduced breeding.
Consequence: Mortality/extirpation, reduced fitness.
Narrative: In addition to native predators (amphibians, snakes, turtles, birds, and small mammals), nonnative and exotic predators include bullfrogs (Rana catesbeiana); nonnative and hybrid tiger salamanders; western mosquitofish (Gambusia affinis) and other introduced fishes like largemouth bass (Micropterus salmoides), fathead minnow (Pimephales promelas), and blue gill (Lepomis macrochirus); nonnative crayfish species (Pacifastacus, Oronectes, and Procambarus spp.), all of which can prey on either the larval or adult (or both) stages of the California tiger salamander (USFWS 2009; USFWS 2015). Other predators include invertebrate species like giant water bugs (Belostomatidae), predacious diving beetles (Dytiscidae), water scorpions (Nepidae), and dragonfly nymphs (Anisoptera), all of which prey on larvae; in some cases, their very presence can preclude California tiger salamanders from successfully breeding (USFWS 2009; USFWS 2015).

Stressor: Inadequacy of existing regulatory mechanisms
Exposure: Direct/indirect
Response:
Consequence: Mortality/extirpation, habitat degradation/loss.
Narrative: The primary cause of the decline of the Central California tiger salamander is the loss, degradation, and fragmentation of habitat that results from human activities. There are several state and federal laws and regulations that are pertinent to the protection of Central California tiger salamanders; however, federal, state, and local laws have not been sufficient to prevent past and ongoing losses of the California tiger salamander and its habitat (USFWS 2009; USFWS 2015).

Stressor: Hybridization with nonnative tiger salamanders
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, increased competition, habitat degradation, greater susceptibility to hybridization, shift in habitat.

Consequence: Mortality/extirpation, higher predation, reduction in population numbers, habitat degradation/loss, decreased reproductive success, higher fitness, reduced genetic purity, shift in habitat.
Narrative: The California tiger salamander (Santa Barbara DPS) has only recently been affected by hybridization. The large-scale introduction of barred tiger salamander was first reported in the Salinas Valley about 60 years ago, when many tens of thousands of barred tiger salamander (Ambystoma mavortium) were introduced in support of the bass-bait industry. Barred tiger salamanders have since been hybridizing with native California tiger salamanders, and have spread from the original source populations out across the Salinas Valley and coast range portion of the range of the species. Barred tiger salamanders were also introduced to two ponds near the North Fork Pacheco Creek in Santa Clara County in the early 1980s, and at three additional locations in Merced County. In the Santa Barbara region, nonnative tiger salamanders are established along the northern edge of the Lompoc valley, and recent discoveries have placed the two species in contact at the edge of their respective distributions (USFWS 2009; USFWS 2015). The hybrids are able to produce viable and fertile offspring, whose hybrid offspring have higher survival rates than either pure California tiger salamanders or pure barred tiger salamander; ultimately, this results in higher fitness, but reduced genetic purity. Furthermore, hybrids appear to thrive and dominate in perennial ponds because they can breed earlier, attain larger sizes, produce more eggs, and persist in a paedomorph form (an intermediate sexually mature, post-larval stage), during which time they can successfully cannibalize native California tiger salamanders (USFWS 2009; USFWS 2015).

Stressor: Contaminants
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation, increased levels of nitrogen, hydrocarbons, and other contaminants.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, increase susceptibility to parasites and bacteria, altered rates of metamorphosis, increase in growth abnormalities, reduced fitness.
Narrative: Sources of chemical pollution that may adversely affect California tiger salamander (Central California DPS) include hydrocarbon and other contaminants from oil production and road runoff; the application of chemicals for agricultural production and urban/suburban landscape maintenance; oil sump ponds and associated oils and other contaminants; and increased nitrogen levels in aquatic habitats. Amphibians in general are extremely sensitive to contaminants, due to their highly permeable skin. Exposure to pesticides can increase their susceptibility to parasitic or bacterial infections, alter their rates of metamorphosis, lead to growth abnormalities, reduce their overall fitness, and lead to increased mortality (USFWS 2009; USFWS 2015).

Stressor: Rodent and vector control programs
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation, increased mortality of burrowing mammals, predation on embryo and larval stages, increased predation on invertebrate prey base.

Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, reduction in small mammal population numbers, reduction invertebrate prey base, increased competition with predators.
Narrative: 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 potential threat to California tiger salamanders. Eradication techniques include the application of poisoned grains; fumigant rodenticide; gases (including aluminum phosphide, carbon monoxide, and methyl bromide) introduced into burrows through cartridges, pellets, and other methods; and combustible gas injected into burrow complexes and then ignited. Other rodent control measures include habitat modifications such as deep ripping of rodent burrow areas or use of flood irrigation. All of these techniques can both directly and indirectly result in mortality of California tiger salamanders. Fumigants applied to burrows could result in direct mortality of California tiger salamanders, including crushing or entombing salamanders. Although some methods may avoid direct mortality of salamanders, they will decrease ground squirrel and pocket gopher populations, which will in turn decrease the amount of available burrow habitat (USFWS 2009; USFWS 2015). Through vector control programs, mosquitofish introduced into wetlands by mosquito abatement agencies or ranchers introduces a nonnative predator that will predate not only on California tiger salamanders embryos and larvae, but also on the available invertebrate prey base, making it possible that mosquitofish may outcompete the salamander larvae for food. Other effects of vector control include the application of insecticides like methoprene, which has been shown to have direct and indirect effects on growth and survival of larval amphibians; and the bacterium Bacillus thuringiensis israeli (Bti), which if effective could reduce the density of available invertebrate prey (USFWS 2009; USFWS 2015).

Stressor: Climate change
Exposure: Indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation, greater susceptibility to hybridization, shorter hydroperiods, temperature fluctuations, increased exposure to UV light, increased exposure to disease.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, decreased reproductive success, reduced period of standing water, increased stranding of larvae/embryos, variance in temperature extremes, altered predator/prey relationships, increased incidence of diseases.
Narrative: The distribution of the California tiger salamander (Santa Barbara DPS) spans a limited range in climatic conditions (including annual variation), and it is uncertain how the various sub-populations of the Santa Barbara tiger salamander might differ in their responses to climate change. Although the life history strategy is adapted to inconsistent environmental conditions, climate change could result in even more erratic weather patterns, to which California tiger salamanders cannot adapt quickly enough. During drought, ponds may not persist long enough for larvae to transform, and temperature extremes or fluctuations in water levels during the breeding season may kill large numbers of embryos. Presumably, the longevity of adult California tiger salamanders is sufficient to ensure local population survival through all but the longest droughts. However, if long-term droughts become the norm in the future, this will have significant implications for California tiger salamanders, because they depend on these ponds for

breeding (USFWS 2009; USFWS 2015). Changes in climatic conditions could have other significant implications for California tiger salamanders, including altered prey/predator relationships; increased effects from ultraviolet radiation; and increased effects from diseases such as chytrid fungus and ATV. All of these changes in environmental conditions could have significant impacts on local populations of California tiger salamander. Because of the isolated and fragmented distribution of this species, this may lead to further population extirpations. In addition, climate change will likely result in warmer air temperatures in California, and this may serve as an advantage for hybrid tiger salamanders, which are able to disperse longer distances and have better endurance than native California tiger salamanders at higher air temperatures (USFWS 2009; USFWS 2015).

Stressor: Introduced species
Exposure: Direct/indirect
Response: Higher susceptibility to mortality/extirpation, habitat degradation.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, decreased reproductive success.
Narrative: Introduced species can have negative effects on California tiger salamander populations through competition. Competition with nonnative tiger salamanders can reduce metamorphic size and lengthen time to metamorphosis in California tiger salamanders, which can in turn increase desiccation and predation risk as well as competitive ability. Therefore, when competing with nonnative tiger salamanders and hybrids in ponds, California tiger salamanders are at a distinct disadvantage. Competition from fish that prey on mosquito larvae and other invertebrates can reduce the survival of salamanders. Both California tiger salamanders and mosquitofish feed on microinvertebrates and macroinvertebrates. Large numbers of mosquitofish may outcompete California tiger salamander larvae for food. The introduction of other fish inadvertently (e.g., fathead minnow), for recreational fishing (e.g., largemouth bass, green sunfish), or for other purposes may also affect the prey base, reducing survival and growth rates of salamanders (USFWS 2015).

Stressor: Vehicle strike mortality
Exposure: Direct
Response: Higher susceptibility to mortality/extirpation, habitat degradation.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, decreased reproductive success.
Narrative: Vehicles on roads contribute to direct mortality of California tiger salamanders (Santa Barbara DPS). 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. Metapopulation fragmentation is accelerated through increased mortality and by preventing recolonization of sites that would otherwise be only temporarily extirpated. 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. The California tiger salamanders most often impacted by vehicle strikes are adults making breeding migrations in breeding condition. Therefore, 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 (USFWS 2015).

Stressor: Agriculture (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: 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 (USFWS, 2022).

Stressor: Land-use and Conservation (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: 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 (USFWS, 2022).

Stressor: Overgrazing (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: 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 (USFWS, 2022)

Stressor: Vehicle-strike Mortality (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: 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 (USFWS, 2022).

Stressor: Non-native Species Introductions (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: 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 (USFWS, 2022).

Stressor: Inbreeding Depression (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: 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 (USFWS, 2022)

Stressor: Entrapment in Technogenic Structures (USFWS, 2022)
Exposure:
Response:

Consequence:
Narrative: 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, aboveground 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 (USFWS, 2022).

Recovery

Reclassification Criteria:
Downlisting may be warranted when the recovery criteria have been met in a sufficient number of metapopulation areas, in such a way that the Santa Barbara County DPS of the California tiger salamander exhibits increased resiliency and redundancy to prevent endangerment in the foreseeable future. Under the current draft recovery plan, it is recommended 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 (USFWS 2015).

At least four functional breeding ponds per metapopulation area are in fully preserved status and managed for the benefit of the Santa Barbara County DPS of the California tiger salamander. Ponds should have pool depths ranging between 40 and 80 cm (15.75 and 31.5 in.), with first priority being preservation of ponds, followed by restored or created ponds (USFWS 2015).

A minimum of 252 hectares (ha) (623 acres [ac.]) of functional upland habitat around each preserved pond (see criteria 1) is in fully preserved status. This functional upland habitat area may overlap with the functional upland habitat around adjacent ponds (USFWS 2015).

Adjacent to the fully preserved ponds (see criteria 1) and fully preserved upland habitat (see criteria 2), a minimum of 659 ha (1,628 ac.) of additional contiguous, functional upland habitat is present, which is at least 50 percent unfragmented and partially preserved. This additional contiguous habitat area may overlap with the functional upland habitat around adjacent ponds (USFWS 2015).

Effective population size (Ne) in the metapopulation shows an overall positive trend across 10 years (USFWS 2015).

Management is implemented to maintain the preserved ponds (see criteria 1) free of nonnative predators and competitors (e.g., bullfrogs and fish) (USFWS 2015).

Risk of introduction and spread of nonnative genotypes is reduced to a level that does not inhibit normal recruitment, and protects genetic diversity within and among metapopulations (USFWS 2015).

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 (USFWS 2015).

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 (USFWS, 2017).

Recovery Priority Number: 3C

Delisting Criteria:
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. Under the current draft recovery plan, it is recommended 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 (USFWS 2015).

At least four functional breeding ponds per metapopulation area are in fully preserved status and managed for the benefit of the Santa Barbara County DPS of the California tiger salamander. Ponds should have pool depths ranging between 40 and 80 cm (15.75 and 31.5 in.), with first priority being preservation of ponds, followed by restored or created ponds (USFWS 2015).

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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 (USFWS 2015).

Recovery Actions:

- The draft recovery plan includes a number of proposed recovery actions for the species:
- Protect and manage habitat for the Santa Barbara County California tiger salamander (USFWS 2015).
- Restore and maintain habitat for the Santa Barbara County California tiger salamander, and reduce vehicle-strike mortalities and barriers to dispersal from roads (USFWS 2015).
- Reduce and remove threats from nonnative species (USFWS 2015).
- Prevent and reduce the potential for the transmission of disease in California tiger salamander metapopulations (USFWS 2015).
- Conduct research on threats to the Santa Barbara County California tiger salamander (USFWS 2015).
- Undertake activities in support of developing and implementing management and monitoring plans (USFWS 2015).
- Conduct public education and outreach programs (USFWS 2015).
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Conservation Measures and Best Management Practices:

- 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 (USFWS, 2022).

Additional Threshold Information:

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SPECIES ACCOUNT: *Ambystoma californiense* (California tiger Salamander (Sonoma))

Species Taxonomic and Listing Information

Commonly-used Acronym: CTS

Listing Status: Endangered

Physical Description

The California tiger salamander is a large, stocky terrestrial salamander with a broad, rounded snout. Adults average 16 to 24 centimeters (cm) (6 to 9.5 inches [in.]) in length, and have random white or yellowish spots or bars against a black body. Their small eyes, which have black irises, protrude from their heads. Males can be distinguished from females, especially during the breeding season, by their swollen cloacae (a common chamber into which the intestinal, urinary, and reproductive canals discharge), more developed tail fins, and larger overall size (68 FR 28648). The larvae are aquatic; range in size from 11.5 to 14.2 millimeters (0.45 to 0.55 in.) in total length; are yellowish gray in color; and have a broad fat head, large, feathery external gills, and broad dorsal fins that extend well onto the back (68 FR 28648).

Taxonomy

Six unique populations consisting of three discrete DPSs have been identified in California. Although each DPS is genetically differentiated and geographically isolated, all California tiger salamanders in California are treated as Ambystoma californiense (68 FR 28648).

Historical Range

Historically, California tiger salamanders were endemic to the San Joaquin-Sacramento river valleys, bordering foothills, and coastal valleys of Central California. Although the historical distribution of California tiger salamanders is not known in detail, their current distribution suggests that they may have been continuously distributed along the low-elevation grassland-oak woodland plant communities of the valleys and foothills (USFWS 2014a). The historical range of the California tiger salamander (Sonoma County DPS) included the Santa Rosa Plain and Petaluma lowlands, an area of approximately 40,468 hectares (ha) (100,000 acres [ac.]). Prior to alteration of the plain by humans, the landscape contained numerous vernal pools scattered across an area dominated by oak savannah, and representing a large, mostly continuous mosaic of suitable upland and aquatic habitat. By the mid-1990s, it was estimated that vernal pool habitat on the plain had been reduced by more than 80 percent (USFWS 2014b).

Current Range

The current core range of the California tiger salamander Sonoma County DPS encompasses approximately 7,284 to 8,094 ha (18,000 to 20,000 ac.) of fragmented habitat, with extant occurrences defined by core (Wright-Kelly, West Cotati, and Llano Crescent - Stony Point) and management (Alton Lane, Horn Hunter, East Cotati, and Americano Stemple) areas. This distribution has been curtailed primarily in two areas in recent times: the Santa Rosa Air Center area (southwestern Santa Rosa), where observations have decreased since the early 1990s; and the southern Cotati area, where salamanders were once commonly observed in the late 1980s to early 1990s (USFWS 2014b).

Critical Habitat Designated

Yes; 8/31/2011.

Legal Description

On August 31, 2011, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for the Sonoma County distinct population segment of the California tiger salamander (Ambystoma californiense) (Sonoma California tiger salamander) under the Endangered Species Act of 1973, as amended (76 FR 54346 - 54372). In total, approximately 47,383 acres (19,175 hectares) of land was designated as revised critical habitat for the Sonoma California tiger salamander.

Critical Habitat Designation

A single unit is designated as critical habitat for the Sonoma California tiger salamander; Santa Rosa Plain Unit:

This unit is located on the Santa Rosa Plain in central Sonoma County and contains approximately 47,383 ac (19,175 ha), which includes 745 ac (301 ha) of State lands, 744 ac (301 ha) of city lands, 498 ac (202 ha) of county lands, 9 ac (4 ha) of individually owned tribal trust land, and 45,387 ac (18,367 ha) of private lands. No Federal lands are included in this proposed unit. The unit is partially bordered on the west by the generalized eastern boundary of the 100- year Laguna de Santa Rosa floodplain, on the southwest by Hensley Road, on the south by Pepper Road (northwest of Petaluma), on the east generally by and near Petaluma Hill Road or by the urban centers of Santa Rosa and Rohnert Park, and on the north by the Town of Windsor. This unit is characterized by vernal pools, seasonal wetlands, and associated grassland habitat. This unit contains the physical and biological features essential to the conservation of the Sonoma California tiger salamander, and is within the geographical area occupied at the time of listing. The critical habitat unit supports vernal pool complexes and manmade ponds that are currently known to support breeding Sonoma California tiger salamanders (PCE 1), upland habitats with underground refugia (PCE 2), and upland dispersal habitat allowing movement between occupied sites (PCE 3). A segment of the 100-year floodplain that is located between the Stony Point Conservation Area (near Wilfred Avenue) and the Northwest Cotati Conservation Area (near Nahmens Road) is included within the final designation to prevent fragmentation of the northern and southern breeding concentrations within the unit, by allowing for potential dispersal and genetic exchange. The physical and biological features essential to the conservation of the Sonoma California tiger salamander may require special management considerations or protection to minimize impacts from nonnative predators on otherwise suitable breeding habitat, disturbance of aquatic breeding habitats, activities that impair the water quality of aquatic breeding habitat, activities that reduce underground refugia, creation of impassable barriers, and disruption of vernal pool complex processes (see Special Management Considerations or Protections section above). Primary threats to the Sonoma California tiger salamander include habitat destruction, degradation, and fragmentation. Secondary threats include predation and competition from introduced exotic species, possible commercial overutilization, disease, hybridization with nonnative salamanders, various chemical contaminants, road-crossing mortality, and rodent control operations. The Sonoma California tiger salamander is also vulnerable to chance environmental or demographic events (to which small populations are particularly vulnerable). The combination of the Sonoma California tiger salamander biology and its specific habitat requirements makes this animal highly susceptible to random events, such as drought or disease. Such events are not usually a concern until the number of breeding sites, refugia habitat, or geographic distribution become severely limited, as is the case with the Sonoma California tiger salamander. General land use in the unit includes urban and rural development, which has taken place for over 100 years in this area. For the past 25 years, urban growth has encroached into areas inhabited by the Sonoma California tiger salamander. Voters in the cities of Cotati, Rohnert Park, and Santa Rosa have established urban growth boundaries for their communities. This is intended to accomplish the goal of city-centered growth, resulting in rural and agricultural land uses being maintained between the urbanized areas. Therefore, it can be reasonably expected that rural land uses will continue into the foreseeable future. There are also acreages of publicly owned property and preserves located in the Santa Rosa Plain, which will further protect against development. Some of the areas within these urban growth boundaries, however, include lands inhabited by Sonoma California tiger salamanders. Agricultural practices, including discing, have also disturbed seasonal wetlands and upland habitat on the Santa Rosa Plain. However, some agricultural practices, such as grazed pasture, have protected habitat from intensive development.

Primary Constituent Elements/Physical or Biological Features

The critical habitat unit is designated for Sonoma County, CA. Within these areas, the primary constituent elements of the physical and biological features essential to the conservation of the California tiger salamander in Sonoma County consist of three components:

(i) Standing bodies of fresh water (including natural and manmade (e.g., stock)) ponds, vernal pools, and other ephemeral or permanent water bodies) that typically support inundation during winter and early spring, and hold water for a minimum of 12 consecutive weeks in a year of average rainfall.

(ii) Upland habitats adjacent to and accessible from breeding ponds that contain small mammal burrows or other underground refugia that the species depends upon for food, shelter, and protection from the elements and predation.

(iii) Accessible upland dispersal habitat between locations occupied by the species that allow for movement between such sites.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

Within the single unit proposed as critical habitat in this final designation, the features essential to the conservation of the Sonoma California tiger salamander may require special management considerations or protection to ameliorate the threats outlined below: 1. Activities that would threaten the suitability of Sonoma California tiger salamander breeding ponds, such as introduction of nonnative predators, including nonnative bullfrogs and nonnative fish; 2. Activities that could disturb or disrupt the hydrology of aquatic breeding habitat, such as heavy equipment operation (e.g., bulldozers or deep ripping), ground disturbance (e.g., discing), maintenance projects (e.g., pipelines, roads, power lines), land conversion to vineyards, off-road travel, or recreation; 3. Activities that impair the water quality of aquatic breeding habitat (e.g., pesticides, increased nitrogen input through recycled water or dairy operations); 4. Activities that would reduce small mammal populations or their burrows to the point that there are insufficient underground refugia, which are used by Sonoma California tiger salamanders for foraging, protection from predators, and shelter from the elements (e.g., discing, deep ripping, land conversion to vineyards, rodent control in existing vineyards); and 5. Activities that create barriers impassable by salamanders, or those activities that increase mortality in upland dispersal habitat between extant breeding occurrences.

In the case of the Sonoma California tiger salamander, natural repopulation of sites where the Sonoma California tiger salamander has been extirpated is likely not possible without human assistance and landowner cooperation. Examples of such proactive activities that benefit the Sonoma California tiger salamander include enhancement or creation of breeding ponds and control of nonnative predators. These are the types of proactive, voluntary conservation efforts that are necessary to prevent the extinction and promote the recovery of many other species as well (Wilcove and Lee 2004, p. 639; Shogren et al. 1999, p. 1260; Wilcove and Chen 1998, p. 1407; Wilcove et al. 1996, pp. 3–5).

Life History

Food/Nutrient Resources

Food Source

Larvae: Zooplankton, small crustaceans, and aquatic insects, moving toward larger prey such as the tadpoles of Sierran tree frog (Pseudacris sierra), western spadefoot toads (Spea hammondii), and California red-legged frogs (Rana draytonii) as they grow in size (USFWS 2014a).

Adult: Invertebrate prey items found in adult salamander stomachs include aphids (Aphididae), wood cockroaches (Blattellidae), ground beetles (Carabidae), springtails (Collembola), centipedes (Cryptopidae, Lithobiidae, and Scolopendra), true weevils (Curculionidae), webspinners (Embioptera), wasps/bees/ants (Hymenoptera), woodlice (Isopoda), silverfish (Lepismatidae), wolf spiders (Lycosidae), owlet moths (Noctuidae), harvestmen (Opiliones), crickets (Rhaphidophoridae), scarab beetles (Scarabaeidae), and crane flies (Tipula) (USFWS 2014a).

Competition

Larvae: Nonnative and hybrid tiger salamanders and western mosquitofish (Gambusia affinis) can outcompete larvae when they occur (USFWS 2014a).

Food/Nutrient Narrative

Larvae: The California tiger salamander larvae is an opportunistic invertivore/carnivore, and is among the top aquatic predators in the seasonal pool ecosystems. The larvae prey on zooplankton, small crustaceans, and aquatic insects, moving toward larger prey such as the tadpoles of Sierran tree frog (Pseudacris sierra), western spadefoot toads (Spea hammondii), and California red-legged frogs (Rana draytonii) as they grow in size (USFWS 2014a). The larvae often rest on the bottom in shallow water, but also may be found at different layers in the water column in deeper water. The young salamanders are wary; when approached by potential predators, they will dart into vegetation on the bottom of the pool (68 FR 28648). Typical competitors include nonnative and hybrid tiger salamanders and western mosquitofish (Gambusia affinis), which can outcompete larvae when they occur. Larvae feed for about 6 to 8 weeks after hatching, after which they switch to larger prey. The larval stage of the California tiger salamander usually lasts 3 to 6 months, with metamorphosis beginning in late spring or early summer. Larvae develop faster in smaller, more rapidly drying pools. The developmental period is prolonged in colder weather and in larger pools; larvae development (time from eggs laid to larvae leaving the pond) has been observed taking from 74 days to 94 days (USFWS 2014a).

Adult: The California tiger salamander adult is an opportunistic invertivore/carnivore, foraging predominantly underground during the dry summer months. Invertebrate prey items found in adult salamander stomachs include aphids (Aphididae), wood cockroaches (Blattellidae), ground beetles (Carabidae), springtails (Collembola), centipedes (Cryptopidae, Lithobiidae, and Scolopendra), true weevils (Curculionidae), webspinners (Embioptera), wasps/bees/ants (Hymenoptera), woodlice (Isopoda), silverfish (Lepismatidae), wolf spiders (Lycosidae), owlet moths (Noctuidae), harvestmen (Opiliones), crickets (Rhaphidophoridae), scarab beetles (Scarabaeidae), and crane flies (Tipula). Most evidence suggests that California tiger salamanders remain active in their underground dwellings during the summer months, making frequent underground movements in burrow systems of less than 10 m (33 ft.), but otherwise remaining underground until the onset of rain and the winter months (USFWS 2014a).

Reproductive Strategy

Adult: Substrate spawner.

Lifespan

Adult: Up to 10 years or more (USFWS 2014a).

Dependency on Other Individuals or Species

Adult: Males typically arrive before the females, generally remaining in the ponds longer (an average of 44.7 days) than females (an average of 11.8 days) (USFWS 2014a).

Breeding Season

Adult: Breeding season is typically from November through April, although migrating adults can be observed as early as October and as late as May (USFWS 2014a).

Key Resources Needed for Breeding

Adult: Females deposit their eggs in ephemeral/vernal or perennial water, attaching the eggs to twigs, grass stems, or other vegetation or debris (USFWS 2014a).

Other Reproductive Information

Egg: Females attach their eggs singly or, in rare circumstances, in groups of two to four (68 FR 28648). California tiger salamander eggs hatch in 10 to 28 days; the amount of time for hatching is likely related to water temperatures (USFWS 2014a).

Adult: The male deposits a spermatophore (a capsule or mass containing spermatozoa) on the bottom of the pond, which the female picks up and uses to fertilize her eggs internally (USFWS 2014a).

Reproduction Narrative

Egg: Females attach their eggs singly or, in rare circumstances, in groups of two to four (68 FR 28648). After deposition, California tiger salamander eggs hatch in 10 to 28 days; the amount of time for hatching is likely related to water temperatures (USFWS 2014a).

Adult: With the onset of the breeding season, typically from November through April (although migrating adults can be observed as early as October and as late as May), adult salamander leave their refugia during rain and storm events in search of breeding ponds (e.g., ephemeral/vernal or perennial water). Males typically arrive before the females, generally remaining in the ponds longer (an average of 44.7 days) than the females (an average of 11.8 days). The male deposits a spermatophore on the bottom of the pond, which the female picks up and uses to fertilize her eggs internally. Females then attach their eggs to twigs, grass stems, or other vegetation or debris (USFWS 2014a).Breeding adults are usually 1 (rare) to 2 years (typical), and up to 4 to 5 years of age; females breed an estimated 1.4 times in their lifetime (up to 10 years or more). Given that an estimated 8.5 young survive to metamorphosis per reproductive event, a female's reproductive capacity averages roughly 12 metamorphic offspring over its lifetime (USFWS 2014a).

Habitat Type

Egg: See Adult life stage.

Larvae: See Adult life stage.

Adult: Grassland/herbaceous, savanna, woodland - hardwood (NatureServe 2015); primarily inhabits annual grasslands and open woodlands of the foothills and valleys surrounding ephemeral/vernal pools for breeding (USFWS 2014a).

Habitat Vegetation or Surface Water Classification

Egg: See Adult life stage.

Larvae: See Adult life stage.

Adult: Lacustrine Habitat(s): shallow water. Palustrine Habitat(s): herbaceous wetland, temporary pool surrounded by uplands characterized by annual grassland and oak woodland (NatureServe 2015).

Dependencies on Specific Environmental Elements

Egg: California tiger salamanders breed in deeper vernal pools and wetlands that have periods of inundation that are long enough to prevent stranding/desiccation (USFWS 2014a). Where breeding habitat is restricted, individuals have also been known to breed in roadside ditches in areas that contain seasonal wetlands (USFWS 2014b).

Adult: Deep, natural vernal pools and ponds with sufficient hydroperiod; and livestock ponds and other modified ephemeral and permanent ponds surrounded by large tracts of land dominated by grassland, oak savanna, or oak woodland. Breeding pools typically have moderate to high levels of turbidity; California tiger salamanders rarely use ponds with clear water (USFWS 2014a).

Geographic or Habitat Restraints or Barriers

Adult: Roads; wide, fast rivers; and areas of intensive development dominated by buildings and pavement (NatureServe 2015). In the Sonoma County DPS, roads like the heavily traveled Stony Point Road create a barrier (or population sink due to mortality) to salamander dispersal; a few culverts exist that run under the roadways and may allow for some dispersal (USFWS 2014b).

Spatial Arrangements of the Population

Adult: Random

Environmental Specificity

Adult: Narrow/specialist or community with key requirements common (NatureServe 2015).

Tolerance Ranges/Thresholds

Larvae: Ponding duration is an important factor for breeding success. Wetlands must have a long enough ponding duration for California tiger salamander larvae to mature into juveniles capable of dispersing from the aquatic breeding site to suitable terrestrial habitat. This typically takes 3 months or more, and will vary depending on factors such as water temperature and the depth of the breeding ponds (USFWS 2014a).

Site Fidelity

Adult: High; California tiger salamanders appear to have high site fidelity, returning to their natal pond as adults. After breeding, they commonly return to the same terrestrial habitat areas (USFWS 2014a).

Dependency on Other Individuals or Species for Habitat

Adult: California tiger salamander populations are strongly correlated with small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae) (USFWS 2014a).

Habitat Narrative

Egg: California tiger salamanders breed in deeper vernal pools and wetlands that have periods of inundation that are long enough to prevent stranding/desiccation (USFWS 2014a). Especially in Sonoma County, where breeding habitat is restricted, individuals have also been known to breed in roadside ditches in areas that contain seasonal wetlands (USFWS 2014b). Eggs are attached to substrates such as twigs, grass stems, or other vegetation or debris (USFWS 2014a).

Larvae: Ponding duration is an important factor for breeding success. Wetlands must have a long enough ponding duration for California tiger salamander larvae to mature into juveniles capable of dispersing from the aquatic breeding site to suitable terrestrial habitat. This typically takes 3 months or more, and will vary depending on factors such as water temperature and the depth of the breeding ponds (USFWS 2014a).

Adult: California tiger salamander populations are strongly correlated with small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta's pocket gopher (Thommomys bottae). Adult California tiger salamanders spend roughly 90 percent of any given year underground. Most evidence suggests that California tiger salamanders remain active in their underground dwellings. California tiger salamanders appear to have high site fidelity, returning to their natal pond as adults. After breeding, they commonly return to the same terrestrial habitat areas (USFWS 2014a).Although California tiger salamanders are adapted to natural vernal pools and ponds, they now frequently use livestock ponds and other modified ephemeral and permanent ponds surrounded by large tracts of land dominated by grassland, oak savanna, or oak woodland. California tiger salamanders breed in deeper vernal pools and wetlands that have sufficiently long periods of inundation. Breeding pools typically have moderate to high levels of turbidity; California tiger salamanders rarely use ponds with clear water. This species is not known to breed in streams or rivers; however, breeding populations have been reported in ditches that contain seasonal wetlands, and have been documented in sewage treatment ponds in Calaveras County. There has been a shift in habitat use from vernal pools on valley floors to livestock ponds and other artificial wetlands in the foothills (USFWS 2014a).In the Sonoma County DPS, roads like the heavily traveled Stony Point Road create a barrier (or population sink due to mortality) to salamander dispersal; a few culverts exist that run under the roadways and may allow for some dispersal (USFWS 2014b). Geographic barriers include heavily traveled roads, especially at night during salamander breeding season, so that salamanders almost never successfully traverse the road; roads with a barrier that is impermeable to salamanders; wide, fast rivers; and areas of intensive development dominated by buildings and pavement (NatureServe 2015).

Dispersal/Migration

Motility/Mobility

Adult: Low due to dependency on aquatic habitat/moist environmental conditions, and seasonal weather conditions (USFWS 2014a).

Dispersal

Adult: Peak periods for metamorphs to leave their natal ponds have been reported from May to July. Once metamorphosis occurs, juveniles often depart their natal ponds at night and enter into terrestrial habitat in search of underground burrows. Although wet conditions are more favorable for upland travel, metamorphs typically travel during dry weather because summer rain events seldom occur as metamorphosis is completed and ponds begin to dry. However, if a rain event does occur, it is likely that it will trigger a mass emergence from the natal pond (USFWS 2014a). The mean distance that juveniles travel before settling in a burrow is 26 m (85 ft.); dispersal into terrestrial habitat occurs randomly with respect to direction (USFWS 2014a). Migrates up to about 2 kilometers (km) (1.25 miles [mi.]) between terrestrial habitat and breeding pond; rain storms precede major migrations to the breeding sites, with most migration on rainy nights (NatureServe 2015; USFWS 2014a). The average dispersal distance is estimated to be 562 m (1,844 ft.). However, estimates suggest that California tiger salamanders are physiologically capable of migrating up to 2.4 km (1.5 mi.) during a breeding season, and an estimated 95 percent of California tiger salamander populations are thought to occur within 1.86 km (1.16 mi.) of a breeding pond (USFWS 2014a). The mean distance adults travel before settling into a burrow is 35.9 m (118 ft.) (USFWS 2014a).

Dependency on Other Individuals or Species for Dispersal

Adult: California ground squirrel (Otospermophilus beecheyi) and Botta’s pocket gopher (Thommomys bottae) (USFWS 2014a).

Dispersal/Migration Narrative

Larvae: See Adult life stage.

Adult: Peak periods for metamorphs to leave their natal ponds have been reported from May to July. Once metamorphosis occurs, juveniles often depart their natal ponds at night and enter into terrestrial habitat in search of underground burrows. Although wet conditions are more favorable for upland travel, metamorphs typically travel during dry weather because summer rain events seldom occur as metamorphosis is completed and ponds begin to dry. However, if a rain event does occur, it is likely that it will trigger a mass emergence from the natal pond (USFWS 2014a). The mean distance that juveniles travel before settling in a burrow is 26 m (85 ft.); dispersal into terrestrial habitat occurs randomly with respect to direction (USFWS 2014a).After breeding events, adults and juveniles disperse from the breeding pond in search of small burrowing mammal communities, particularly California ground squirrel (Otospermophilus beecheyi) and Botta’s pocket gopher (Thommomys bottae), or in their absence (especially as recent metamorphs), soil cracks (USFWS 2014a). The average dispersal distance is estimated to be 562 m (1,844 ft.). The mean distance adults travel before settling into a burrow is 35.9 m (118 ft.) (USFWS 2014a).During the breeding season, rain storms precede major migrations to breeding sites, with most migrations occurring on rainy nights. Adult California tiger salamanders migrate up to about 2 km (1.25 mi.) between terrestrial habitat and breeding pond (NatureServe 2015; USFWS 2014a). However, estimates suggest that California tiger salamanders are physiologically capable of migrating up to 2.4 km (1.5 mi.) during a breeding season, and an estimated 95 percent of California tiger salamander populations are thought to occur within 1.86 km (1.16 mi.) of a breeding pond (USFWS 2014a).

Population Information and Trends

Population Trends:

Decreasing; in the past few years, four breeding sites have been destroyed or have suffered severe degradation. Only eight breeding sites remain (NatureServe 2015).

Species Trends:

Decreasing (NatureServe 2015)

Population Growth Rate:

Slow

Number of Populations:

The Sonoma County DPS of California tiger salamander represents one of the six known populations (USFWS 2014b).

Population Size:

The total adult population size is unknown (NatureServe 2015).

Resistance to Disease:

Low

Adaptability:

Low

Additional Population-level Information:

Since the California tiger salamander Sonoma County DPS was listed, multiple conservation banks have been established, and vernal pool and grassland habitat have been protected with conservation easements. Although the trend of habitat loss has continued since the species was listed, protection of land through conservation easements and other conservation tools has resulted in the preservation of wetland and upland habitat for the California tiger salamander. Several conservation banks have been authorized to offer credits as compensation for impacts to the California tiger salamander for projects that result in habitat loss or degradation. All have funding mechanisms, such as endowment funds for the perpetual management of the habitat to ensure the survival of the listed species present in the conservation banks (USFWS 2014b).

Population Narrative:

Both the California tiger salamander (Sonoma County DPS) population levels and the overall California tiger salamander species are decreasing; in the past few years, four breeding sites have been destroyed or have suffered severe degradation, and only eight breeding sites remain (NatureServe 2015).Since the California tiger salamander Sonoma County DPS was listed, multiple conservation banks have been established and vernal pool and grassland habitat have been protected with conservation easements. Although the trend of habitat loss has continued since the species was listed, protection of land through conservation easements and other conservation tools has resulted in the preservation of wetland and upland habitat for the California tiger salamander. Several conservation banks have been authorized to offer credits as compensation for impacts to the California tiger salamander for projects that result in habitat loss or degradation. All have funding mechanisms such as endowment funds for the perpetual management of the habitat to ensure the survival of the listed species present in the conservation banks (USFWS 2014b);Given the species' comparatively limited, fragmented, and isolated distribution across the landscape, their ecological diversity/variation across their range, and their sensitivity to environmental changes, the species shows a low resilience to withstand stochastic events, has a low representation to adapt to changing environmental conditions across the landscape, a low redundancy to withstand catastrophic events, a low resistance to disease, and low adaptability.

Threats and Stressors

Stressor: Urbanization
Exposure: Direct/indirect.
Response: Higher susceptibility to mortality/extirpation, and habitat degradation/fragmentation.
Consequence: Mortality/extirpation, and habitat degradation/loss.
Narrative: Urban impacts include development activities such as building and maintenance of housing, commercial, and industrial developments; construction and widening of roads and highways; and golf course construction and maintenance. Urbanization leads to direct and indirect loss of habitat for the California tiger salamander. Direct effects include the loss of suitable aquatic and terrestrial habitat through grading or other habitat modifications. Indirect effects can be caused by many actions, including pond modifications that favor exotic predators; ground squirrel eradication; habitat fragmentation from roads and urban areas; increases in contaminated run-off from urbanized areas; and increases in native species, such as raccoons (Procyon lotor), that may be artificially abundant in association with urban development (USFWS 2014b; USFWS 2015).

Stressor: Land conversion to intensive agriculture
Exposure: Direct/indirect.
Response: Higher susceptibility to mortality/extirpation/predation, and habitat degradation.
Consequence: Mortality/extirpation; decrease or elimination of population; and habitat degradation/loss.
Narrative: Agricultural impacts include the conversion of native habitat by discing and deep-ripping; and cultivation, planting, and maintenance of row crops, orchards, and vineyards. Conversion of grasslands to intensive agricultural uses, such as vineyards, orchards, and row

crops, has led to the direct loss of California tiger salamander (Sonoma County DPS) populations. Some less intensive agriculture uses (such as irrigated pasture) may still provide areas for California tiger salamanders to persist; however, even less intensive forms of agricultural use often lead to the alteration of wetlands and upland habitat, which will result in less favorable conditions for California tiger salamanders. For example, if vernal pool grasslands are converted to irrigated pasture for cattle grazing, the repetitive flooding of the grasslands throughout the summer months decreases the abundance of burrowing mammals such as ground squirrels, thereby reducing the number of available burrows for California tiger salamanders. Suitable habitat adjacent to intensive agricultural uses may also be impacted. Aquatic breeding habitat may be affected by changes to hydrology (e.g. changing seasonal wetlands to perennial wetlands), increases in sediment inputs, increases in harmful contaminants, changes in predator and prey assemblages, and other alterations. Upland habitat may be impacted by the loss of small mammal burrows resulting from ground squirrel or gopher eradication programs, fragmentation from roads, and changes in available forage. All of these factors will result in less favorable conditions for California tiger salamanders, and may decrease or eliminate populations (USFWS 2014b; USFWS 2015).

Stressor: Disease
Exposure: Direct/indirect.
Response: Increased molt frequency.
Consequence: Reduced fitness and increased energy requirements.
Narrative: Because the Sonoma County DPS of the California tiger salamander has limited genetic variation, it is likely to be more vulnerable to unpredictable factors, including disease (USFWS 2014b). For example, diseases such as Ambystoma tigrinum virus (ATV) and regina ranavirus (RRV) are known to cause die-offs of other Ambystoma species, and although not yet documented to occur in California tiger salamander in the Central California DPS, such diseases are lethal to the species in experimental conditions. If introduced (i.e., by way of nonnative tiger salamanders sold as fishing bait), such diseases could spread from a single pond to an entire metapopulation (USFWS 2014b; USFWS 2015). California tiger salamanders are also susceptible to infection by Chytrid fungus (Batrachochytrium dedrobatidis), which causes infected individuals to molt (slough) their entire skin every 2 to 3 days (rather than the typical once every 1 to 2 weeks); this may help prevent mortality, but also requires more energy and reduces individual fitness (USFWS 2014b; USFWS 2015).

Stressor: Predation
Exposure: Direct/indirect.
Response: Higher susceptibility to mortality/extirpation and predation, and reduced breeding.
Consequence: Mortality/extirpation, and reduced fitness.
Narrative: In addition to native predators (amphibians, snakes, turtles, birds, and small mammals), nonnative and exotic predators include bullfrogs (Rana catesbeiana); nonnative and hybrid tiger salamanders; western mosquitofish (Gambusia affinis) and other introduced fishes like largemouth bass (Micropterus salmoides), fathead minnow (Pimephales promelas), and blue gill (Lepomis macrochirus); and nonnative crayfish species (Pacifastacus, Oronectes, and Procambarus spp.), all of which can prey on either the larval or adult (or both) stages of the

California tiger salamander (USFWS 2014b; USFWS 2015). Other predators include invertebrate species like giant water bugs (Belostomatidae), predacious diving beetles (Dytiscidae), water scorpions (Nepidae), and dragonfly nymphs (Anisoptera), all of which prey on larvae; in some cases, their very presence can preclude California tiger salamanders from successfully breeding (USFWS 2014b; USFWS 2015).

Stressor: Inadequacy of existing regulatory mechanisms.
Exposure: Direct/indirect.
Response: Higher susceptibility to mortality/extirpation, and habitat degradation/fragmentation.
Consequence: Mortality/extirpation, and habitat degradation/loss.
Narrative: The primary cause of the decline of the Central California tiger salamander is the loss, degradation, and fragmentation of habitat that results from human activities. There are several state and federal laws and regulations that are pertinent to the protection of Central California tiger salamanders; however, federal, state, and local laws have not been sufficient to prevent past and ongoing losses of the California tiger salamander and its habitat (USFWS 2014b; USFWS 2015).

Stressor: Hybridization with nonnative tiger salamanders
Exposure: Direct/indirect.
Response: Higher susceptibility to mortality/extirpation; increased competition; habitat degradation; greater susceptibility to hybridization; and shift in habitat.
Consequence: Mortality/extirpation, higher predation, reduction in population numbers, habitat degradation/loss, decreased reproductive success, higher fitness, reduced genetic purity, and shift in habitat.
Narrative: The California tiger salamander (Sonoma County DPS) has not been affected by hybridization. The large-scale introduction of barred tiger salamander was first reported in the Salinas Valley about 60 years ago, when many tens of thousands of barred tiger salamander (Ambystoma mavortium) were introduced in support of the bass-bait industry. Barred tiger salamanders have since been hybridizing with native California tiger salamanders (Central California and Santa Barbara DPS), and have spread from the original source populations out across the Salinas Valley and coast range portion of the range of the species. Barred tiger salamanders were also introduced to two ponds near the North Fork Pacheco Creek in Santa Clara County in the early 1980s, and at three additional locations in Merced County. In the Sonoma County region, nonnative tiger salamanders have not yet been recorded, although the risk exists (USFWS 2014b; USFWS 2015). The hybrids are able to produce viable and fertile offspring, whose hybrid offspring have higher survival rates than either pure California tiger salamanders or pure barred tiger salamander; ultimately, this results in higher fitness, but reduced genetic purity. Furthermore, hybrids appear to thrive and dominate in perennial ponds because they can breed earlier, attain larger sizes, produce more eggs, and persist in a paedomorph form (an intermediate sexually mature, post-larval stage), during which time they can successfully cannibalize native California tiger salamanders (USFWS 2014b; USFWS 2015).

Stressor: Contaminants
Exposure: Direct/indirect.

Response: Higher susceptibility to mortality/extirpation; habitat degradation; and increased levels of nitrogen, hydrocarbons, and other contaminants.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, increased susceptibility to parasites and bacteria, altered rates of metamorphosis, increased growth abnormalities, and reduced fitness.
Narrative: Sources of chemical pollution that may adversely affect California tiger salamander (Central California DPS) include hydrocarbon and other contaminants from oil production and road runoff; the application of chemicals for agricultural production and urban/suburban landscape maintenance; and increased nitrogen levels in aquatic habitats. Amphibians in general are extremely sensitive to contaminants, due to their highly permeable skin. Exposure to pesticides can increase their susceptibility to parasitic or bacterial infections, alter their rates of metamorphosis, lead to growth abnormalities, reduce their overall fitness, and lead to increased mortality (USFWS 2014b; USFWS 2015).

Stressor: Rodent and vector control programs
Exposure: Direct/indirect.
Response: Higher susceptibility to mortality/extirpation; habitat degradation; increased mortality of burrowing mammals; predation on embryo and larval stages; and increased predation on invertebrate prey base.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, reduction in small mammal population numbers, reduction invertebrate prey base, and increased competition with predators.
Narrative: 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 potential threat to California tiger salamanders. Eradication techniques include the application of poisoned grains; fumigant rodenticide; gases (including aluminum phosphide, carbon monoxide, and methyl bromide) introduced into burrows through cartridges, pellets, and other methods; and combustible gas injected into burrow complexes and then ignited. Other rodent control measures include habitat modifications such as deep ripping of rodent burrow areas or use of flood irrigation. All of these techniques can both directly and indirectly result in mortality of California tiger salamanders. Fumigants applied to burrows could result in direct mortality of California tiger salamanders, including crushing or entombing salamanders. Although some methods may avoid direct mortality of salamanders, they will decrease ground squirrel and pocket gopher populations, which will in turn decrease the amount of available burrow habitat (USFWS 2015). Through vector control programs, mosquitofish introduced into wetlands by mosquito abatement agencies or ranchers represent a nonnative predator that will prey not only on California tiger salamanders embryos and larvae, but also on the available invertebrate prey base, making it possible that mosquitofish may outcompete the salamander larvae for food. Other effects of vector control include the application of insecticides like methoprene, which has been shown to have direct and indirect effects on growth and survival of larval amphibians; and the bacterium Bacillus thuringiensis israeli (Bti), which if effective could reduce the density of available invertebrate prey (USFWS 2014b; USFWS 2015).

Stressor: Climate change

Exposure: Indirect
Response: Higher susceptibility to mortality/extirpation; habitat degradation; greater susceptibility to hybridization; shorter hydroperiods; temperature fluctuations; increased exposure to UV light; and increased exposure to disease.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, decreased reproductive success, reduced period of standing water, increased stranding of larvae/embryos, variance in temperature extremes, altered predator/prey relationships, and increased incidence of diseases.
Narrative: The distribution of the California tiger salamander (Sonoma County DPS) spans a limited range encompassing separate sub-populations within the metapopulation, and it is thought that sub-populations in different habitats may serve as population sources in different years, allowing different areas to recolonize others over the years, thereby buffering the metapopulation against climatic variability. Although the life history strategy is adapted to inconsistent environmental conditions, climate change could result in even more erratic weather patterns, to which California tiger salamanders cannot adapt quickly enough. During drought, ponds may not persist long enough for larvae to transform, and temperature extremes or fluctuations in water levels during the breeding season may kill large numbers of embryos. Presumably, the longevity of adult California tiger salamanders is sufficient to ensure local population survival through all but the longest droughts. However, if long-term droughts become the norm in the future, this will have significant implications for California tiger salamanders, because they depend on these ponds for breeding (USFWS 2014b; USFWS 2015). Changes in climatic conditions could have other significant implications for California tiger salamanders, including altered prey/predator relationships; increased effects from ultraviolet radiation; and increased effects from diseases such as chytrid fungus and ATV. All of these changes in environmental conditions could have significant impacts on local populations of California tiger salamander. Because of the isolated and fragmented distribution of this species, this may lead to further population extirpations. In addition, climate change will likely result in warmer air temperatures in California, and this may serve as an advantage for hybrid tiger salamanders, which are able to disperse longer distances and have better endurance than native California tiger salamanders at higher air temperatures (USFWS 2015).

Stressor: Introduced species
Exposure: Direct/indirect.
Response: Higher susceptibility to mortality/extirpation, and habitat degradation.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, decreased reproductive success.
Narrative: Introduced species can have negative effects on California tiger salamander populations through competition. Competition with nonnative tiger salamanders can reduce metamorphic size and lengthen time to metamorphosis in California tiger salamanders, which can in turn increase desiccation and predation risk as well as competitive ability. Therefore, when competing with nonnative tiger salamanders and hybrids in ponds, California tiger salamanders are at a distinct disadvantage. Competition from fish that prey on mosquito larvae and other invertebrates can reduce the survival of salamanders. Both California tiger salamanders and mosquitofish feed on microinvertebrates and macroinvertebrates. Large numbers of mosquitofish

may outcompete California tiger salamander larvae for food. The introduction of other fish inadvertently (e.g., fathead minnow), for recreational fishing (e.g., largemouth bass, green sunfish), or for other purposes may also affect the prey base, reducing survival and growth rates of salamanders (USFWS 2015).

Stressor: Vehicle strike mortality
Exposure: Direct
Response: Higher susceptibility to mortality/extirpation, and habitat degradation.
Consequence: Mortality/extirpation, reduction in population numbers, habitat degradation/loss, and decreased reproductive success.
Narrative: Vehicles on roads contribute to direct mortality of California tiger salamanders (Sonoma County DPS). Salamanders are at risk of being run over by vehicles on their first dispersal as juveniles away from the pond, and on future migrations to and from the ponds for breeding. Metapopulation fragmentation is accelerated through increased mortality and by preventing recolonization of sites that would otherwise be only temporarily extirpated. Dead California tiger salamanders have been found on more than 16 roadways, from Santa Rosa to northern Petaluma. In particular, high numbers of California tiger salamander kills have been documented on Stony Point Road, between Santa Rosa and Cotati. The California tiger salamanders most often impacted by vehicle strikes are adults making breeding migrations in breeding condition. Therefore, particularly in metapopulations that are already compromised by other factors, road morality threatens the viability of the Sonoma County DPS of the California tiger salamander (USFWS 2014b; USFWS 2015).

Recovery

Reclassification Criteria:
To downlist the California tiger salamander Sonoma County DPS to threatened status, threats to the species' habitat must be reduced. This will have been accomplished if the following have occurred (USFWS 2014b):

At least three viable metapopulations are protected within the core range of the California tiger salamander Sonoma County DPS. This will be reflected by at least one self-sustaining metapopulation in each of the three core areas: the Wright-Kelly Core Area, the Llano Crescent-Stony Point Core Area, and the West Cotati Core Area (USFWS 2014b).

Each core area must have sufficient aquatic and upland habitat to support metapopulation dynamics by ensuring population connectivity, dispersal, and re-colonization of suitable breeding pools. This requires, at a minimum, a 124-ha (308-ac.) centralized wetland/upland complex in fully preserved status in each of the three core areas. In addition, contiguous, functional upland habitat must be present around each preserved complex, and must be substantially unfragmented (i.e., constituting no less than 50 percent of adjoining area extending 2.09 km (1.3 mi.) from the center of the pool complex). This area may only be partially preserved (USFWS 2014b).

Each core area will support suitable aquatic breeding habitat to sustain the population in perpetuity (i.e., 95 percent probability of persistence over 100 years). The hydrology of aquatic breeding habitat and the adjacent environment will be managed to sustain optimal breeding habitat conditions for California tiger salamander Sonoma County DPS in the central breeding pool complexes. Based on best available information, we believe this requires no fewer than four ponds, totaling 3.2 ha (8 ac.) of breeding pool area (fewer acres would be required if more ponds are available—e.g., with 10 ponds, a total area of 1 ha [2.5 ac.] may be sufficient), with an inundation period of approximately 4 months. To achieve the desired pooling duration, the best existing information suggests that pond areas should be no less than 0.10 ha (0.25 ac.), and pool depths should range from 40 to 80 cm (15.75 to 31.5 in.). Smaller pools are allowable if the local conditions ensure pond duration sufficient for progeny to complete metamorphosis (USFWS 2014b).

Upland habitat must be in suitable land use categories to support conditions necessary to sustain California tiger salamander Sonoma County DPS populations in perpetuity. These areas must be contiguous to the central complexes, and connected by habitat corridors no less than 457 m (1,200 ft.) in width (USFWS 2014b).

A U.S. Fish and Wildlife Service (USFWS)-approved rodent management plan is implemented for preserves, to ensure that small mammal eradication efforts are managed at intensities below those that may adversely affect the California tiger salamander Sonoma County DPS populations in all preserve areas (including adjacent compatible lands counted toward recovery). Limited eradication efforts in small areas (e.g., around a livestock watering trough or along a levee), may be permissible if these are determined to not directly or indirectly harm California tiger salamander Sonoma County DPS, or determined to have an overall net benefit to the habitat (USFWS 2014b).

A USFWS-approved management plan is implemented covering the preserves in the three core areas, to incorporate optimum livestock grazing regimes and grazing management techniques to enhance habitat suitability and survival for California tiger salamander Sonoma County DPS populations (USFWS 2014b).

Wetland complexes in the preserves must meet or exceed the ponding criteria set out above no fewer than eight times in a 10-year period, when measured on a 25-year moving average that includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 years or more of below-average local rainfall. Preserves (natural or created) will balance availability of dry year breeding habitat against normal to wet year perennial ponding, which could lead to proliferation of nonnative competitors and predators (USFWS 2014b).

A USFWS-approved disease management plan is finalized and implemented to ensure that: 1) monitoring for early detection of ranaviruses and other pathogens is conducted in a representative sampling of sites across the three core areas; 2) infected populations are isolated should a ranavirus or other pathogen be detected; and 3) the risk of introduction of novel pathogens to California tiger salamander Sonoma County DPS populations is reduced to a negligible level. Funding for disease monitoring and mitigation is ensured in perpetuity through an endowment fund or other funding mechanism (USFWS 2014b).

Predation from nonnative species in all preserves contributing to recovery will be at a level that does not inhibit recruitment for the California tiger salamander Sonoma County DPS below sustainable population growth rates (USFWS 2014b).

To the maximum extent feasible, all aquatic breeding habitats should be ephemeral to ensure that fish, bullfrogs, and other nonnative species cannot establish breeding populations. New preserves will be sited to minimize colonization risk posed by adjacent natural waterways or ditches (USFWS 2014b).

A USFWS-approved contaminants management plan is implemented at preserves to ensure that any detected contaminants at concentrations that may be harmful to California tiger salamander Sonoma County DPS at the population level are reduced to tolerable thresholds (e.g., no greater than an effective concentration to reduce survival in adult life stage greater than 1 percent [EC01]) (USFWS 2014b).

Sufficient habitat is protected to ensure that all populations in the three core areas are adequately buffered from contaminant effects due to adjacent incompatible land uses (USFWS 2014b).

A USFWS-approved management plan is adopted in coordination with the local mosquito abatement district to implement specific mosquito control techniques at intensities compatible with California tiger salamander Sonoma County DPS reproduction (including survival, growth, and maturation of larvae) (USFWS 2014b).

All roads in protected core areas are assessed for road crossing issues (either as a barrier to dispersal or as an area where high levels of mortality from vehicle strikes occur). A management plan approved by USFWS is implemented to reduce roadway mortality by providing a means for effective dispersal in a roadway-impacted landscape. To the maximum extent practical, preserves should be at least a 1.6 km (1 mi.) from major road crossings (USFWS 2014b).

A USFWS-approved management plan is implemented to reduce the risk of hybridization of nonnative salamanders with California tiger salamander Sonoma County DPS. The plan should include management contingencies for reducing the degree of hybridization should nonnative genes be introduced (USFWS 2014b).

Each of the three core areas must support a minimum viable population of interbreeding individuals, at an estimated abundance of 5,409 individuals (USFWS 2014b).

The Sonoma County California tiger salamander is ranked as a 3C, indicating that this DPS faces a high degree of threat and conflict, and has a high potential for recovery (USFWS, 2016).

Recovery Priority Number: 3C

Delisting Criteria:
To delist the California tiger salamander Sonoma County DPS, threats to the species' habitat must be reduced or removed. This will have been accomplished when the downlisting criteria have been met and when the following additional conditions have occurred (USFWS 2014b):

Sufficient habitat to support viable metapopulations is protected in two management areas of the four that have been identified as suitable for restoration: the Alton Lane Management Area, the Horn/Hunter management area, the Americano/Stemple Management Area, and the Southeast Cotati Management Area (USFWS 2014b).

Habitat criteria for management area preserves (124 ha [308 ac.] central wetland complexes with 50 percent of land within 2.1 km [1.3 mi.] in compatible land use management) are identical to the ones defined in the downlisting criteria, with the exception that all habitat counted toward the recovery criteria in both core and management areas will be fully preserved by public ownership or private easement, endowment, etc., to meet the delisting standard (USFWS 2014b).

To delist California tiger salamander Sonoma County DPS, the threat of disease and predation must be measured and controlled to ensure that its potential impact is minimal. This will be accomplished through the same management plans enumerated for downlisting for disease and predation, with the additional provision that funding to cover the geographic area encompassed in the incremental additional habitat preserves is available (USFWS 2014b).

To delist the California tiger salamander Sonoma County, the threat of other natural or manmade factors must collectively be reduced. This will be accomplished via the same management plans enumerated for downlisting for contaminants, mosquito abatement, road mortality, and genetic integrity, with the provision that funding is available to cover the geographic area encompassed by the incremental additional habitat preserves. Downlisting criteria to mitigate the threats of small population size will also apply in these two additional management areas for the purposes of delisting the California tiger salamander Sonoma County DPS (USFWS 2014b).

Recovery Actions:
- The following Recovery Actions Stepdown Narrative provides detail of the actions necessary to achieve full recovery (USFWS 2014b):
- Maintain current geographic, elevational, and ecological distribution of California tiger salamander Sonoma County DPS (USFWS 2014b).
- Siting, design, and construction of California tiger salamander Sonoma County DPS breeding habitat (USFWS 2014b).
- Agency Coordination. Partner with California Department of Fish and Wildlife; U.S. Army Corps of Engineers; Regional Water Quality Control Board; Sonoma County; Marin/Sonoma Mosquito and Vector Control District; and the cities of Santa Rosa, Cotati, Rohnert Park, and

Windsor to ensure that resource management practices are aligned with species conservation needs (USFWS 2014b).
- Adaptive management of California tiger salamander Sonoma County DPS recovery (USFWS 2014b).
- Reporting and Planning, California Tiger Salamander Sonoma County DPS. Develop and implement a California tiger salamander Sonoma County DPS management plan to maintain habitat suitability in perpetuity (USFWS 2014b).
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Additional Threshold Information:
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SPECIES ACCOUNT: *Ambystoma cingulatum* (Frosted Flatwoods salamander)

Species Taxonomic and Listing Information

Listing Status: Threatened; April 1, 1999; R4

Physical Description

The flatwoods salamander is a slender, small-headed mole salamander that rarely exceeds 13 centimeters (cm) (approximately 5 inches (in)) in length when fully mature (Means 1986, Conant and Collins 1991, Ashton 1992). Adult dorsal color ranges from black to chocolate-black with highly variable, fine, light gray lines forming a netlike or cross-banded pattern across the back (Palis 1996). Undersurfaces are plain gray to black with a few creamy or pearl-gray blotches or spots. Sexual dimorphism (the existence of separable male and female forms) is only apparent in breeding males (swollen cloacal region) or in gravid (with fertilized eggs) females. Adults most closely resemble Mabee's salamander, A. mabeei, with which it shares part of its range in South Carolina (Martof 1968). Flatwoods salamander larvae are long and slender, broad-headed and bushygilled, with white bellies and striped sides (Means 1986, Ashton 1992, Palis 1995d). They have distinctive color patterns, typically a tan mid-dorsal (middle of upper surface) stripe followed by a grayish black dorsolateral (back and sides) stripe, a pale cream mid-lateral (side) stripe, a blue-black lower lateral stripe, and a pale yellow ventrolateral (belly) stripe (Palis 1995d). The head has a dark brown stripe passing through the eye from the nostril to the gills (Means 1986).

Taxonomy

This salamander is a member of the family Ambystomatidae, the mole salamanders, which contains 15 North American species. Shaffer et al. 1991, conducted a phylogenetic analysis of ambystomatid salamanders and determined that the flatwoods salamander is most closely related to the ringed salamander (A. annulatum). Taxonomic revision resulting from research done by Pauly et al. (2007, pp. 415–429) split the flatwoods salamander into two species—the frosted flatwoods salamander and the reticulated flatwoods salamander.

Historical Range

Flatwoods salamanders are endemic to the lower southeastern Coastal Plain and occur in what were historically longleaf pine-wiregrass flatwoods and savannas. The historical range of what is now considered the frosted flatwoods salamander included parts of the States of Florida, Georgia, and South Carolina. This area encompassed the lower Coastal Plain of the southeastern United States along the Gulf Coast east of the Apalachicola-Flint Rivers, across north Florida, south into north-central Florida, and north along the Atlantic Coast through coastal Georgia and South Carolina.

Current Range

Baker, Franklin, Jefferson, Liberty, and Wakulla Counties in Florida. Berkeley, Charleston, and Jasper Counties in South Carolina. Bryan, Evans, Liberty, and McIntosh Counties in Georgia.

Range includes the lower southeastern Coastal Plain of the United States from southern South Carolina southward to Marion County (north-central Florida) and disjunctly westward through southern Georgia (Jensen et al. 2008) and northern Florida to the Apalachicola and Flint rivers (mid-Panhandle of Florida and northward) (Pauly et al. 2007). The combined State data from all survey work completed since 1990 indicate that 51 populations of flatwoods salamanders are known from across the historical range. Most of these occur in Florida (36 populations or 71 percent). Eleven populations have been found in Georgia, four in South Carolina, and none have been found in Alabama. Some of these populations are inferred from the capture of a single individual. Slightly more than half the known populations for the flatwoods salamander occur on public land (32 of 51, or 63 percent). Federal land holdings that harbor flatwoods salamanders include the Apalachicola National Forest, Osceola National Forest, St. Marks National Wildlife Refuge, Eglin Air Force Base, Hurlburt Field, and Naval Air Station Whiting Field's Holley Out-lying Field in Florida; Fort Stewart Military Installation and Townsend Bombing Range in Georgia; and Francis Marion National Forest in South Carolina. State agencies manage three additional populations—in Florida, Pine Log State Forest and Pt. Washington State Forest harbor a single population each; and in Georgia, the Mayhaw Wildlife Management Area supports a recently discovered population. The remaining 19 populations are on private land.

Critical Habitat Designated

Yes; 3/12/2009.

Legal Description

On February 10, 2009, the U.S. Fish and Wildlife Service (Service) finalized the listing under the Endangered Species Act of 1973, as amended (Act), of the currently threatened flatwoods salamander (Ambystoma cingulatum) into two distinct species: Frosted flatwoods salamander (Ambystoma cingulatum) and reticulated flatwoods salamander (Ambystoma bishopi) due to a recognized taxonomic reclassification; determined endangered status for the reticulated flatwoods salamander; retained threatened status for the frosted flatwoods salamander; and designated critical habitat for the frosted flatwoods salamander and the reticulated flatwoods salamander. In total, approximately 27,423 acres (ac) (11,100 hectares (ha)) in 35 units or subunits fall within the boundaries of the critical habitat designation; 22,970 ac (9,297 ha) of critical habitat is designated for the frosted flatwoods salamander and 4,453 ac (1,803 ha) for the reticulated flatwoods salamander. This area is a reduction of 3,205 ac (977 ha) from the proposed designation; 162 ac (66 ha) less for the frosted flatwoods salamander and 3,043 ac (928 ha) less for the reticulated flatwoods salamander.

Critical Habitat Designation

6 units, some of which are divided into subunits (for a total of 19 units and subunits), are designated as critical habitat.

Unit FFS–1 Unit FFS–1 is comprised of 10 subunits in Liberty and Franklin Counties, Florida. These subunits are comprised primarily of U.S. Forest Service land lying within the Apalachicola National Forest. The combined acreage of these subunits is 15,414 ac (6,238 ha). Of these acres, 14,614 ac (5,914 ha) are on the Apalachicola National Forest, 22 ac (9 ha) are under State management, and

778 ac (315 ha) are in private ownership. Subunits A through G and subunit J (14,365 ac (5,813 ha)) were occupied at the time of listing and are currently occupied; subunits H and I (1,049 ac (425 ha)) were not occupied at the time of listing, but are currently occupied. Subunit A Unit FFS–1, Subunit A encompasses 2,285 ac (925 ha) in Liberty County, Florida. Within this subunit, 1,976 ac (800 ha) are in the Apalachicola National Forest and 309 ac (125 ha) are in private ownership. Lands within this subunit owned by the U.S. Forest Service are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit B Unit FFS–1, Subunit B encompasses 733 ac (296 ha) in Liberty County, Florida. Within this subunit, 695 ac (281 ha) are in the Apalachicola National Forest and 38 ac (15 ha) are in private ownership. Lands within this subunit owned by the U.S. Forest Service are protected from direct agricultural and urban development (Griep 2008); however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit C Unit FFS–1, Subunit C encompasses 972 ac (393 ha) in Liberty County, Florida. All of this subunit is within the Apalachicola National Forest. Lands within this subunit are owned by the U.S. Forest Service and are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit D Unit FFS–1, Subunit D encompasses 568 ac (230 ha) in Liberty County, Florida. All of this subunit is within the Apalachicola National Forest. Lands within this subunit are owned by the U.S. Forest Service and are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit E Unit FFS–1, Subunit E encompasses 3,679 ac (1,489 ha) in Liberty County, Florida. Within this subunit, 3,473 ac (1,406 ha) are in the Apalachicola National

Forest and 206 ac (83 ha) are in private ownership. Lands within this subunit owned by the U.S. Forest Service are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat, as well as agricultural and urban development. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit F Unit FFS–1, Subunit F encompasses 162 ac (66 ha) in Liberty County, Florida. All of this subunit is within the Apalachicola National Forest. Lands within this subunit are owned by the U.S. Forest Service and are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit G Unit FFS–1, Subunit G encompasses 5,373 ac (2,175 ha) in Liberty County, Florida. Within this subunit, 5,277 ac (2,136 ha) are in the Apalachicola National Forest and 96 ac (39 ha) are in private ownership. Lands within this subunit owned by the U.S. Forest Service are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat, as well as agricultural and urban development. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit H Unit FFS–1, Subunit H encompasses 887 ac (359 ha) in Liberty County, Florida. Within this subunit, 861 ac (348 ha) are in the Apalachicola National Forest, 22 ac (9 ha) are under State management, and 4 ac (2 ha) are in private ownership. This subunit was not occupied at the time of listing, but is currently occupied. The currently occupied habitat of the flatwoods salamander is highly localized and fragmented. Flatwoods salamanders are particularly susceptible to drought, as breeding cannot occur if breeding ponds do not receive adequate rainfall. These small populations are at a high risk of extinction due to random events such as drought, and human-induced threats such as urban-agricultural development and habitat degradation due to fire suppression and hydrological alterations. Thus, to ensure the persistence and conservation of this species throughout its current geographic and ecological distribution despite fluctuations in the status of subpopulations, we have determined that this subunit, although not occupied at the time of listing, is essential for the conservation of the species. Lands within this subunit owned by the U.S. Forest Service are likely protected from direct agricultural and urban development. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit I Unit FFS–1, Subunit I encompasses 162 ac (66 ha) within the

Apalachicola National Forest in Liberty County, Florida. This subunit was not occupied at the time of listing, but is currently occupied. The currently occupied habitat of the flatwoods salamander is highly localized and fragmented. Flatwoods salamanders are particularly susceptible to drought, as breeding cannot occur if breeding ponds do not receive adequate rainfall. These small populations are at a high risk of extinction due to random events such as drought, and human-induced threats such as urban-agricultural development and habitat degradation due to fire suppression and hydrological alterations. Thus, to ensure the persistence and conservation of this species throughout its current geographic and ecological distribution despite fluctuations in the status of subpopulations, we have determined that this subunit is essential for the conservation of the species. Lands within this subunit are owned by the U.S. Forest Service and are likely protected from direct agricultural and urban development. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit J Unit FFS–1, Subunit J encompasses 593 ac (240 ha) in Franklin County, Florida. All of this subunit is within the Apalachicola National Forest. Lands within this subunit are owned by the U.S. Forest Service and are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes.

Unit FFS–3 Unit FFS–3, which was occupied at the time of listing, is comprised of three subunits encompassing 5,045 ac (2,042 ha) in Jefferson and Wakulla Counties, Florida. Within this unit, 2,049 ac (829 ha) are on St. Marks National Wildlife Refuge (NWR) (managed by the Service), 85 ac (34 ha) are in the Aucilla Wildlife Management Area managed by the State of Florida, and 2,911 ac (1,178 ha) are in private ownership. Subunit A Unit FFS–3, Subunit A encompasses 3,078 ac (1,245 ha) on Federal and private land in Wakulla County, Florida. This subunit is located south of U.S. Hwy. 98 and southeast of the town of Newport, Florida. Within this subunit, 1,456 ac (589 ha) are in the St. Marks NWR and 1,622 ac (656 ha) are in private ownership. Portions of this subunit that are within Federal ownership are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. Special management is needed to address the threats of agricultural and urban development on portions of the unit within private ownership. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit B Unit FFS–3, Subunit B encompasses 1,804 ac (730 ha) on Federal and private land. This subunit is located south of U.S. Hwy. 98 in southeastern Wakulla and southwestern Jefferson counties. Within this subunit, 593 ac (240 ha) are in the St. Marks NWR and 1,211 ac (490 ha) are in private ownership. Portions of this subunit that are within Federal ownership are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. Special management is needed to address the threats of agricultural and urban development on portions of the unit within private ownership. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit C Unit FFS–3, Subunit C encompasses 163 ac (66 ha) in Jefferson County, Florida. Within this subunit, 85 ac (34 ha) are in the Aucilla Wildlife Management Area managed by the State of Florida and 78 ac (32 ha) are in private ownership. This subunit is bisected by State Hwy. 59, 5.3 mi (8.4 km) north of U.S. Hwy. 98, and approximately 2 mi (3.2 km) east of the Jefferson-Wakulla County line. Portions of this subunit that are within State ownership are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. Special management is needed to address the threats of agricultural and urban development on portions of the unit within private ownership. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes.

Unit FFS–4 Unit FFS–4 is comprised of two subunits encompassing 712 ac (288 ha) in Baker County, Florida. Within this unit, which was occupied at the time of listing, 550 ac (223 ha) are on Osceola NF and 162 ac (66 ha) are in private ownership. Subunit A Unit FFS–4, Subunit A encompasses 550 ac (223 ha) on the Osceola National Forest in Baker County, Florida. This subunit is located adjacent and south of Interstate 10 in the southwestern corner of Baker County between State Highways 250 and 229. Portions of this subunit within Federal ownership are likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit B Unit FFS–4, Subunit B encompasses 162 ac (66 ha) on private land in Baker County, Florida. This subunit occurs approximately 2 mi (3.2 km) south of State Hwy. 229 and 3.5 mi (5.6 km) north of Interstate 10. This subunit requires special management to address threats including the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat, as well as agricultural and urban development. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes.

Unit FFS–5 Unit FFS–5 is comprised of two subunits encompassing 337 ac (136 ha) on privately owned land in Jasper County, South Carolina. Both subunits were occupied at the time of listing and are currently occupied. Subunit A Unit FFS–5, Subunit A encompasses 154 ac (62 ha) on private land in Jasper County, South Carolina. This subunit is bisected by State Hwy. 46 and occurs near a rapidly developing area of Jasper County. Within this subunit, threats to the frosted flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture and residential development into the unit, potential detrimental alterations in forestry practices that could destroy the belowground soils structure, potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat, and future habitat destruction due to urban and commercial development. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes. Subunit B Unit FFS–5, Subunit B encompasses 183 ac (74 ha) on private land in Jasper County, South Carolina. This subunit is bisected by a county road, approximately 1 mi (1.6 km) west of U.S. Hwy. 321, northwest of Hardeeville, South Carolina. Within this subunit, threats to the frosted flatwoods salamander and its habitat that may require special management of the PCEs include the potential for fire suppression, potential expansion of agriculture and residential development into the unit, potential detrimental alterations in forestry practices that could destroy the below-ground soils structure, potential hydrologic changes resulting from adjacent roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat, and future habitat destruction due to urban and commercial development. In addition, run-off from highways can introduce toxic chemicals into breeding sites. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes.

Unit FFS–6 Unit FFS–6, occupied at the time of listing, encompasses 1,300 ac (526 ha) on Federal and private land in Berkeley County, South Carolina. This unit is bisected by State Highway 41 approximately 10 mi (16 km) south of the town of Huger. Within this unit, 1,176 ac (476 ha) are in the Francis Marion National Forest and 124 ac (50 ha) are on private land. Land within this subunit owned by the U.S. Forest Service is protected from agricultural and urban development; however, threats remain to frosted flatwoods salamander habitat that may require special management of the PCEs. These threats include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecological functioning of the breeding pond and surrounding terrestrial habitat. Special management of the PCEs may also be required for the threats posed by agricultural and urban development on the lands in private ownership. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes.

Unit FFS–7 Unit FFS–7 encompasses 162 ac (66 ha) on the Santee Coastal Reserve (managed by the State of South Carolina) in Charleston County, South Carolina. Approximately 0.32 ac (0.13 ha) on private land are also included within this unit. Since most of this unit, which was occupied at the time of listing, is owned by the State of South Carolina, it is likely protected from direct agricultural and urban development; however, threats remain to the frosted flatwoods salamander and its habitat that may require special management of the PCEs. Threats include the potential for fire suppression, potential detrimental alterations in forestry practices that could destroy the below-ground soil structure, and potential hydrologic changes resulting from adjacent highways and roads that could alter the ecology of the breeding pond and surrounding terrestrial habitat. All lands designated as critical habitat contain all PCEs and support multiple frosted flatwoods salamander life processes.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are depicted for Baker, Franklin, Jefferson, Liberty, and Wakulla Counties in Florida; and Berkeley, Charleston, and Jasper Counties in South Carolina. The primary constituent elements of critical habitat for the frosted flatwoods salamander are:

(i) Breeding habitat. Small (generally less than 1 to 10 ac (less than 0.4 to 4.0 ha)), acidic, depressional standing bodies of freshwater (wetlands) that: (A) Are seasonally flooded by rainfall in late fall or early winter and dry in late spring or early summer; (B) Are geographically isolated from other water bodies; (C) Occur within pine flatwoodssavanna communities; (D) Are dominated by grasses and grass-like species in the ground layer and overstories of pond-cypress, blackgum, and slash pine; (E) Have a relatively open canopy, necessary to maintain the herbaceous component that serves as cover for flatwoods salamander larvae and their aquatic invertebrate prey; and (F) Typically have a burrowing crayfish fauna, but, due to periodic drying, the breeding ponds typically lack large, predatory fish (for example, Lepomis (sunfish), Micropterus (bass), Amia calva (bowfin)).

(ii) Non-breeding habitat: Upland pine flatwoods-savanna habitat that is open, mesic woodland maintained by frequent fires and that: (A) Is within 1,500 ft (457 m) of adjacent and accessible breeding ponds; (B) Contains crayfish burrows or other underground habitat that the flatwoods salamander depends upon for food, shelter, and protection from the elements and predation; (C) Has an organic hardpan in the soil profile, which inhibits subsurface water penetration and typically results in moist soils with water often at or near the surface under normal conditions; and (D) Often has wiregrasses as the dominant grasses in the abundant herbaceous ground cover, which supports the rich herbivorous invertebrates that serve as a food source for the frosted flatwoods salamander.

(iii) Dispersal habitat. Upland habitat areas between nonbreeding and breeding habitat that allows for salamander movement between such sites and that is characterized by: (A) A mix of vegetation types representing a transition between wetland and upland vegetation (ecotone); (B)

An open canopy and abundant native herbaceous species; (C) Moist soils as described in paragraph (2)(ii); and (D) Subsurface structure, such as that provided by deep litter cover or burrows, that provides shelter for salamanders during seasonal movements.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

Special management of the PCEs for the frosted flatwoods salamander and the reticulated flatwoods salamander and their habitat may be required for the following threats: Direct and indirect impacts of land use conversions, primarily urban development and conversion to agriculture and pine plantations; stump removal and other soil-disturbing activities which destroy the belowground structure within forest soils; fire suppression and low fire frequencies; wetland destruction and degradation; and random effects of drought or floods.

Life History

Food/Nutrient Resources

Food Source

Larvae: Aquatic invertebrates

Juvenile: Terrestrial invertebrates

Adult: Terrestrial invertebrates

Food/Nutrient Narrative

Larvae: Larvae hide amid inundated graminaceous vegetation by day, but will enter the water column at night (J. Palis, pers. obs.). A relatively open canopy is necessary to maintain the herbaceous component, which serves as cover for flatwoods salamander larvae and their aquatic invertebrate prey.

Juvenile: Seldom seen except during the breeding season. Small numbers of post-larval salamanders continue to be active on the surface during the winter months (Palis, unpubl. data). Herbaceous ground cover supports a rich herbivorous invertebrate community that serves as a food source for the flatwoods salamander.

Adult: Seldom seen except during the breeding season. Small numbers of post-larval salamanders continue to be active on the surface during the winter months (Palis, unpubl. data).Herbaceous ground cover supports a rich herbivorous invertebrate community that serves as a food source for the flatwoods salamander.

Reproductive Strategy

Adult: Colonial, oviparity, R-selected

Lifespan

Adult: 8 - 10+ years

Breeding Season

Adult: October - December

Key Resources Needed for Breeding

Adult: Rainy weather, herbaceous vegetation, ephemeral ponds

Reproduction Narrative

Egg: Embryos begin development immediately; eggs develop to hatching size within three weeks, but do not hatch until inundated (Anderson and Williamson 1976).

Larvae: Depending on when eggs are inundated, the larvae usually metamorphose (change into adult form) in March or April; the length of the larval period varies from 11 to 18 weeks (Palis 1995d).

Juvenile: Although not much bigger than metamorphs, males attain sexual maturity in their first year (Palis 1997). Females, however, do not sexually mature until at least two years old (Palis and Jensen 1995, Palis 1997).

Adult: They breed in relatively small, isolated ephemeral ponds where the larvae develop until metamorphosis. Preliminary data indicate that flatwoods salamander males first breed at 1 year of age and females at 2 years of age (Palis 1996). Adult flatwoods salamanders move to their wetland breeding sites during rainy weather, in association with cold fronts, from October to December (Palis 1997a). Breeding sites are isolated (not connected to any other water body) pond cypress (Taxodium ascendens), blackgum (Nyssa sylvatica var. biflora), or slash pine dominated depressions which dry completely on a cyclic basis. They are generally shallow and relatively small. Breeding sites in Florida have a mean size of 1.49 hectares (ha) (3.68 acres (ac)) and a mean depth of less than 39.2 cm (15.4 in) (Palis 1997b). These wetlands have a marsh-like appearance with sedges often growing throughout and wiregrasses (Aristida sp.), panic grasses (Panicum spp.), and other herbaceous species concentrated in the shallow water edges. Trees and shrubs grow both in and around the ponds. The females lay their eggs (singly or in clumps) beneath leaf litter, under logs and sphagnum moss (grows in wet acid areas) mats, or at bases of bushes, small trees, or clumps of grass (Anderson and Williamson 1976, Means 1986). Egg masses have also been found at the entrances of and within crayfish burrows (Anderson and Williamson 1976). The timing and frequency of rainfall are critical to the successful reproduction and recruitment of flatwoods salamanders. Fall rains are required to facilitate movements to the pond and winter rains are needed to ensure that ponds are filled sufficiently to allow hatching, development, and metamorphosis of larvae. In contrast, too much rainfall in the summer will keep pond levels from dropping below the grassy pond edge, as needed to provide dry substrate for egg deposition. This reliance on specific weather conditions results in unpredictable breeding events and reduces the likelihood that recruitment will occur every year.The longevity record for their close relative, A. annulatum, is 4 years, 11 months; however, many Ambystomatidae live 10 years or longer (Snider and Bowler 1992). Generation length is presumed to be about 8 years.

Habitat Type

Egg: Freshwater

Larvae: Freshwater

Juvenile: Freshwater, terrestrial, fossorial

Adult: Freshwater, terrestrial, fossorial

Habitat Vegetation or Surface Water Classification

Egg: Lacustrine: shallow water; palustrine: wetland, ephemeral pool

Larvae: Lacustrine: shallow water; palustrine: wetland, ephemeral pool

Juvenile: Lacustrine: shallow water; palustrine: riparian, wetland, ephemeral pool; terrestrial: forest

Adult: Lacustrine: shallow water; palustrine: riparian, wetland, ephemeral pool; terrestrial: forest

Dependencies on Specific Environmental Elements

Egg: Periodic fires

Larvae: Periodic fires

Juvenile: Moist soils, periodic fires

Adult: Moist soils, periodic fires

Geographic or Habitat Restraints or Barriers

Egg: Restricted to the lower southeastern Coastal Plain in Florida, Georgia, and South Carolina.

Larvae: Restricted to the lower southeastern Coastal Plain in Florida, Georgia, and South Carolina.

Juvenile: Restricted to the lower southeastern Coastal Plain in Florida, Georgia, and South Carolina. Barriers that separate occurrences of include heavily traveled roads, especially at night during salamander breeding season, such that salamanders almost never successfully traverse the road; roads with a barrier that is impermeable to salamanders; wide, fast rivers; areas of intensive development dominated by buildings and pavement.

Adult: Restricted to the lower southeastern Coastal Plain in Florida, Georgia, and South Carolina. Barriers that separate occurrences of include heavily traveled roads, especially at night during salamander breeding season, such that salamanders almost never successfully traverse the road; roads with a barrier that is impermeable to salamanders; wide, fast rivers; areas of intensive development dominated by buildings and pavement.

Spatial Arrangements of the Population

Adult: Scattered isolated populations

Environmental Specificity

Egg: Narrow

Larvae: Narrow

Juvenile: Narrow

Adult: Narrow

Site Fidelity

Adult: High-see Dispersal/Migration narrative

Dependency on Other Individuals or Species for Habitat

Juvenile: Crayfish (Pracambarus), Wiregrasses (Aristida sp.), especially A. beyrichiana

Adult: Crayfish (Pracambarus), Wiregrasses (Aristida sp.), especially A. beyrichiana

Habitat Narrative

Egg: See adult habitat. Eggs are laid in relatively small, isolated ephemeral ponds where the larvae develop until metamorphosis. Eggs are laid beneath leaf litter, under logs and sphagnum moss (grows in wet acid areas) mats, or at bases of bushes, small trees, or clumps of grass (Anderson and Williamson 1976, Means 1986). Egg masses have also been found at the entrances of and within crayfish burrows (Anderson and Williamson 1976). Sites where eggs are laid are isolated (not connected to any other water body) pond cypress (Taxodium ascendens), blackgum (Nyssa sylvatica var. biflora), or slash pine dominated depressions which dry completely on a cyclic basis. They are generally shallow and relatively small. These wetlands have a marsh-like appearance with sedges often growing throughout and wiregrasses (Aristida sp.), panic grasses (Panicum spp.), and other herbaceous species concentrated in the shallow water edges. Trees and shrubs grow both in and around the ponds.

Larvae: See adult habitat. Sites where eggs are laid are isolated (not connected to any other water body) pond cypress (Taxodium ascendens), blackgum (Nyssa sylvatica var. biflora), or slash pine dominated depressions which dry completely on a cyclic basis. They are generally shallow and relatively small. These wetlands have a marsh-like appearance with sedges often growing throughout and wiregrasses (Aristida sp.), panic grasses (Panicum spp.), and other herbaceous species concentrated in the shallow water edges. Trees and shrubs grow both in and around the ponds. A relatively open canopy is necessary to maintain the herbaceous component, which serves as cover for flatwoods salamander larvae and their aquatic invertebrate prey.

Juvenile: Flatwoods salamander are endemic to the lower southeastern Coastal Plain and occur in what were historically longleaf pinewiregrass flatwoods and savannas (Palis and Means 2005, pp. 608–609). Optimum habitat for the flatwoods salamander is an open, mesic woodland of longleaf/slash pine (Pinus palustris/P. elliottii) flatwoods maintained by frequent fires. Pine flatwoods are typically flat, lowlying open woodlands that lie between the drier sandhill community upslope and wetlands down slope (Wolfe et al. 1988). An organic hardpan, 0.3 to 0.7 meters (m) (1 to 2 feet (ft)) into the soil profile, inhibits subsurface water penetration and results in moist soils with water often at or near the surface (Wolfe et al. 1988). Wiregrasses (Aristida sp.), especially A. beyrichiana, are often the dominant grasses in the herbaceous (non-woody) ground cover (Wolfe et al. 1988). Subadult flatwoods salamanders are fossorial (Mount 1975). They enlarge crayfish burrows (Ashton 1992) or build their own.

Adult: This salamander occurs in isolated populations scattered across the lower southeastern Coastal Plain in Florida, Georgia, and South Carolina. Flatwoods salamander are endemic to the lower southeastern Coastal Plain and occur in what were historically longleaf pinewiregrass flatwoods and savannas (Palis and Means 2005, pp. 608–609). Optimum habitat for the flatwoods salamander is an open, mesic woodland of longleaf/slash pine (Pinus palustris/P. elliottii) flatwoods maintained by frequent fires. Pine flatwoods are typically flat, lowlying open woodlands that lie between the drier sandhill community upslope and wetlands down slope (Wolfe et al. 1988). An organic hardpan, 0.3 to 0.7 meters (m) (1 to 2 feet (ft)) into the soil profile, inhibits subsurface water penetration and results in moist soils with water often at or near the surface (Wolfe et al. 1988). Wiregrasses (Aristida sp.), especially A. beyrichiana, are often the dominant grasses in the herbaceous (non-woody) ground cover (Wolfe et al. 1988).Ponds typically have a burrowing crayfish fauna (genus Procambarus) and a diverse macroinvertebrate fauna, but lack large predatory fish (e.g., Lepomis (sunfish), Macropterus (bass), Amia calva (bowfin)).Adult salamanders are fossorial (Mount 1975). They enlarge crayfish burrows (Ashton 1992) or build their own. This species has a narrow environmental requirements based on the the degree to which it depends on a relatively scarce set of habitats, substrates, food types, or other abiotic and/or biotic factors within the overall range.See Reproduction Narrative for breeding habitat.

Dispersal/Migration

Motility/Mobility

Larvae: Low

Juvenile: Low

Adult: Low

Dispersal

Adult: Low

Dispersal/Migration Narrative

Juvenile: Metamorphs emigrate from their natal ponds during the months of March and April (J. Palis, pers. obs.).

Adult: Ambystomatid salamanders generally stay within a few hundred meters of their breeding pool. Salamanders of the Ambystoma cingulatum/bishopi complex migrate up to hundreds of meters between breeding and nonbreeding habitats; Ashton (1992) mentioned movements of over 1,700 meters. Migrations to breeding sites occur at night in conjunction with rains and passing cold fronts from mid-fall through early winter (Means 1972, Anderson and Williamson 1976; Palis, unpubl. data). Since they may disperse long distances from their breeding ponds to upland sites where they live as adults, desiccation (drying out) can be a limiting factor in their movements. Amphibian populations may be unable to recolonize areas after local extinctions due to their physiological constraints, relatively low mobility, and site fidelity (Blaustein et al. 1994).Metamorphs emigrate from their natal ponds during the months of March and April (J. Palis, pers. obs.).

Population Information and Trends

Population Trends:

Declining

Resiliency:

Resiliency, assessed at the population level, describes the ability of a population to withstand stochastic disturbance events. Like many amphibians that breed in ephemeral wetlands, flatwoods salamanders exhibit dramatic fluctuations in abundance across years. Specific environmental conditions are required for successful recruitment; drought years result in catastrophic reproductive failure. To discern long-term trends from natural fluctuations, a stochastic Integral Projection Model (IPM) was constructed from 10 years of drift fence data obtained at two breeding wetlands on Eglin AFB. A population viability analysis (PVA) was conducted, whereby simulated populations were projected into the future and extinction risks under various scenarios were calculated (George Brooks, Virginia Tech, 2019, unpublished data). Owing to the stochastic nature of recruitment, extinction risk was high for a single population. Thus, the species will need 101 resilient metapopulations distributed across its range to persist into the future and avoid extinction. As we consider the future viability of the species, more metapopulations with high resiliency distributed across the known range are associated with higher overall viability. For the reticulated flatwoods salamander, metapopulations were delineated by occupied breeding wetlands (i.e., ponds) buffered by a 1500 foot (approximately 500 m) radius of upland habitat in the 2009 critical habitat designation (74 FR 6700). In this document, we follow that definition of a, metapopulation although we discuss additional advancements in the understanding of flatwoods salamander populations. In addition to the PVA, species' resiliency was assessed based on breeding wetland occupancy and according to 6 resiliency categories describing habitat quality: (1) extent of woody vegetation in understory of upland habitat; (2) quality and composition of the wetland basin overstory; (3) presence and composition of the wetland midstory vegetation; (4) type of wetland understory vegetation and presence of organic duff/peat layer in basin; (5) adequacy of wetland hydroperiod for completion of metamorphosis; and (6) burn frequency/burn season for the compartment in which breeding sites are located. We discuss each of these factors. (USFWS, 2020)

Representation:

Representation characterizes a species adaptive potential by assessing geographic, genetic, ecological, and niche variability. The frosted flatwoods salamander historically occurred throughout the Coastal Plain of the southeastern U.S., across South Carolina, Georgia, and the panhandle of Florida (Palis and Means, 2005). The species is currently represented in both genetic clades, albeit at one isolated and small population at Fort Stewart Army Base in Liberty County, Georgia in the Atlantic Coastal Plain on the eastern portion of the range. Multiple populations exist in and around the two areas of St. Marks National Wildlife Refuge and Apalachicola National Forest in Liberty and Wakulla Counties, Florida, respectively, representing the Gulf Coastal Plain on the western portion of the range. The RMUs were derived by dividing the range of the species into more manageable units, and assure better distribution of recovered populations across the range, by establishing 25 population targets in each of the RMUs. This would help prevent potentially clumping too many metapopulations into a confined geographic area within the range. (USFWS, 2020)

Redundancy:

Redundancy describes the ability of the species to withstand catastrophic disturbance events. A PVA conducted for this species revealed a high probability of local extirpation under a business as usual scenario (George Brooks, Virginia Tech, 2019, unpublished data). Multiple independent populations, exhibiting asynchronous dynamics, will be required to secure long-term viability of the species and avoid regional extinction. For the reticulated flatwoods salamander, we considered the distribution of the species remaining on the landscape. We also considered flood models (e.g. SLOSH, etc) for potential sea level rise to get an indication of threat for extant populations near the Gulf Coast. Roughly 25 metapopulations per each of the 4 Recovery Management Units (RMUs) is necessary to provide redundancy across the historic range; 101 resilient metapopulations in total will be required across the historic range to ensure the risk of extinction is low enough to allow the species to persist into the foreseeable future. Currently, all the extant metapopulations occur within RMU 1 (within the boundaries of the Apalachicola National Forest, and St Marks National Wildlife Refuge), except one metapopulation with low resiliency within RMU 3 located at Fort Stewart, Georgia. (USFWS, 2020)

Number of Populations:

51

Population Size:

2500 - 100,000

Adaptability:

Moderate

Population Narrative:

Populations of the flatwoods salamander are small, fragmented, and isolated by various human-related factors including habitat conversion. Fifty-five percent of extant populations are widely separated from each other by unsuitable habitat. The isolated nature of flatwoods salamander populations makes them vulnerable to extirpation by random events. If their populations do cycle naturally at low densities, they will be less likely to rebound or become reestablished after a catastrophic event. Extinction becomes a possibility following a catastrophic event, if adjacent habitat is degraded or destroyed and no source populations to recolonize the area occur within dispersal distance. This species is considered moderately vulnerable to natural or anthropogenic stresses or catastrophes.The combined State data from all survey work completed since 1990 indicate that 51 populations of flatwoods salamanders are known from across the historical range. Secretive habits of adults make population estimates difficult. Total adult population size likely is at least several thousand, but actual number is unknown. Estimates range from 2,500 to 100,000 individuals. During extensive surveys of historical (pre-1990) breeding ponds, researchers recorded the species at only a small minority of formerly inhabited sites. The salamander has lost much of its former habitat in Georgia and South Carolina. Due to high breeding site fidelity and limitation of breeding to pool basins, populations using different breeding sites exhibit little or no interbreeding among adults. It is estimated that the population has declined by 70 - 90%. Currently, the species presumably is declining in concert with continued loss of remaining intact pine flatwoods community (particularly degradation of groundcover). The rate of decline is unknown.

Threats and Stressors

Stressor: Fire suppression
Exposure:
Response:
Consequence:
Narrative: Ecologists consider fire suppression the primary reason for the degradation of remaining longleaf pine forest habitat. The disruption affects both the upland forested habitat of adult salamanders and their ponded breeding habitat also required for development of larval salamanders. Alterations of the longleaf pine ecosystem, as a result of incompatible forest practices, have caused the historic loss of most of the original frosted flatwoods salamander habitat.

Stressor: Land use conversion
Exposure:
Response:
Consequence:
Narrative: Land use conversions to housing, other development projects, and agriculture eliminated large areas of pine flatwoods in the past (Schultz 1983, pp. 24–47; Stout and Marion

1993, pp. 422–429; Outcalt and Sheffield 1996, pp. 1–5; Outcalt 1997, pp. 1–6). Residential development and conversion to agriculture have resulted in the historical loss of one frosted flatwoods salamander population each from Ben Hill, Berrien, Brooks, Effingham, Emanuel, and Irwin Counties, Georgia (Seyle 1994, pp. 4–5); an additional site has been degraded in Orangeburg County, South Carolina, and the population at this site is also considered extirpated (LaClaire 1994a). State forest inventories completed between 1989 and 1995 indicated that flatwoods losses through land use conversion were still occurring (Outcalt 1997, pp. 3–6); however, further conversions are only likely to impact three of the populations occurring in large part on private lands or only 12 percent of the total frosted flatwoods salamander populations.

Stressor: Loss of wetlands
Exposure:
Response:
Consequence:
Narrative: The number and diversity of small wetlands where frosted flatwoods salamanders breed have been substantially reduced. Threats to breeding sites include alterations in hydrology, agricultural and urban development, road construction, incompatible silvicultural practices, shrub encroachment, dumping in or filling of ponds, conversion of wetlands to fish ponds, domestic animal grazing, soil disturbance, and fire suppression (Vickers et al. 1985, pp. 22–26; Palis 1997, p. 58; Ashton and Ashton 2005, p. 72).

Stressor: Roads
Exposure:
Response:
Consequence:
Narrative: Roads have contributed to habitat fragmentation by isolating blocks of remaining contiguous habitat. Roads disrupt migration routes and dispersal of individuals to and from breeding sites. Road construction can result in changes in hydrology and destruction of breeding ponds. Highway construction and associated development resulted in the destruction of a historic frosted flatwoods salamander breeding pond in Chatham County, Georgia (Seyle 1994, pp. 3–4). In addition, vehicles may also cause the death of frosted flatwoods salamanders when they are attempting to cross roads (Means 1996, p. 2).

Stressor: Habitat fragmentation
Exposure:
Response:
Consequence:
Narrative: Habitat fragmentation of the longleaf pine ecosystem resulting from habitat conversion is primarily a historical threat to the frosted flatwoods salamander. Large tracts of intact longleaf pine flatwoods habitat are fragmented by pine plantations, roads, and unsuitable habitat. Although the threat of ongoing habitat fragmentation has slowed, the effect of past habitat loss is that many frosted flatwoods salamander populations are widely separated from each other by unsuitable habitat

Stressor: Off-road vehicle use
Exposure:
Response:
Consequence:
Narrative: Off-road vehicle (ORV) use within frosted flatwoods salamander breeding ponds and their margins severely degrades the wetland habitat. In the Southeast, ORV use impacts habitat used by frosted flatwoods salamanders, has the potential to cause direct mortality of individual salamanders, and is a threat on both public and private land. On public lands, areas may be designated as off-limits to ORV use (U.S. Forest Service 2007, p. 19), but these restrictions are difficult to enforce. Even a single afternoon of individuals riding their ORVs in a pond can completely destroy the integrity of breeding sites by damaging or killing the herbaceous vegetation and rutting the substrate (Ripley and Printiss 2005, pp. 11–12). There is also the potential for direct injury or mortality of salamanders by ORVs at breeding sites (Ripley and Printiss 2005, p. 12).

Stressor: Disease
Exposure:
Response:
Consequence:
Narrative: Although disease has not been specifically documented in the frosted flatwoods salamander thus far, disease outbreaks with mass mortality in other species of salamanders indicate that disease may be a threat for this species as well (Daszak et al. 1999, p. 736). Whiles et al. (2004, p. 211) found a parasitic nematode (Hedruris siredonis, family Hedruridae) in larvae of the frosted flatwoods salamander from South Carolina and Florida. This parasite has been found in other ambystomatids and can cause individuals to become undersized and thin, thus reducing their fitness (Whiles et al. 2004, p. 212). Ranaviruses in the family Iridoviridae and the amphibian chytrid fungus (Batrachochytrium dendrobatidis) may be other potential threats, although the susceptibility of the frosted flatwoods salamander to these diseases is unknown.

Stressor: Predation
Exposure:
Response:
Consequence:
Narrative: Exposure to increased predation by fish is a threat to the frosted flatwoods salamander when isolated, seasonally ponded wetland breeding sites are changed to or connected to more permanent wetlands inhabited by fish species not typically found in temporary ponds. The presence of predatory fish has a marked effect on invertebrate communities and alters prey availability for larval salamanders with the potential for negative effects on larval fitness and survival (Semlitsch 1987, p. 481). Red imported fire ants (Solenopsis invicta) are also potential predators of flatwoods salamanders, especially in disturbed areas. They have been seen in areas disturbed by the installation of drift fences at known frosted flatwoods salamander breeding sites (Palis 2008). Mortality of amphibians trapped at drift fences has occurred when fire ants were present and traps were not monitored with sufficient frequency

(Palis et al. 2002, p. 6). The severity and magnitude of effects, as well as the long-term effect, of fire ants on frosted flatwoods salamander populations are currently unknown.

Stressor: Invasive plants
Exposure:
Response:
Consequence:
Narrative: Invasive plant species, such as cogongrass (Imperata cylindrica), threaten to further degrade existing flatwoods habitat. Cogongrass, a perennial grass native to Southeast Asia, is one of the leading threats to the ecological integrity of native herbaceous flora, including that in the longleaf pine ecosystem (Jose et al. 2002, p. 43). Cogongrass can displace most of the existing vegetation except large trees.

Stressor: Pesticides and herbicides
Exposure:
Response:
Consequence:
Narrative: Pesticides (including herbicides) may pose a threat to amphibians because their permeable eggs and skin readily absorb substances from the surrounding aquatic or terrestrial environment (Duellman and Trueb 1986, pp. 199–200). Negative effects that commonly used pesticides and herbicides may have on amphibians include delayed metamorphosis, paralysis, reduced growth rate, and mortality (Bishop 1992, pp. 67–69). In addition, herbicides used near salamander breeding ponds may alter the density and species composition of vegetation surrounding a breeding site and reduce the number of potential sites for egg deposition, larval development, or shelter for migrating salamanders.

Recovery

Delisting Criteria:
This recovery plan sets forth criteria which, when met, will increase the range of extant populations; will increase the number of individuals and populations; and will reduce threats to the species existence. Justification for these criteria is found in the accompanying RIS and section 3.4 of the SSA. We believe delisting may be considered when the following criteria are met: (1) At least 101 resilient metapopulations exhibit a stable or increasing trend are extant or reestablished as evidenced by natural recruitment and multiple age classes. (2) Approximately 25 resilient metapopulations are present in each of the four Recovery Management Units (RMUs; Figure 1) that represent the spatial distribution of historic range: RMU 1 (St Marks/Apalachicola Complex), RMU 2 (Southeastern Georgia/North Florida Complex), RMU 3 (Fort Stewart Complex), and RMU 4 (South Carolina Complex). The precise number in each RMU is dependent on habitat suitability and availability, but an approximate equal distribution will allow for sufficient redundancy across the historic range. (3) Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future. Breeding and adjacent upland habitats within the resilient metapopulations are protected long-

term though management agreements, public ownership, or other means, in sufficient quantity and quality to support growing populations. (USFWS, 2021)

Recovery Actions:

- Forest management recommendations within the buffer included harvesting only in dry periods, clear-cutting if no more than 25 percent of the buffer is cut at each harvest, restricting the use of mechanical site preparation techniques or other actions that would disturb the upper soil layers, and restricting herbicides to use for control of woody shrub encroachment only when fire could not be employed. An inner zone within the buffer with a radius of 164 m (538 ft) out from the wetland edge, the area needed to protect 95 percent of an ambystomatid population as estimated by Semlitsch, was considered to be important. Within this inner zone, it was recommended that clear-cutting be excluded.
- Minimize skid trails and their effects through the use of prescription planning and techniques such as pallets and bridges. Locate skid trails parallel to, rather than perpendicular to, the wetland edge to reduce alterations in wetland hydrology. Locate all log landings outside the primary and secondary zones.
- Keep soil disturbance to a minimum. Do not conduct intensive mechanical site preparation (i.e., rootraking, discing, stumping, bedding) or any other actions that cause significant soil disturbance.
- Prescribed fire should be the preferred method for site preparation and control of woody vegetation. Limit herbicide use to manual application, following BMPs, when fire cannot be employed.

Conservation Measures and Best Management Practices:

- To avoid further population declines and ensure that populations are as resilient as possible in the face of anticipated climate changes, land managers will need to engage in and maximize the active restoration of potentially suitable breeding wetlands to offset anticipated breeding pond losses to sea level rise and other climate changes. In addition to wetland restoration efforts, salamander translocations to restored wetlands may be necessary if salamanders fail to colonize restored ponds. We estimate approximately 25 resilient metapopulations per RMU are required to ensure persistence of the species into the future. (USFWS, 2020)
- Three types of management scenarios were developed based on the current number of active breeding ponds observed during recent surveys (2014–2018) and breeding pond succession and restoration rates elicited from knowledgeable land managers and species experts. A wetland loss scenario estimated the loss of active breeding ponds over time due to a loss of nesting habitat from natural habitat succession in which wetland herbaceous vegetation is reduced due to shrub encroachment and organic matter accumulation over time. This scenario assumed that no species-specific management of breeding ponds would occur and no measurable or successful restoration of potentially suitable (but currently degraded) breeding ponds would offset the loss of currently active breeding ponds. This represents a worst-case pond management scenario and the current scenario on many properties within the range of this species that lack adequate species-specific management or wetland restoration programs. We also modeled a wetland maintenance scenario where currently active breeding ponds are maintained in suitable condition by species-specific wetland management activities, but without successful efforts to restore additional potential breeding ponds. This scenario would reflect a situation where all speciesspecific management is focused on currently active breeding ponds. Finally, we modeled a wetland restoration scenario in which no active breeding ponds are being lost and currently unsuitable breeding ponds are restored to increase the

population size. This represents a best-case scenario in which species management is a high priority, where all active breeding ponds are maintained by appropriate species-specific management such that no succession and loss of active breeding ponds occur, and all restored breeding ponds are colonized by the species. This scenario is not currently achievable due to the species management challenges discussed in previous chapters. However, if current barriers to species management are resolved and species management is considered a top priority for land managers, this scenario might be possible. In reality, the management of breeding ponds on most currently occupied properties lies somewhere between the wetland loss and wetland maintenance scenarios where the loss of breeding ponds over time due to wetland succession is offset, at least to some degree, by the addition of new breeding ponds from active restoration programs. However, survey results show recent declines of active breeding ponds on all properties, suggesting that all occupied properties are losing active breeding wetlands over time. These declines reflect species population declines due to deficits in wetland habitat management and other factors. (USFWS, 2020)

- To avoid further population declines and ensure populations are as resilient as possible in the face of anticipated changes to the climate, land managers will need to engage in and maximize the active restoration of potentially suitable breeding wetlands to offset anticipated breeding pond losses to sea level rise. Wetland restoration efforts should be primarily focused on Apalachicola National Forest and Fort Stewart, which are not anticipated to be affected by sea level rise in the next 80 years, as well as other inland areas with potentially suitable habitat in the range of the species. Similarly, long-term protection (via acquisition or easements) should focus on this portion of the species range. Currently, many managers lack the resources to maintain all active breeding ponds or the ponds they restore in suitable condition. Therefore, efforts should be made to remove barriers to and provide support for wetland restoration and management on occupied and potentially suitable properties. (USFWS, 2020)

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SPECIES ACCOUNT: *Ambystoma macrodactylum croceum* (Santa Cruz long-toed salamander)

Species Taxonomic and Listing Information

Listing Status: Endangered; March 11, 1967 (32 FR 4001).

Physical Description

The Santa Cruz long-toed salamander is a small, dark-colored salamander of the family Ambysomatidae. Adults have an average snout-to-vent length of 42 to 71 millimeters (mm) (1.7 to 2.8 inches [in.]), with an average total length of 105 to 150 mm (4.2 to 6.0 in.). In general, adult female Santa Cruz long-toed salamanders have longer snout-to-vent lengths and weigh more than adult males. Post-metamorphic juvenile Santa Cruz long-toed salamanders have slightly greater than half the snout-to-vent length of adults and are less than half the weight of adults. They weigh approximately 3.0 to 9.8 grams (0.1 to 0.4 ounce). Adults have dull orange or metallic yellow dorsal markings and a sooty black ventral surface (USFWS 1999, USFWS 2009).

Taxonomy

The Santa Cruz long-toed salamander differs from the western long-toed salamander (A. m. macrodactylum) subspecies in its dull orange or metallic yellow dorsal markings and its greatly reduced dorsal head markings of small scattered dots, which are often absent, anterior to the eyes (USFWS 1999). Recent research on the genetics, biochemistry, physiology, and life history of the Santa Cruz long-toed salamander suggests that it may be a distinct species rather than a subspecies, although additional research is needed for confirmation (USFWS 2009).

Historical Range

At the time of listing, the subspecies was known from three sites in Santa Cruz County (USFWS 2009).

Current Range

The Santa Cruz long-toed salamander is restricted to southern Santa Cruz and northern Monterey counties. It has likely been extirpated from two locations: Bennet Slough/Struve Pond in Monterey County, and Rancho Road Pond in Santa Cruz County (USFWS 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

<u>Juvenile:</u> Mosquito larvae, worms, larval amphibians.

Adult: Isopods, beetles, slugs, earthworms.

Competition

Adult: The presence of nonnative invasive plants may reduce the numbers of invertebrates available as prey for Santa Cruz long-toed salamanders (USFWS 2009).

Food/Nutrient Narrative

Juvenile: See Adult narrative.

Adult: Santa Cruz long-toed salamander larvae are invertivores and omnivores that feed on mosquito larvae, worms, and larval amphibians that are distributed in the ponds they inhabit. Larvae remain in pond environments until they reach about 32 mm (1.3 in.) in snout-to-vent length. Body size at initiation of metamorphosis ranges from 26 to 48 mm (1.0 to 1.8 in.) in snout-to-vent length. Juvenile and adult Santa Cruz long-toed salamanders are opportunistic invertivores, feeding on isopods, beetles, slugs, and earthworms distributed on the soil surface (USFWS 1999). The presence of nonnative invasive plants may reduce the numbers of invertebrates available as prey (USFWS 2009).

Reproductive Strategy

Adult: Polygamous, oviparity.

Lifespan

Adult: 12 or more years (USFWS 1999).

Breeding Season

Adult: Mating reaches a peak in January and February, when heavy rains have filled breeding ponds (NatureServe 2015).

Key Resources Needed for Breeding

Adult: Breeding occurs in shallow, usually ephemeral, freshwater ponds with abundant submerged vegetation. Ponds fill in winter and spring and dry by late summer. Ponds must hold water for at least 90 days to support breeding (NatureServe 2015).

Other Reproductive Information

Juvenile: Eggs are laid on submerged stalks of spike rush (Eleocharis sp.) or similar aquatic plants about two to 3 centimeters (1 in.) apart, and hatch in about 1 week. Larvae metamorphose in 90 to 140 days, depending on temperature. Metamorphosis may extend from early May to mid-August. Once metamorphosis occurs, juvenile Santa Cruz long-toed salamanders leave the pond (NatureServe 2015; USFWS 1999).

Reproduction Narrative

Juvenile: See Adult narrative.

Adult: Santa Cruz long-toed salamander breeding occurs in shallow, usually ephemeral, freshwater ponds with abundant submerged vegetation. Ponds fill in winter and spring, and dry by late summer; but they must hold water for at least 90 days to support breeding. Mating reaches a peak in January and February, when heavy rains have filled breeding ponds (NatureServe 2015). During the breeding season, males apparently remain in ponds twice as long (1 to 5 weeks) as females, and may successfully breed with more than one female each season. At breeding sites, sex ratios of one to two males per female are common, but 0.6 male per female is more typical farther from breeding ponds (USFWS 1999). Each breeding female lays about 300 eggs per year on submerged stalks of spike rush (Eleocharis sp.) or similar aquatic plants about 2 to 3 cm (1 in.) apart (NatureServe 2015; USFWS 1999). Females can produce approximately 2,400 to 2,700 eggs during their lifetime (NatureServe 2015; USFWS 1999).Eggs hatch into larvae about 1 week, and there is no parental care of eggs or larvae. Larvae remain in the breeding ponds and metamorphose in 90 to 140 days (early May to mid-August), depending on temperature (NatureServe 2015; USFWS 1999). Once metamorphosis occurs, juvenile Santa Cruz long-toed salamanders leave the pond and seek upland habitat. Juveniles reach reproductive maturity in 3 to 4 years, before which they remain in upland habitat and do not return to breeding ponds (NatureServe 2015). It is thought that Santa Cruz long-toed salamanders may live up to 12 years or more (USFWS 1999).

Habitat Type

Juvenile: Shrubland/chaparral, woodland, ephemeral pool, riparian, wetland.

Adult: Shrubland/chaparral, woodland, ephemeral pool, riparian, wetland.

Habitat Vegetation or Surface Water Classification

Juvenile: Freshwater ephemeral ponds, woodland, riparian.

Adult: Freshwater ephemeral ponds, woodland, riparian.

Dependencies on Specific Environmental Elements

Juvenile: Shade and abundant soil humus are critical (NatureServe 2015).

Adult: Shade and abundant soil humus are critical. Adults spend most of the time underground in small mammal burrows; under leaf litter, rotten logs, and fallen branches; and among the root system of trees (NatureServe 2015).

Geographic or Habitat Restraints or Barriers

Juvenile: Larvae are restricted to pond environments. Roads, highways, buildings, walls, and fences may form complete barriers to dispersing juveniles (USFWS 1999).

Adult: Roads, highways, buildings, walls, and fences may form complete barriers to dispersing adults (USFWS 1999).

Spatial Arrangements of the Population

Juvenile: Random

Adult: Random

Environmental Specificity

Juvenile: Narrow; specialist or community with key requirements common (NatureServe 2015).

Adult: Narrow; specialist or community with key requirements common (NatureServe 2015).

Tolerance Ranges/Thresholds

Juvenile: Moderate

Adult: Moderate

Site Fidelity

Juvenile: High

Adult: High

Habitat Narrative

Juvenile: See Adult narrative.

Adult: Adult Santa Cruz long-toed salamanders inhabit freshwater ephemeral ponds and wetlands during the breeding season, and lay eggs in the breeding ponds. Larvae are restricted to pond environments until they metamorphose into juveniles. During the nonbreeding season, juveniles and nonbreeding adults disperse to adjacent upland mesic coastal scrub and woodland areas of coast live oak (Quercus agrifolia) or Monterey pine (Pinus radiata); and riparian vegetation, such as arroyo willows (Salix lasiolepis) (USFWS 2009). During the nonbreeding season, shade and abundant soil humus are critical to Santa Cruz long-toed salamanders retaining moisture (NatureServe 2015). Adults and juveniles spend most of their time underground in small mammal burrows; under leaf litter, rotten logs, and fallen branches; and among the root systems of trees (NatureServe 2015). Manmade structures like roads, highways, buildings, walls, and fences may form complete dispersal barriers to juveniles and adults migrating between pond and upland habitats (USFWS 1999). Urbanization, road construction, and agriculture have also led to habitat loss and degradation for the Santa Cruz long-toed salamander (USFWS 1999).

Dispersal/Migration

Motility/Mobility

Juvenile: Moderate

Adult: Moderate

Dispersal

Juvenile: Eggs and larvae do not disperse. Juveniles disperse approximately 30 to 60 meters (m) (100 to 200 feet [ft.]) during the initial migration phase. During their second rainy season, they disperse farther away from the pond (USFWS 1999).

Adult: Moderate; up to 1.6 kilometers (km) (1.0 mile [mi.]) (USFWS 1999).

Dependency on Other Individuals or Species for Dispersal

Juvenile: No

Adult: No

Dispersal/Migration Narrative

Juvenile: See Adult narrative.

Adult: Adult Santa Cruz long-toed salamanders migrate from upland habitats to breeding ponds on misty, rainy, or foggy nights in September and October; breed in ponds during January and February; and return to upland habitat in March (NatureServe 2015). It is estimated that between 26 and 36 percent of adult Santa Cruz long-toed salamanders travel at least 335 m (1,100 ft.) to reach suitable upland habitat; the maximum recorded dispersal distance was 1.6 km (1 mi.) (USFWS 1999, USFWS 2009). Mark-recapture studies suggest that adult Santa Cruz long-toed salamanders return to the uplands from which they migrated previously in the breeding season (USFWS 2009). Metamorphs disperse approximately 30 to 60 m (100 to 200 ft.) to upland habitats during the onset of winter rains. During their second rainy season, they disperse farther away from the pond and do not return to the breeding ponds until 2 to 3 years later, when they have reached reproductive maturity (USFWS 2009).

Additional Life History Information

Juvenile: During the onset of winter rains, metamorphs disperse away from ponds and do not return until they reach reproductive maturity at 2 to 3 years (USFWS 2009).

Population Information and Trends

Population Trends:

One population is stable; the status of all other populations is unknown (NatureServe 2015).

Species Trends:

Relatively unknown; the species and overall population could be in decline or relatively stable (NatureServe 2015).

Population Growth Rate:

Unknown

Number of Populations:

Six metapopulations (four in Santa Cruz County, two in Monterey County) (USFWS 2009).

Population Size:

Valencia-Seascape Metapopulation: The population at this site was estimated at 734 adults in 2007 and 2008. Freedom Metapopulation: A baseline population of 984 adults was detected in 2002; however, the status of the majority of (three of the five) ponds is unknown, because they were not under active management by California Department of Fish and Wildlife in 2009. McClusky Metapopulation: An adult population of 97 was estimated in 2003; results could suggest that the population here is not increasing, does not have a stable age distribution, and may not be self-sustaining. No estimates are available for the Ellicott-Buena Vista, Larkin Valley, and Elkhorn metapopulations (USFWS 2009).

Resistance to Disease:

Low

Population Narrative:

There are six known metapopulations in Santa Cruz and Monterey counties: the Valencia-Seascape, Ellicot-Buena Vista, Freedom, Larkin Valley, McClusky, and Elkhorn metapopulations (USFWS 2009). The Valencia-Seascape metapopulation was estimated to contain 734 adults in 2007 and 2008, and is thought to be the only stable metapopulation (USFWS 2009). The Freedom metapopulation was estimated to contain 984 adults in 2002; however, the status of three of the five ponds is unknown, because they were not actively managed by California Department of Fish and Wildlife (USFWS 2009). The McClusky metapopulation was estimated to contain 97 adults in 2003, and surveys suggest that the population is not increasing, does not have a stable age distribution, and may not be self-sustaining (USFWS 2009). No population estimates are available for the Ellicott-Buena Vista, Larkin Valley, and Elkhorn metapopulations (USFWS 2009). As a whole, the subspecies is thought to be relatively stable, although there are numerous threats to the subspecies and the restricted range and small number of populations leaves the subspecies vulnerable to inbreeding depression and extirpation due to stochastic events (USFWS 2009).

Threats and Stressors

Stressor: Agriculture, road construction, urbanization.
Exposure: Agriculture, road construction, urbanization.
Response: Habitat degradation, fragmentation, and loss of aquatic and upland habitats.
Consequence: Declining populations of Santa Cruz long-toed salamander.
Narrative: The primary factors that continue to endanger populations of the Santa Cruz long-toed salamander throughout its range include degradation, fragmentation, and loss of aquatic and upland habitats through agriculture, road construction, and urbanization. Roads, highways, buildings, walls, and fences may form complete barriers to dispersing Santa Cruz long-toed salamanders. Additionally, vehicular traffic frequently kills Santa Cruz long-toed salamanders attempting to cross roads and highways. Together, these factors result in genetically isolated subpopulations and mortality of Santa Cruz long-toed salamanders. The loss of upland habitat

through urbanization reduces or eliminates terrestrial retreats such as viable root systems and small mammal burrows that are necessary for the subspecies during the nonbreeding season (USFWS 2009).

Stressor: Invasive nonnative plants.
Exposure: Invasive nonnative plants.
Response: Reduction in area available for native vegetation.
Consequence: Reduction in availability of root systems that are preferred by Santa Cruz long-toed salamander.
Narrative: Invasive nonnative plants such as eucalyptus trees (Eucalyptus sp.), jubata grass (Cortaderia jubata), and Pampas grass (C. selloana) reduce the area available for native vegetation, thereby reducing the availability of root systems that are preferred by the species. Additionally, the presence of nonnative invasive plants may reduce the numbers of invertebrates available as prey for Santa Cruz long-toed salamanders (USFWS 2009).

Stressor: Drought
Exposure: Drought
Response: Reduction in water in ephemeral ponds.
Consequence: Reduction in breeding habitat for Santa Cruz long-toed salamander.
Narrative: Droughts could affect aquatic habitat of Santa Cruz long-toed salamanders by reducing the availability of water in ephemeral ponds; in drought years, rainfall is sometimes insufficient to allow normal breeding and larval development to occur. However, droughts could benefit Santa Cruz long-toed salamanders in some situations by reducing the numbers of nonnative fish and bullfrogs (Rana catesbeiana) in aquatic habitats. Drought could affect upland habitat for the species by causing mortality of some coast live oaks (Quercus agrifolia) (USFWS 2009).

Stressor: Predation
Exposure: Presence of introduced species.
Response: Increased rates of predation.
Consequence: Declining populations of Santa Cruz long-toed salamander.
Narrative: Santa Cruz long-toed salamanders are vulnerable to several predators. Eggs and larvae may be preyed on by mosquitofish (Gambusia spp.) and crayfish. Larvae are also eaten by adult Santa Cruz long-toed salamanders, California tiger salamanders (Ambystoma californiense), predacious aquatic insects, and birds. Larvae and metamorphs are likely preyed on by herons (Ardea herodias, Butorides striatus, Egretta spp.), grebes (Podilymbus podiceps, Podiceps spp.), and kingfishers (Ceryle alcyon). Mammalian predators of Santa Cruz long-toed salamanders include introduced opossums (Didelphis virginiana), striped skunks (Mephitis mephitis), and raccoons (Procyon lotor). Metamorphs and adults are also prey to California tiger salamanders and garter snakes (Thamnophis sp.) (USFWS 2009).

Stressor: Chytrid fungus.
Exposure: Presence of chytrid fungus.
Response: Infection of Santa Cruz long-toed salamanders.
Consequence: Declining populations of Santa Cruz long-toed salamander.

Narrative: Chytrid fungus has been confirmed in Santa Cruz long-toed salamanders in both Santa Cruz and Monterey counties. Research on the effects of chytrid on the Santa Cruz long-toed salamander is needed to gain further insights on its potential impacts (USFWS 2009).

Stressor: Climate change.
Exposure: Warmer air temperatures, more intense precipitation events, and increased summer continental drying resulting from climate change.
Response: Potential for declining habitat quality for Santa Cruz long-toed salamander.
Consequence: Potential to adversely impact populations of Santa Cruz long-toed salamander.
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. Predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. Although climate change is an important issue with potential effects to Santa Cruz long-toed salamander, there is not enough information to make accurate predictions regarding its effects on this subspecies (USFWS 2009).

Stressor: Chemical contamination and sedimentation of water.
Exposure: Chemical contamination and sedimentation introduced to water supply.
Response: Breeding habitat degradation.
Consequence: Declining populations of Santa Cruz long-toed salamander.
Narrative: Degraded water quality through chemical contamination (e.g., pesticides, herbicides, or petroleum products) and sedimentation via runoff reduces the growth and survival of larval amphibians. Methoprene, an insect growth regulator and larvicide, has been used at Valencia Lagoon and other ponds to control mosquito populations. It is not known how methoprene affects Santa Cruz long-toed salamanders, but possible effects could include increased larval mortality, increased rates of malformations, and delayed metamorphosis. The survival of many amphibians relies on an abundance of invertebrates, and any delay in insect growth could reduce the numbers and density of prey available to Santa Cruz long-toed salamanders (USFWS 2009).

Recovery

Reclassification Criteria:

The Santa Cruz long-toed salamander will be considered for reclassification from endangered to threatened status when the following four complexes are protected and managed in such a way that habitat is conserved, maintained, and/or restored: Valencia-Seascape, Larkins Valley, Ellicott-Buena Vista, and McClusky Slough (USFWS 1999).

Each complex must contain at least two functional breeding ponds or sites, as well as sufficient upland habitat to support self-sustaining populations (USFWS 1999).

A self-sustaining subpopulation is defined as one exhibiting an average adult sex ratio of 1:1, and either a stable age distribution or evidence of a population increasing in size. Evidence of continued breeding success, metamorphosis, and recruitment of adults must be documented over a 20-year period (USFWS 1999).

Each secured population must be self-maintaining—that is, not requiring any direct human assistance to reproduce successfully, and maintain a stable or growing population during years of average or above-average precipitation (USFWS 1999).

All protected areas must provide sufficient acreage and habitat diversity to ensure that each subpopulation is capable of self-maintenance, even after adverse environmental conditions such as drought, heavy rains, or catastrophic fires. Upland scrub or woodland habitats must be adjacent to the breeding ponds or within migration distance; protected corridors for migration to nonbreeding habitat must be established and maintained where necessary; and protected corridors for dispersal to other ponds in the complex must be established and maintained (USFWS 1999).

Delisting Criteria:
The Santa Cruz long-toed salamander will be considered for delisting when the reclassification criteria are met, with the added stipulation that there shall be at least three functional breeding ponds or sites in each complex (more in some complexes); and at least two additional self-sustaining populations and their associated habitats protected, with at least one in Monterey County.

The additional subpopulations should be at least 2 km (1.2 mi.) from currently protected sites, or otherwise be separated by barriers to migration between subpopulations (USFWS 1999).

Recovery Actions:
- Perpetuate self-sustaining populations of Santa Cruz long-toed salamanders by ensuring that existing ponds remain, or become, functional breeding sites; securing and managing upland habitats to provide hydrologic integrity to the ponds and adequate cover and food for nonbreeding salamanders; establishing additional ponds or restoring existing ponds in each complex; reducing human-related mortality; and determining and monitoring population status.
- Conduct surveys and identify habitat for protection, including surveying areas in Santa Cruz County (Valencia-Seascape complex, Larkins Valley/Calabasas Road area, the area north of the Ellicott site and Buena Vista Pond, and the Merk Road drainage and Pleasant Valley) and in Monterey County (the inner dune face from the Pajaro River to the Salinas River, upper Moro Cojo Slough drainages, the area along Elkhorn Road, and the upper reaches of Elkhorn Slough) (USFWS 1999).
- Assess distribution and population status in the Merk Road (Santa Cruz County) and upper Moro Cojo (Monterey County) areas, and implement appropriate management by locating breeding sites and assessing threats for the Merk Road and Moro Cojo Slough salamander populations; determining relative numbers of adults at breeding sites and assessing threats; monitoring egg and larval survival at breeding sites; determining the location and extent of upland habitat used by Santa Cruz long-toed salamanders in the Merk Road drainage and in upper Moro Cojo Slough; and instituting management actions as necessary to protect any new site (USFWS 1999).

- Conduct research applicable to the management of the Santa Cruz long-toed salamander and its habitats (USFWS 1999).
- Conduct public education and information programs by continuing to provide information to all interested parties; continuing the program for controlled public access to the Ellicott site; installing postings and informational signs around protected areas to educate the public; and continuing the interpretive program at the Ellicott site and expanding to other sites as feasible (USFWS 1999).
- Valencia-Seascape Complex: The residual California Department of Transportation property at Valencia Lagoon was transferred to the Department of the Interior (Department) in 1979, and the Department purchased six additional lots on the hillside above Valencia Lagoon in 1981 and 1982. Since then, the Department has purchased more undeveloped lots and conservation easements on the hillside, and in 1982 the County of Santa Cruz formed a Santa Cruz long-toed salamander Protection District, with strict zoning regulations to protect the remaining privately owned upland salamander habitat. Fencing of the Valencia Lagoon core area and initial efforts to restore the breeding pond were completed in 1978.
- Larkins Valley Complex: The entire Larkins Valley area has been designated as a Salamander Protection Zone by Santa Cruz County. Continued monitoring by California Department of Fish and Wildlife personnel resulted in efforts to check erosion of the dam, which has enabled successful reproduction to occur at the Calabasas Pond in Larkins Valley. Concerted efforts by the Department, the Trust for Public Lands, and the U.S. Fish and Wildlife Service have resulted in the acquisition of approximately 12 hectares (ha) (30 acres) in Larkins Valley, including the Calabasas Pond and surrounding upland habitat.
- Ellicott-Buena Vista Complex: Due to threats from development and other incompatible land uses, the Service and the Wildlife Conservation Board purchased the 12-ha (30-ac.) pond site and adjacent parcels. The purchase secured the entire pond area and most of the surrounding habitat. Past management actions at the Ellicott site focused on controlling vehicular trespass and erosion, and removing pampas grass (Cortaderia selloana) and eucalyptus trees (Eucalyptus sp.).
- McClusky Slough Complex: 17 ha (41 ac.) adjacent to Zmudowski State Beach were acquired by the California Department of Fish and Game. Portions of McClusky Slough that are privately owned have been primarily managed to provide waterfowl habitat and hunting opportunities, although efforts are being made to develop management plans that include the Santa Cruz long-toed salamander.
- Moro Cojo Slough: The slough and its drainage basin are included in the Natural Resources Conservation Service Elkhorn Slough Watershed Management Plan and the Moro Cojo Slough Watershed Rehabilitation and Management Plan. Some land has been transferred to The Nature Conservancy, and will be managed by the Elkhorn Slough Foundation; possibilities of further land acquisitions are being investigated.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: • Locate and conserve (through acquisition, conservation easements, or other mechanisms) suitable upland and breeding habitat for the species • Enhance existing and potential breeding ponds, as necessary, through the removal of excess sedimentation, the removal of exotic plants and animals, the deepening or lining of ponds, the planting of native vegetation, or other actions deemed necessary by the Service • Maintain and/or restore upland habitat in proximity to all current breeding sites and translocation sites • Create new breeding ponds and restore upland and dispersal habitats for the species • Investigate and implement a population augmentation program, including controlled crossing experiments, strategic translocations to suitable breeding habitats, genetic analyses, and captive propagation • Trap out individuals at McClusky pond to conserve genetic uniqueness in the face of extirpation • Increase population survey efforts to better understand population dynamics • Coordinate with mosquito abatement districts to reduce application of pesticides and herbicides in areas that contain Santa Cmz long-toed salamanders. Landowners and land managers should accompany mosquito abatement district staff during monitoring and treatment activities. Coordination should involve dissemination of information regarding monitoring and treatment dates and pesticide (adulticide/larvacide) application (amounts and areal extent). • Investigate and implement potential road crossings or under-road tunnel locations to reduce impacts from vehicle strike and to assist in metapopulation connectivity (USFWS, 2019)

Additional Threshold Information:

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See Adult narrative.

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SPECIES ACCOUNT: *Ambystoma tigrinum stebbinsi (= A. mavortium)* (Sonora tiger Salamander (AKA A. mavortium))

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/6/1997

Physical Description

Metamorphosed terrestrial Sonora tiger salamanders have a color pattern ranging from "a reticulate pattern with an irregular network of light coloration, often coupled with light spots, on a dark background color", to a pattern of large, well-defined light or yellow spots or transverse bars, some of which encroach on the dark venter (Jones et al. 1988). Metamorphosed Sonora tiger salamanders measure from about 45 to 150 mm snout to vent length (SVL). Branchiate adults are gray to olive on the dorsum, head, and tail, and off-white to yellow on the ventral side. They have three external gills on each side of their head, and measure between 65 and 165 mm SVL. Male and female adult salamanders can be distinguished by the presence of two black folds of tissue (cloacal folds) on the caudal side of a male's vent. Larvae are gray on the dorsum, head, and tail, with little pigment on the ventral surface. They have external gills and hatch without legs, but grow hind and fore-limbs early in development (from USFWS 2002).

Taxonomy

The Sonora tiger salamander, A. t. stebbinsi, was described by Lowe (1954), who, along with Reed (1951), found the subspecies in ponds in the San Rafael Valley (SRV) where most known Sonora tiger salamander populations exist. The SRV lies between the Huachuca and Patagonia mountains, is bordered by the Canelo Hills to the north, and extends from Santa Cruz County in Arizona south for approximately 30 km into Sonora, Mexico.

Historical Range

U.S.: Cochise and Santa Cruz counties, Arizona. Mexico: Sonora.

Current Range

U.S.: Cochise and Santa Cruz counties, Arizona. Mexico: Sonora.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food Source

<u>Larvae:</u> Zooplankton (daphnids, copepods, bosminids, ostracods, etc.), but incorporate larger aquatic macroinvertebrates (chironomids, trichopterans, molluscs, zygopterans, etc.) into their diet as they grow.

Adult: Zooplankton and a variety of macroinvertebrates, and salamander eggs and larvae during the breeding season

Food/Nutrient Narrative

Larvae: Small tiger salamander larvae feed primarily on zooplankton (daphnids, copepods, bosminids, ostracods, etc.), but incorporate larger aquatic macroinvertebrates (chironomids, trichopterans, molluscs, zygopterans, etc.) into their diet as they grow (Collins and Holomuzki 1984). Sources of mortality for tiger salamander larvae include pond drying, disease (Jancovich et al. 1997), and predation by wading birds, introduced fish and bullfrogs (Snyder 1998), aquatic insects (Holomuzki 1986), and adult salamanders (Holomuzki 1986). Crayfish may prey upon larval salamanders, as well.

Adult: Branchiate adult tiger salamanders prey on zooplankton and a variety of macroinvertebrates, and eat salamander eggs and larvae during the breeding season (Holomuzki 1986). Although branchiate adult Sonora tiger salamanders probably eat salamander eggs and larvae, they seldom develop into the cannibalistic morph.

Reproductive Strategy

Adult: R-selected

Lifespan

Adult: up to 8 years

Breeding Season

Larvae: n/a

Adult: early January through early May

Reproduction Narrative

Larvae: Following hatching, Sonora tiger salamander larvae can develop to the minimum size necessary to metamorphose in as little as two months. However, because many SRV sites with salamanders hold water all year, larvae often remain in the water longer before metamorphosing, or develop into branchiate adults instead of metamorphosing. Sources of mortality for tiger salamander larvae include pond drying, disease (Jancovich et al. 1997), and predation by wading birds, introduced fish and bullfrogs (Snyder 1998), aquatic insects (Holomuzki 1986), and adult salamanders (Holomuzki 1986). Crayfish may prey upon larval salamanders, as well.

Adult: Salamander larvae in permanent water often develop into branchiate adults that stay in the pond throughout their lives. Branchiate adults can sometimes metamorphose into the terrestrial form in response to stressful events such as pond drying, but branchiates are often unable to complete metamorphosis or even die during the process (Roth, pers. comm.). Sources of mortality for branchiate adults include pond drying, disease (Jancovich et al. 1997), and predation by wading birds and larger introduced fish species (Snyder 1998). The lifespan of branchiate adult Sonora tiger salamanders in the field is not known, but Arizona tiger salamanders have survived as branchiates for up to 8 years in captivity (Roth, pers. comm.). The reason that branchiates have not been kept longer is that they eventually metamorphose, even after years as branchiates.

Habitat Type

Larvae: Freshwater pond

Adult: Freshwater pond

Habitat Vegetation or Surface Water Classification

Adult: Permanent pond water may support branchiate adults throught their lives.

Dispersal/Migration

Motility/Mobility

Larvae: Unknown

Adult: Low

Dispersal

Adult: Dispersal distance - The Recovery Plan indicated that the longest movement of a terrestrial Sonoran tiger salamander was between 1.5 and 2 km. This was based on a marked salamander found in two different aquatic sites. A study is currently underway to look at movement of adult Sonoran tiger salamanders away from breeding ponds. To date, 10 terrestrial adults have been documented moving an average straight-line distance of 372.80 m (SD 245.87 m) and a maximum of just under 1 km from the aquatic site from which they were captured (C. Broska, pers. comm, 2019) (USFWS, 2019).

Population Information and Trends

Population Trends:

Population trends and interactions - Completion of a 10-year (2004–2013) monitoring program coordinated by the Arizona Game and Fish Department generated data sufficient to estimate (1) trends in breeding site occupancy by the Sonoran tiger salamander, (2) trends in occupancy of introduced predators, and (3) probability of co-occurrence between Sonoran tiger salamanders and invasive predators (Hossack et al. 2017). Hossack et al. (2017) found that occupancy of Sonoran tiger salamanders increased, annually, by 2.2% over the 10-year monitoring period even though drought persisted during the monitoring period and invasive predators were commonly present at sites occupied by Sonoran tiger salamanders. Of the 159 aquatic sites included in the study, 16% of sites were dry every time they were sampled, and an additional 33% of sites were dry at least once during the study. Across all years, distance to the nearest sampled pond averaged 1.02 km and the average distance to all other surveyed ponds was 12.4 km.

Salamander occupancy of wet ponds averaged 59.2% annually. Presence of invasive predators (fish or American bullfrogs) in a given pond reduced probability of salamander presence by 23%. Predatory fish were detected at five sites surveyed and had no salamanders. American bullfrogs, a predator and competitor of the salamander, were detected during 55% of all surveys when water was present. American bullfrogs were found to co-occur with salamanders at 25 of 69 sites at least once during the study (USFWS files). Of the 25 sites that had surveys with both salamanders and American bullfrogs present, 92% of the sites also had only American bullfrogs present at some point during the study. American bullfrogs were detected at an additional 15 sites that were never occupied by salamanders during the study. Occupancy of salamanders and invasive predators both declined dramatically following the 5th consecutive year of drought. However, salamander occupancy recovered quickly after return to non-drought conditions, while occupancy of invasive predators remained suppressed (USFWS, 2019).

Species Trends:

Lack of adequate data prevent a robust assessment of long-term trend of the species, but likely the range extent and area of occupancy have been relatively stable (a decline of <30% to an increase of 25%) (NatureServer 2015).

Number of Populations:

21 to 81

Population Size:

2500 to 100,000

Population Narrative:

Distribution - From 2004 through 2013, Sonoran tiger salamanders were found in 69 of 159 aquatic sites sampled in southern Arizona. This represented an increase in number of sites occupied by the subspecies and primarily resulted from obtaining access to survey private lands beginning in 2009. In total, partners have been able to sample aquatic sites across 90% of the known range of the subspecies with 82% of all salamander detections occurring in aquatic sites on lands managed by the U.S. Forest service, 17% on private lands, and 1% on state park lands. Surveys of several stock ponds in northern Sonora, Mexico, during the 1980s, did not produce any salamander detections (Jones et al. 1988). In 2009, salamanders presumed to be Sonoran tiger salamanders were found and photo-documented at two stock ponds in the San Rafael Valley in Sonora (Rorabaugh et al. 2013). One of these sites is 0.85 km from the nearest known Sonoran tiger salamander population in the U.S., which is within the known dispersal distance of the subspecies. Additional surveys during 2015–2018 revealed tiger salamander presence in 40 stock ponds south of the Arizona border in northern Sonora, Mexico, including the two sites where tiger salamanders were found in 2009 (B. Hossack, pers. comm., 2019; Hossack et al. 2016). It is yet unconfirmed that tiger salamanders at any of the sites in Sonora are the Sonoran tiger salamander subspecies, as identification must be verified by further genetic analysis of tissue and eDNA samples. We are in the process of obtaining funding to complete this research (USFWS, 2019).

Threats and Stressors

Stressor: Lost and altered habitat
Exposure:
Response:
Consequence:
Narrative: The historical habitats of the salamander have been largely lost or dramatically altered, and currently the species breeds almost exclusively in cattle ponds that are small, often very dynamic, and require maintenance to ensure habitat persistence.

Stressor: Fragmentation and isolation of small populations
Exposure:
Response:
Consequence:
Narrative: Habitat fragmentation and the isolation of small populations increase the chances of extirpation or extinction from natural events such as catastrophic storms or drought.

Stressor: Collection
Exposure:
Response:
Consequence:
Narrative: Bait collectors and anglers may illegally capture salamanders and transport them to other areas. Such activities could adversely affect small populations.

Stressor: Introduced predators
Exposure:
Response:
Consequence:
Narrative: Introduced predaceous fish, bullfrogs, and crayfish threaten to eliminate the Sonora tiger salamander from portions of its range. The disease ATV causes dramatic die-offs of salamanders in breeding ponds. The disease can be spread by researchers or others working at cattle ponds in the SRV, or by anglers. A single effort to control American bullfrogs within the range of the Sonoran tiger salamander took place near the end and after completion of the 10-year monitoring program. From 2010-2012, and in 2015, the Coronado National Forest (CNF) surveyed, monitored, and eliminated American bullfrogs within a six-mile radius of Peterson Ranch Pond in Scotia Canyon. Thirty-six lentic and seven lotic sites were surveyed and al life stages of bullfrogs were removed from 24 lentic sites. American bullfrogs were not detected in 19 sites including all of the lotic sites. Fourteen sites had 10 or fewer bullfrogs removed, and the remaining 10 sites accounted for 98% of the total bullfrogs removed. In 2016 and 2017, the CNF conducted a related effort to determine the current status of American bullfrogs within approximately two-thirds of the known range of the Sonoran tiger salamander. Of 163 aquatic sites surveyed, 32% were dry. Of the wetted sites, American bullfrogs were detected in 35% of the sites, and 32% of sites showed signs of likely American bullfrog breeding (Hall 2018). Six of the 24

sites where American bullfrogs had been removed within 6 miles of Scotia Canyon were re-occupied by bullfrogs, but at much lower levels (Hall 2018) (USFWS, 2019).

Stressor: Hybridization
Exposure:
Response:
Consequence:
Narrative: The barred salamander has been introduced to portions of the SRV and may hybridize with the Sonora tiger salamander. Barred salamanders are most likely introduced by anglers using them as bait or by bait collectors who wish to create a source for future collection.

Stressor: Climate change
Exposure:
Response:
Consequence:
Narrative: Small and isolated populations are vulnerable to extirpation or extinction from natural events such as catastrophic storms or drought.

Stressor: Pathogens
Exposure:
Response:
Consequence:
Narrative: Pathogens - During the 10-year monitoring program, dead salamanders were reported in <1% of sampling events. Dead salamanders found were presumed to indicate evidence of disease outbreaks including that cause by the Ambystoma tigrinum virus (ATV). No disease testing was conducted on any dead salamanders found. Outbreaks of ATV can wipe out an entire population very quickly, so it is possible that sites where salamanders disappeared during some years could have experienced disease outbreaks. Also of note, a new pathogenic chytrid fungus, Batrachochytrium salamandrivorans (Bsal), was described in 2013 after observations of unusual mortality among fire salamanders (Salamandra salamandra) in Europe (Spitzen-van der Sluijs et al. 2013; Martel et al. 2013). Bsal has not yet been detected in the U.S. Susceptibility to Bsal varies among salamander species, but is not known to be lethal to the Ambystomidae family that includes the Sonoran tiger salamander (Martel et al. 2014). The USGS is currently testing tiger salamanders found along the US Mexico border for Bsal (E. Muths, pers. comm 2018) (USFWS, 2019).

Recovery

Reclassification Criteria:
1. When approximately 90 percent of salamander’s currently occupied range (lands managed by Coronado National Forest, Arizona State Parks Board, Fort Huachuca, and cooperating private landowners) and approximately 90 percent of current breeding ponds are protected in accordance with recovery actions 1.1 through 1.5 (see USFWS 2002), are free from introduced

fish and crayfish, and are monitored to detect new threats, including introductions of predators and non-native salamanders.

2. When scientifically credible monitoring data resulting from monitoring protocols identified in recovery action 5.1, collected over a consecutive 5-year period, and reviewed by the Participation Team, indicate that the number of Sonora tiger salamander populations is not in decline and that there are no new factors that threaten the persistence of the Sonora tiger salamander metapopulation.

Justification: Criterion two is identical to the original delisting criterion #2 in the 2002 Recovery Plan. Non-native predatory fish are known to completely decimate salamander populations, but have not persisted in aquatic sites occupied by the salamander as they did prior to ongoing drought conditions. Likewise, American bullfrogs have not completely replaced salamanders from aquatic sites, although they have likely increased in presence throughout the range of the salamander since the 1990s. The effects of non-native aquatic species have likely been mitigated by sites drying periodically due the long term drought, and drying of sites is included as a potential tool in the Recovery Plan for managing non-native predators. Effects of disease and introgression remain largely unknown. Because the Sonoran tiger salamander has a very limited distribution, it is important that habitat is protected and threats are addressed across the majority of its range. Criterion 2 is derived from downlisting criteria that require monitoring of the subspecies and its habitat as well as address threats of aquatic habitat destruction, predation by nonnatives, control of introduced salamanders, and die-offs from disease across approximately 90 percent of salamander's currently-occupied range. The delisting criteria expand upon the downlisting criteria to continue to address these threats across the entire range of the subspecies (USFWS, 2019).

Delisting Criteria:
1. Maintain populations at a level that demonstrates at least 60% annual occupancy in at least 80% of all 159 currently known available aquatic breeding sites averaged over each 10-year period for 30 years. All potential aquatic sites that can support Sonoran tiger salamanders shall be spatially distributed throughout the range of the subspecies to maintain a 1 km overall average distance from each site to the next nearest site, and a 12 km overall average distance from each site to all other sites. Justification: Trend data shows that Sonoran tiger salamander occupancy of known sites has increased annually over a 10-year period despite documented ongoing effects of two of the main threats identified in the original Recovery Plan: predation by and competition with non-native aquatic species and drying of aquatic habitat caused by ongoing long term drought. Long term trends in occupancy in all known aquatic salamander habitats, based on annual surveys using standardized protocols, are a measurable metric to gauge success of recovery of the subspecies. The salamander demonstrated increased occupancy over a ten-year period when very few actions took place to address known threats to the subspecies. Therefore, it is reasonable to expect the current occupancy level to be maintained over the long term and to improve if threats are addressed. Over the past 10 years, salamanders exhibited an average occupancy level of 60% across the known range (Hossack et al. 2017), which suggests this could indicate a stable population level despite environmental

fluctuations. This 60% annual occupancy is therefore used in the criterion to describe the minimal level of occupancy across 80% of breeding sites to attain delisting, above. Maintaining or increasing occupancy in at least 80% of all known aquatic sites that can support Sonoran tiger salamanders will reduce the effects of disease, predation, and potential increase of drought. It is reasonable to expect that an average 20% of aquatic sites will continue to be dry during the breeding season each year throughout the range of the salamander. Although effects of disease remain unknown, maintaining occupancy at a majority of sites may decrease the effects of disease outbreaks on the subspecies as a whole. Having aquatic sites distributed throughout the landscape allows for wetted sites to persist even when some sites dry each year. Maintaining connectivity between aquatic sites would increase the likelihood that these habitats would be recolonized if salamanders were extirpated due to disease, predation, or drying. The 1 km and 12 km distances are derived from recent research on dispersal and current distribution of aquatic sites that could potentially support breeding of the salamander, as discussed above, to allow for adequate connectivity among potential breeding sites. If newly found tiger salamander populations in Sonora, Mexico, are determined to be Sonoran tiger salamanders, it will also improve our understanding of the status of the subspecies (USFWS, 2019).

2. Regulatory mechanisms and land management commitments that provide for adequate long term protection of the Sonora tiger salamander and its habitat, such as those priority tasks described in the step-down narrative in the Recovery Plan, have been implemented. These commitments and mechanisms should address management of non-native predators in perpetuity, disease transmission, introduction and collection of salamanders, interbreeding with non-native salamanders, public education, and other issues as described in the step-down narrative or identified in subsequent revisions of this plan (USFWS, 2019).

Justification: Criterion two is identical to the original delisting criterion #2 in the 2002 Recovery Plan. Non-native predatory fish are known to completely decimate salamander populations, but have not persisted in aquatic sites occupied by the salamander as they did prior to ongoing drought conditions. Likewise, American bullfrogs have not completely replaced salamanders from aquatic sites, although they have likely increased in presence throughout the range of the salamander since the 1990s. The effects of non-native aquatic species have likely been mitigated by sites drying periodically due the long term drought, and drying of sites is included as a potential tool in the Recovery Plan for managing non-native predators. Effects of disease and introgression remain largely unknown. Because the Sonoran tiger salamander has a very limited distribution, it is important that habitat is protected and threats are addressed across the majority of its range. Criterion 2 is derived from downlisting criteria that require monitoring of the subspecies and its habitat as well as address threats of aquatic habitat destruction, predation by nonnatives, control of introduced salamanders, and die-offs from disease across approximately 90 percent of salamander's currently-occupied range. The delisting criteria expand upon the downlisting criteria to continue to address these threats across the entire range of the subspecies (USFWS, 2019).

Resiliency is met by maintaining or exceeding current occupancy of Sonoran tiger salamanders at sites throughout its historical range so that populations are able to withstand effects associated with disturbances such as variations in rainfall, nonnative species invasions, (environmental stochasticity), and random fluctuations in populations (demographic stochasticity). Any increase in occupancy above that needed to downlist the Sonoran tiger salamander will provide greater resiliency of the Sonoran tiger salamander subspecies (USFWS, 2019).

Redundancy is met by maintaining or increasing the number of sites occupied by the Sonoran tiger salamander established under the delisting criteria. Aquatic sites occupied by salamanders are spread throughout the range of the subspecies and the current spatial distribution will be maintained or improved (USFWS, 2019).

Representation is met by maintaining diversity within the populations of Sonoran tiger salamanders that occur within the historical range. We consider all salamander populations to be a single representative unit as threats to the subspecies currently act on all populations similarly throughout the range. A spatial distribution of populations located an average distance to the nearest population of 1km or less allows for increased genetic diversity across a range of environmental conditions. This allows Sonoran tiger salamander populations to adapt to changing conditions that enhances the viability of the subspecies (USFWS, 2019).

Recovery Actions:

- 1. Maintain and enhance habitat where salamanders have been found, and create new habitat, if deemed necessary. Protect and manage for healthy small mammal populations within 500 m of breeding sites to provide burrows (USFWS 2007).
- 2. Control non-native predators (fish, bullfrogs, and crayfish) by enforcing and enhancing existing policies prohibiting the introduction and pond to pond transport of these taxa and by removing populations of non-native fish, bullfrogs, and crayfish.
- 3. Control introduction, transport, and collection of tiger salamanders in the San Rafael Valley by enforcing existing policies prohibiting these acts and by removing populations of barred tiger salamanders.
- 4. Create and enforce policies to minimize frequency of die-offs.
- 5. Monitor salamander populations and their habitat on public and, if permitted, private land, to observe threats as they arise and fulfill research objectives.
- 6. Conduct research to acquire demographic and dispersal information and develop a population viability analysis, better understand salamander disease, conduct genetic analyses, investigate reports of low pH, and determine distribution of crayfish and methods of crayfish removal.
- 7. Develop public education and information programs.
- 8. Practice adaptive management.
- 1. Protect and enhance salamander habitat: (a) development, implementation, and enforcement of guidelines for watershed use and maintenance, cattle pond use and maintenance, and for cleaning and maintenance of stock ponds; (b) Enhance bank-line and aquatic vegetation at breeding ponds; (c) Build more ponds, if needed; (d) Develop self-sustaining cienega habitats that can support salamander populations.
- 2. Control non-native predators, such as fish, bullfrogs, and crayfish through removal and enforcement of regulations to prevent introduction to SRV ponds.

- 3. Control introduction, transport, and collection of tiger salamanders in SRV: (a) Enforce regulations preventing introduction, transport, and collection of tiger salamanders in SRV; (b) Remove non-native tiger salamander populations from SRV ponds.
- 4. Educate the public about the Sonora tiger salamander and other sensitive species in the SRV: (a) Post and maintain signage; (b) Prepare brochures and make available to the public.

References

USFWS 2002. Sonora tiger salamander (Ambystoma tigrinum stebbinsi) recovery plan. U.S. Fish and Wildlife Service, Phoenix, Arizona. iv + 67 p.

USFWS 2007. Sonora Tiger Salamander (Ambystoma tigrinum stebbinsi) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, Phoenix, AZ. October 4, 2007. 15 p.

USFWS 2007. Sonora Tiger Salamander (Ambystoma tigrinum stebbinsi) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, Phoenix, AZ. October 4, 2007. 15 p. USFWS. 2019. U.S. Fish and Wildlife Service. 2002. Sonora tiger salamander (Ambystoma tigrinum stebbinsi) recovery plan. U.S. Fish and Wildlife Service, Phoenix, Arizona. iv + 67 pp. Draft Amendment 1.

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USFWS. 2002. Sonora tiger salamander (Ambystoma tigrinum stebbinsi) recovery plan. U.S. Fish and Wildlife Service, Phoenix, Arizona. iv + 67 p.

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SPECIES ACCOUNT: *Anaxyrus californicus* (Arroyo (=arroyo southwestern) toad)

Species Taxonomic and Listing Information

Listing Status: Endangered; December 16, 1994 (59 FR 64859).

Physical Description

The arroyo toad is relatively small compared to other toads, with a snout-vent length of 5.1 to 7.6 centimeters (cm) (2 to 3 inches [in.]), and females are often larger than males. Its coloration ranges from light olive green or gray to light brown. It can be distinguished from other toads by the presence of nonpaired, symmetrical, dorsal (back) splotches, and the pale coloration of the anterior portion of the oval parotoid glands just behind the eyes. It has a prominent, white, “v-shaped” stripe that crosses the top of the head between the eyes. The belly is white or buff and often lacks dark blotches or spots. Unlike the western toad (Bufo boreas), arroyo toads normally lack a mid-dorsal stripe. Compared to other toads, arroyo toads generally hop high and fast rather than walk. Arroyo toad tadpoles are difficult to distinguish from those of the western toad until several weeks after hatching. At hatching, the tadpoles of each species are small and black, but arroyo toad tadpoles become tan and more fusiform in shape after several weeks, as opposed to the darker and more globose shape of western toad tadpoles. After metamorphosis, toadlets appear as miniature adults, although they do not have the large parotoid glands that are evident on adults (NatureServe 2015; USFWS 1999; USFWS 2009).

Taxonomy

At the time of listing, the arroyo toad was considered a subspecies of the southwestern toad (Bufo microscaphus). By the late 1990s, it had become increasingly clear that the arroyo toad was morphologically distinct from the other subspecies, Arizona toad (B. m. microscaphus). In 1998, the evolutionary relationships of the complex of toads assigned to the name B. microscaphus were reviewed by comparing allozyme frequencies between the three recognized subspecies: Arizona toad, Arroyo toad (B. m. californicus), and southwestern toad (B .m. mexicanus). It was found that each subspecies exhibited mutually exclusive evolutionary lineages, and determined that each should be treated as a full species. As a result of this research, the arroyo toad was reclassified as the full species Bufo californicus. In 2006, in an effort to move amphibian systematics toward a taxonomy more consistent with new information on evolutionary relationships, it was recommended to partition the genus Bufo into three genera, with the North American clade of Bufo renamed as the genus Anaxyrus. Recognition of the Anaxyrus taxon is consistent with the results of research on molecular phylogenetics of Nearctic toads (Bufo). Accordingly, the arroyo toad (Bufo californicus) has been renamed Anaxyrus californicus, and this revised nomenclature has been adopted by the Center for North American Herpetology, the American Museum of Natural History, the Society for the Study of Amphibians and Reptiles, the American Society of Ichthyologists and Herpetologists, and the Herpetologists’ League. Based on the interpretation of the best available information, U.S. Fish and Wildlife Service therefore recommended that the name used for the arroyo toad under the Endangered Species Act, be changed to Anaxyrus californicus (USFWS 2009).

Historical Range

The historical range of the arroyo toad extended south from the upper Salinas River system on Fort Hunter Liggett Military Reservation, Monterey County, to the Arroyo San Simeon system, about 16 kilometers (10 miles) southeast of San Quintin, Baja California. The range included the Santa Ynez, Santa Clara, and Los Angeles River basins; and the coastal drainages of Orange, Riverside, and San Diego Counties. Apparent gaps in distribution—such as those in San Luis Obispo County, California, and northwestern Baja California—may be due to misidentification of specimens or to inadequate surveys. Although the arroyo toad occurs principally along coastal drainages, it also has been recorded at several locations on the desert slopes of the Transverse and Peninsular Mountain ranges south of the Santa Clara River, Los Angeles County. The elevation range for the arroyo toad was historically recorded from near sea level to about 2,440 meters (8,000 feet) in Baja California (USFWS 1999).

Current Range

Known to central and southern California in the United States and Baja California, Mexico, arroyo toads have disappeared from approximately 75 percent of the species' historically occupied habitat in California. Arroyo toads now survive primarily in the headwaters of coastal streams as small, isolated populations. The arroyo toad has been extirpated in San Luis Obispo County and remaining populations persist in headwater areas of streams in Santa Barbara, Ventura, Orange, San Bernardino, Los Angeles, Riverside, and San Diego counties (USFWS 2009; 76 FR 7246).

Critical Habitat Designated

Yes; 2/9/2011.

Legal Description

On February 9, 2011, the U.S. Fish and Wildlife Service (Service) designated final revised critical habitat for the arroyo toad (Anaxyrus californicus, Bufo californicus). Approximately 98,366 acres (ac) (39,807 hectares (ha)) of habitat in Santa Barbara, Ventura, Los Angeles, San Bernardino, Riverside, Orange, and San Diego Counties, California, is designated as critical habitat for the arroyo toad. This final revised designation constitutes an increase of approximately 86,671 ac (35,074 ha) from the 2005 designation of critical habitat for the arroyo toad.

Critical Habitat Designation

Approximately 98,366 ac (39,807 ha) is designated as critical habitat for the arroyo toad within 21 units, identified as Units 2 through 22. The area identified as critical habitat Unit 1 (6,453 ac (2,612 ha)) was exempted in its entirety under section 4(a)(3) of the Act and, therefore, was not proposed.

Northern Recovery Unit: As described in the recovery plan (Service 1999, pp. 1–119), maintaining arroyo toad populations in the areas described by the following seven unit descriptions is necessary to conserve the species in the northern recovery unit. Because the toad populations in this recovery unit have been reduced in size and their habitat fragmented by road construction, dams, agriculture, and urbanization, it is important to protect all of them and safeguard against the loss of any one population due to random natural or human-caused events. The Forest Service is the primary landowner of revised critical habitat within the northern recovery unit.

Unit 1: San Antonio River: (6,453 ac (2,612 ha)) All lands in Unit 1 (approximately 6,453 ac (2,612 ha)) were exempted under section 4(a)(3)(B) of the Act in the October 2009 proposed revised designation for the arroyo toad (74 FR 52612; October 13, 2009) because they are subject to the 2007 Service-approved Integrated Natural Resources Management Plan (INRMP) for Fort Hunter Liggett. The INRMP provides a benefit to the arroyo toad, including monitoring arroyo toad population status, reducing public and military vehicle encroachment into arroyo toad habitats, reducing bullfrogs and other invasive species, and integrating species management and conservation with Fort Hunter Liggett training and maintenance activities.

Unit 2: Sisquoc River (3,775 ac (1,528 ha)) This unit is located in Santa Barbara County and encompasses approximately 33 miles (mi) (54 kilometers (km)) of the Sisquoc River and adjacent uplands from Sycamore Campground downstream to just below the confluence with La Brea Creek. Upper stretches of the river are within the Los Padres National Forest and mostly within the San Rafael Wilderness Area. Below the National Forest boundary, the river and adjacent uplands are on rural private lands. The unit consists of 1,700 ac (688 ha) of Federal land and 2,073 ac (839 ha) of private land. This long, undammed river is one of the few remaining major rivers in southern California with a natural flow regime, and supports a core population of arroyo toads that is important for maintaining the genetic diversity of the species. Unit 2 contains the physical and biological features that are essential to the conservation of the species, including breeding pools in lowgradient stream segments with sandy or fine gravel substrates (PCEs 1 and 2), seasonal flood flows (PCE 3), and relatively undisturbed riparian and upland habitat for foraging and dispersal (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from the removal and alteration of habitat due to sand and gravel mining, livestock overgrazing of riparian habitats, and limited recreational activities.

Unit 3: Upper Santa Ynez River Basin (3,032 ac (1,227 ha)) This unit is located in Santa Barbara County upstream of Gibraltar Reservoir and encompasses approximately 27 mi (43 km) of the upper Santa Ynez River, Indian Creek, Mono Creek, and adjacent uplands. The unit consists of 2,214 ac (896 ha) of Federal land and 818 ac (331 ha) of private land within the Los Padres National Forest, and supports a large and well-studied arroyo toad population that likely experiences precipitation and soil moisture conditions not faced by toads at drier sites (Sweet 1992, pp. 1–198; 1993, pp. 1–73). Potential adaptations to these conditions make this unit important for maintaining the genetic diversity of the species. Unit 3 contains the physical and biological features that are essential to the conservation of the species, including breeding pools in lowgradient stream segments with sandy or fine gravel substrates (PCEs 1 and 2), seasonal flood flows (PCE 3), and relatively undisturbed riparian and upland habitat for foraging and dispersal (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats, primarily along the lower Santa Ynez River and lower Mono Creek, from nonnative species, recreation, and problems associated with an upstream dam (such as sediment trapping, altered hydrological regime, and temperature changes).

Unit 4: Sespe Creek (2,760 ac (1,117 ha)) This unit is located in Ventura County and encompasses approximately 27 mi (43 km) of Sespe Creek and adjacent uplands, from the lower end of Sespe Gorge (elevation approximately 3,530 ft (1,076 m)) downstream to the confluence with Alder Creek. The unit consists of 2,498 ac (1,011 ha) of Federal land and 262 ac (106 ha) of private land. This unit supports one of the largest arroyo toad populations on the Los Padres National Forest along Sespe Creek, which is undammed and retains its natural flooding regime. Up to several hundred adult arroyo toads inhabit this reach of the Sespe Creek (Sweet 1992, p. 192), and during years of successful reproduction, such as 2003, thousands of juveniles can be found as well (Murphy 2008, pers. comm.). Arroyo toads have been found up to 3,300 ft (1,000 m) in elevation in this area, which is one of the highest known occurrences in the northern recovery unit. Unit 4 contains the physical and biological features that are essential to the conservation of the species, including numerous suitable breeding pools (shallow, sand- or gravelbased pools with a minimum of vegetation along one or both margins during the breeding season from late March to June (Sweet 1992, p. 28)) and an abundance of sandy substrates (PCEs 1 and 2), unimpeded seasonal flood flows (PCE 3), and relatively undisturbed riparian habitat and upland benches for foraging and dispersal (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from recreational activities and nonnative predators.

Unit 5: Piru Creek (2,507 ac (1,015 ha)) This unit is located in Ventura and Los Angeles Counties and consists of two subunits totaling 2,105 ac (852 ha) of Federal land and 402 ac (163 ha) of private inholdings. Subunit 5a Subunit 5a encompasses approximately 17 mi (27 km) of Piru Creek and adjacent uplands from the confluence with Lockwood Creek downstream to Pyramid Reservoir. The subunit consists of 1,277 ac (517 ha) of Federal land and 81 ac (33 ha) of private land. As recently as 2003, the upper portion of Subunit 5a was documented to be free of nonnative vertebrate predators, and the substantial arroyo toad population supported by this subunit was documented to be increasing and expanding over the course of several years (Uyehara 2003, pers. comm.). Subunit 5a contains the physical and biological features that are essential to the conservation of the species, including breeding pools in low-gradient stream segments with sandy substrates (PCEs 1 and 2), seasonal flood flows (PCE 3), and riparian habitat and upland benches for foraging and dispersal (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from livestock grazing and recreational activities. Subunit 5b Subunit 5b is primarily within the Sespe Wilderness and encompasses approximately 15 mi (24 km) of Piru Creek from the confluence with Fish Creek downstream to Lake Piru, as well as Agua Blanca Creek from Devil's Gateway downstream to the confluence with Piru Creek. The subunit supports a substantial arroyo toad population and consists of 828 ac (335 ha) of Federal land and 321 ac (130 ha) of private land. Subunit 5b contains the physical and biological features that are essential to the conservation of the species, including breeding pools in lowgradient stream segments with sandy substrates (PCEs 1 and 2), seasonal flood flows (modified to some extent below Pyramid Dam) (PCE 3), and riparian habitat and upland benches for foraging and dispersal (PCE 4). Because lower Piru Creek in Subunit 5b is downstream of a large dam, the habitat there has experienced some degradation over the years from perennial water releases, rapid changes in flow volume, excessive flows during the breeding season, and an increased presence of nonnative predators. However, in 2005, the California Department of Water Resources proposed to permanently change the water release schedule for Pyramid Dam to one that more closely mimics the pre-dam hydrograph and benefitted downstream habitat for the arroyo toad (State Water Board 2008, p. 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative predators and recreational activities.

Unit 6: Upper Santa Clara River Basin (2,802 ac (1,134 ha)) This unit is located in northwestern Los Angeles County and consists of three subunits totaling 443 ac (179 ha) of Federal land and 2,359 ac (955 ha) of private land. Subunit 6a Subunit 6a encompasses approximately 7 mi (12 km) of Castaic Creek from Bear Canyon downstream to Castaic Lake, and 0.7 mi (1.2 km) of Fish Creek from Cienaga Spring to the confluence with Castaic Creek. The subunit consists of 284 ac (115 ha) of Federal land and 236 ac (96 ha) of private land. Subunit 6a contains the physical and biological features that are essential to the conservation of the species, including breeding pools in low-gradient stream segments with sandy substrates (PCEs 1 and 2), seasonal flood flows (PCE 3), and riparian habitat and upland benches for foraging and dispersal (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from urban development, agriculture, recreation, mining, and nonnative predators. Subunit 6b Subunit 6b encompasses: (1) Approximately 2.6 mi (4.2 km) of Castaic Creek from the downstream edge of The Old Road right-of-way (adjacent to Interstate 5) down to the confluence with the Santa Clara River; and (2) 4 mi (6.4 km) of the Santa Clara River from the confluence with San Francisquito Creek down to the confluence with Castaic Creek. Subunit 6b consists of VerDate Mar2010 18:03 Feb 08, 2011 Jkt 223001 PO 00000 Frm 00016 Fmt 4701 Sfmt 4700 E:\FR\FM\09FER2.SGM 09FER2 srobinson on DSKHWCL6B1PROD with RULES2 Federal Register / Vol. 76, No. 27 / Wednesday, February 9, 2011 / Rules and Regulations 7261 1,003 ac (406 ha) of private land. This subunit allows for natural population expansion and fluctuation of the Santa Clara River population by connecting arroyo toad habitat in Castaic Creek with San Francisquito Creek and the occupied reach of the Santa Clara River. Subunit 6b contains the physical and biological features that are essential to the conservation of the species, including breeding pools in lowgradient stream segments with sandy substrates (PCEs 1 and 2), seasonal flood flows (PCE 3), and riparian habitat and upland benches for foraging and dispersal (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from urban development, agriculture, recreation, mining, and nonnative predators. The Secretary is exercising his discretion under section 4(b)(2) of the Act to exclude 330 ac (134 ha) of Subunit 6b that we proposed as revised critical habitat. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion, and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Other Relevant Impacts section below). Additionally, based on closer examination of some upland areas that we proposed in the revised critical habitat proposal (74 FR 52612, October 13, 2009) and that we believed met the definition of critical habitat, we have found that these lands are either developed, used for intensive agriculture, or are inaccessible to arroyo toads due to busy roads or steep slopes. We now find that little of these lands remain as native habitats that would be useable as foraging areas by arroyo toads, do not contain the physical and biological features that are essential to the conservation of the arroyo toad, and therefore, do not meet the definition of critical habitat. Therefore, we have removed approximately 662 ac (268 ha) from Subunit 6b. Subunit 6c Subunit 6c encompasses approximately 11 mi (18 km) of upper Santa Clara River from Arrastre Canyon downstream to the confluence with Bee Canyon Creek. The subunit consists of 159 ac (64 ha) of Federal land and 1,120 ac (453 ha) of private land. This subunit is important for maintaining the arroyo toad metapopulation in the upper Santa Clara River Basin. Additionally, the upper portion of the Santa Clara River in this subunit supports a breeding population of arroyo toads (Farris 2001, pers. comm.; Hovore 2001, in litt.; Sandburg 2001, in litt.) that has the potential to greatly increase in size. Subunit 6c contains the physical and biological features that are essential to the conservation of the species, including breeding pools in lowgradient stream segments with sandy substrates (PCEs 1 and 2), seasonal flood flows (PCE 3), and riparian habitat and upland benches for foraging and dispersal (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from urban development, agriculture, recreation, mining, and nonnative predators.

Unit 7: Upper Los Angeles River Basin (1,190 ac (482 ha)) This unit is located in central Los Angeles County and encompasses: (1) Approximately 8 mi (13 km) of upper Big Tujunga Creek from immediately above Big Tujunga Reservoir upstream to approximately 1.2 mi (2 km) above the confluence with Alder Creek, (2) almost 3.7 mi (6 km) of Mill Creek from the Monte Cristo Creek confluence downstream to Big Tujunga Creek, and (3) approximately 1.9 mi (3 km) of Alder Creek from the Mule Fork confluence downstream to Big Tujunga Creek. The unit consists of 1,113 ac (451 ha) of Forest Service land and 77 ac (31 ha) of private land. This unit supports an arroyo toad population in the Big Tujunga Creek Canyon watershed in the Upper Los Angeles River Basin within the Angeles National Forest. This population is important because it occurs at a relatively high elevation that is atypical for arroyo toads, and it is the only known substantial population remaining in the coastal foothills of the San Gabriel Mountains. Unit 7 contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative predators, such as crayfish, bullfrogs, and nonnative plants, such as Arundo donax (giant reed grass). Southern Recovery Unit As described in the recovery plan (Service 1999, pp. 1–119), maintaining arroyo toad populations in the areas described by the following 12 unit descriptions is necessary to conserve the species in the southern recovery unit. These critical habitat units consist of a range of geographic locations from coastal regions to interior mountains. Arroyo toads likely occurred throughout each of these river and creek basins, but are now found only in segments of the rivers and creeks due to loss or change of habitat and nonnative predators. Conserving arroyo toad populations in these river basins is necessary for preserving the species' full range of genetic and phenotypic variation.

Unit 8: Lower Santa Ana River Basin (737 ac (298 ha)) This unit is located in east-central Orange County and encompasses: (1) Approximately 5.8 mi (9 km) of Santiago Creek from just below the town of Modjeska downstream to the confluence with Black Star Creek, (2) approximately 2 mi (3 km) of Black Star Creek downstream to the confluence with Santiago Creek, (3) an approximately 2.4-mi (4-km) stretch of lower Baker Canyon downstream to the confluence with Santiago Creek, and (4) approximately 7.3 mi (12 km) of Silverado Creek from the eastern edge of section 11 (T05S, R07W) in the Cleveland National Forest downstream to the confluence with Santiago Creek. As proposed, Unit 8 included a total of 2,182 ac (883 ha). Of these lands, we have now removed approximately 185 ac (75 ha), as we determined that these lands do not contain the physical or biological features essential to the conservation of the arroyo toad (see numbers 3 and 20 in Summary of Changes from the 2009 Proposed Rule To Revise Critical Habitat section above for a detailed discussion). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Unit 8 totaling 1,259 ac (508 ha). The portion of Unit 8 we are designating as critical habitat consists of 54 ac (22 ha) of Forest Service land and 683 ac (276 ha) of private land. This unit contains a vital arroyo toad population in central Orange County that may represent one of the last remnants of a greater historical population from the Santa Ana River Basin that was mostly extirpated due to urbanization of the greater Los Angeles metropolitan area. It is also possible that this population belongs to a larger metapopulation that extends across the lower coastal mountain slopes of the Santa Ana Mountains from Santiago Creek to San Mateo Creek (including Units 10 and 11 discussed below). Unit 8 contains the physical and biological features that are essential to the VerDate Mar2010 18:03 Feb 08, 2011 Jkt 223001 PO 00000 Frm 00017 Fmt 4701 Sfmt 4700 E:\FR\FM\09FER2.SGM 09FER2 srobinson on DSKHWCL6B1PROD with RULES2 7262 Federal Register / Vol. 76, No. 27 / Wednesday, February 9, 2011 / Rules and Regulations conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nearby residential activities and degraded habitat conditions due to past commercial sand and gravel removal operations. As indicated above, the Secretary is exercising his discretion to exclude approximately 1,259 ac (508 ha) that are owned by or are under the jurisdiction of the permittees of the Orange County Central–Coastal NCCP/HCP and the associated NRPPA. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species.

Unit 9: San Jacinto River Basin (2,391 ac (968 ha)) This unit is located in west-central Riverside County and consists of two subunits totaling 14 ac (5 ha) of BLM land, 531 ac (215 ha) of Forest Service land, 232 ac (94 ha) of State land, and 1,614 ac (653 ha) of private land. This unit supports the most northeastern arroyo toad populations within the coastal region of the species' range. This unit also is geographically isolated from other known toad populations to the south in the Santa Margarita Watershed, to the west in the San Juan Watershed, and from residual populations to the north in the Santa Ana Watershed. Therefore, this location is important to maintain the current geographic extent of the species. Subunit 9a Subunit 9a encompasses approximately 6.3 mi (10 km) of the San Jacinto River from the Sand Canyon confluence downstream to the Soboba Indian Reservation border. The subunit consists of 64 ac (26 ha) of Forest Service land, 8 ac (3 ha) of BLM land, and 1,154 ac (467 ha) of private land. Subunit 9a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from human activities, including direct mortality from vehicular traffic, trampling by people during recreational activities or trash dumping, and collection (Ortega 2009, in litt. p. 1; Wilcox 2009, pers. comm.). Subunit 9b Subunit 9b encompasses approximately 7.4 mi (12 km) of Bautista Creek from near the eastern edge of section 20 (T6S, R2E) downstream to approximately the middle of section 27 (T5S, R1E), where the stream enters a debris basin. As proposed, Subunit 9b included a total of 1,180 ac (478 ha). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Subunit 9b totaling 14 ac (6 ha). The portion of Subunit 9b we are designating as critical habitat consists of 467 ac (189 ha) of Forest Service land, 6 ac (2 ha) of BLM land, 232 ac (94 ha) of State land, and 461 ac (187 ha) of private land. Subunit 9b contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from recreation and vehicular traffic (U.S. Geological Survey (USGS) 2001, p. 8). As indicated above, the Secretary is exercising his discretion to exclude approximately 14 ac (6 ha) that are owned by or are under the jurisdiction of the permittees of the Western Riverside County MSHCP. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species.

Unit 10: San Juan Creek Basin (3,496 ac (1,415 ha)) This unit is located in southern Orange County and southwestern Riverside County and consists of two subunits totaling 558 ac (226 ha) of Forest Service land, 38 ac (15 ha) of local government land, and 2,900 ac (1,174 ha) of private land. This unit supports a large arroyo toad population in the San Juan Creek Basin, and arroyo toad populations in this unit may function as an important linkage between toads in Santiago Creek (Unit 8) to the north and the San Mateo Creek Basin (Unit 11) to the south. Subunit 10a This subunit is located in southern Orange County and southwestern Riverside County. Subunit 10a encompasses: (1) Approximately 5 mi (8 km) of San Juan Creek from immediately above the Upper San Juan Campground downstream to Interstate 5, (2) approximately 9.9 mi (16 km) of Bell Canyon from the southern half of section 8 (T06S, R06W) in the Cleveland National Forest downstream to the confluence with San Juan Creek, and (3) approximately 1.2 mi (2 km) of an unnamed tributary to the west of Bell Canyon in sections 8 and 18 (T06S, R06W) downstream to the confluence with Bell Creek. As proposed, Subunit 10a included a total of 4,728 ac (1,913 ha). Of these lands, we have now removed approximately 1 ac (2010 18:03 Feb 08, 2011 Jkt 223001 PO 00000 Frm 00018 Fmt 4701 Sfmt 4700 E:\FR\FM\09FER2.SGM 09FER2 srobinson on DSKHWCL6B1PROD with RULES2 Federal Register / Vol. 76, No. 27 / Wednesday, February 9, 2011

/ Rules and Regulations 7263 exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Other Relevant Impacts section below for a detailed discussion). Subunit 10b This subunit is located in southern Orange County. Subunit 10b encompasses 5.2 mi (8 km) of Trabuco Creek downstream from approximately the middle of section 6 (T06S, R06W) in the Cleveland National Forest. As proposed, Subunit 10b included a total of 939 ac (380 ha). Of these lands, we have now removed approximately 31 ac (13 ha), as we determined that these lands do not contain the physical or biological features essential to the conservation of the arroyo toad (see number 6 in Summary of Changes from the 2009 Proposed Rule To Revise Critical Habitat section above for a detailed discussion). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Subunit 10b totaling 509 ac (206 ha). The portion of Subunit 10b we are designating as critical habitat consists of 11 ac (4 ha) of Forest Service land, 35 ac (14 ha) of local government land, and 353 ac (143 ha) of private land. Subunit 10b contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative predators (bullfrogs), water diversions, and residual effects of recent gravel mining operations (Bloom 1998, p. 2). As indicated above, the Secretary is exercising his discretion to exclude approximately 509 ac (206 ha) that are owned by or are under the jurisdiction of the permittees of the Southern Orange County NCCP/Master Streambed Alteration Agreement/HCP. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Other Relevant Impacts section below for a detailed discussion).

Unit 11: San Mateo Creek Basin (1,820 ac (737 ha)) This unit is located in northwestern San Diego County, southern Orange County, and southwestern Riverside County and consists of two subunits totaling 844 ac (341 ha) of Forest Service land and 975 ac (395 ha) of private land. This unit supports large arroyo toad populations in close proximity to the coast. Nearly all of the other nearcoastal, historical populations of arroyo toad were extirpated due to extensive urbanization and river channelization along the coastal regions of southern California. Distinctive climatic conditions near the coast may provide different selective pressures on toads in this area, and favor specific genetic characteristics that help maintain the genetic diversity of the species. We exempted approximately 6,014 ac (2,427 ha) of military land under section 4(a)(3)(B) of the Act because the lands are subject to the 2007 INRMP for Marine Corps Base Camp Pendleton, and the INRMP provides a benefit to the arroyo toad (see the Application of Section 4(a)(3) of the Act section below for details on the INRMP and the benefits it provides to the arroyo toad). Subunit 11a Subunit 11a encompasses: (1) Approximately 1.7 mi (3 km) of Cristianitos Creek from just above Gabino Creek downstream to the MCB Camp Pendleton boundary; (2) approximately 3.1 mi (5 km) of Gabino Creek upstream from its confluence with Cristianitos Creek, including about 0.6 mi (1 km) of La Paz Creek; and (3) approximately 4 mi (6 km) of Talega Creek upstream from its confluence with Cristianitos Creek and beyond the boundaries of MCB Camp Pendleton. As proposed, Subunit 11a included a total of 1,034 ac (418 ha). Of these lands, we have now exempted approximately 20 ac (8 ha) (see number 7 in Summary of Changes from the 2009 Proposed Rule To Revise Critical Habitat section above for a detailed discussion). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, a portion of Subunit 11a totaling 39 ac (16 ha). The portion of Subunit 11a we are designating as critical habitat totals 975 ac (395 ha), and is comprised entirely of private land. Subunit 11a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from human activities, including direct mortality from vehicle collisions and vehicular crossings of streambeds, grazing, and nonnative predators (Bloom 1996, pp. 4–5; Bloom 1998, in litt., pp. 1, 3). As indicated above, the Secretary is exercising his discretion to exclude approximately 39 ac (16 ha) that are owned by or are under the jurisdiction of the permittees of the Southern Orange County NCCP/Master Streambed Alteration Agreement/HCP. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Other Relevant Impacts section below for a detailed discussion). Subunit 11b Subunit 11b encompasses: (1) Approximately 9.3 mi (15 km) of San Mateo Creek from Los Alamos Canyon downstream to MCB Camp Pendleton, and (2) approximately 2.4 mi (4 km) of Los Alamos Canyon downstream to the confluence with San Mateo Creek. The subunit consists of 844 ac (341 ha) of Forest Service land. Subunit 11b contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from habitat conditions favorable for nonnative predators (ECORP 2004, p. 16).

Unit 12: Lower Santa Margarita River Basin (1,009 ac (408 ha)) This unit is located in northwestern San Diego County and consists of two subunits totaling 5 ac (2 ha) of State land and 1,004 ac (406 ha) of private land. This unit supports large arroyo toad populations in proximity to other large arroyo toad populations to the north (Unit 11), and provides potential connectivity to populations in the upper Santa Margarita River Basin (Unit 13). We exempted approximately 7,239 ac (2,929 ha) of military land (7,016 ac (2,839 ha) on MCB Camp Pendleton and 223 ac (90 ha) on Fallbrook Naval VerDate Mar2010 18:03 Feb 08, 2011 Jkt 223001 PO 00000 Frm 00019 Fmt 4701 Sfmt 4700 E:\FR\FM\09FER2.SGM 09FER2 srobinson on DSKHWCL6B1PROD with RULES2 7264 Federal Register / Vol. 76, No. 27 / Wednesday, February 9, 2011 / Rules and Regulations Weapons Station) in this unit under section 4(a)(3)(B) of the Act in the October 2009 proposed revised designation for the arroyo toad (74 FR 52612) because the lands are subject to the 2007 INRMP for MCB Camp Pendleton and the 2006 INRMP for the Fallbrook Naval Weapons Station, and each INRMP provides a benefit to the arroyo toad. Please refer to the Application of Section 4(a)(3) of the Act section below for details on the INRMPs and the benefits they provide to the arroyo toad. Subunit 12a Subunit 12a encompasses approximately 2.1 mi (3 km) of De Luz Creek from the town of De Luz downstream to the MCB Camp Pendleton boundary. The subunit consists of 394 ac (159 ha) of private land. Subunit 12a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from cumulative impacts to the species' habitat from recreation, nonnative predators, and nonnative plants (CNDDB 2008, EO 26). Subunit 12b Subunit 12b encompasses approximately 5.5 mi (9 km) of the Santa Margarita River upstream from the MCB Camp Pendleton boundary. The subunit consists of 5 ac (2 ha) of State land and 610 ac (247 ha) of private land. Subunit 12b contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from cumulative impacts to the species' habitat from nonnative predators, nonnative plants, and vehicular traffic (Varanus Biological Services, Inc. 1999, pp. 34–35).

Unit 13: Upper Santa Margarita River Basin (7,863 ac (3,182 ha)) This unit is located in southern Riverside County and northern San Diego County and consists of three subunits totaling 22 ac (9 ha) of BLM land, 432 ac (174 ha) of Forest Service land, and 7,409 ac (2,998 ha) of private land. This unit provides potential links to arroyo toad populations in the lower Santa Margarita River Basin (Unit 12) and other nearby drainages containing suitable habitat. Subunit 13a Subunit 13a encompasses approximately 7.3 mi (12 km) of Arroyo Seco Creek from just south of the San Diego-Riverside County boundary downstream to Vail Lake. The subunit consists of 337 ac (136 ha) of Forest Service land and 818 ac (331 ha) of private land. Subunit 13a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative predators and campground activities (USGS 2000, p. 3). Subunit 13b Subunit 13b encompasses approximately 16.3 mi (26 km) of Temecula Creek from Dodge Valley downstream to Vail Lake. As proposed, Subunit 13b included a total of 4,756 ac (1,925 ha). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Subunit 13b totaling 26 ac (11 ha). The portion of Subunit 13b we are designating as critical habitat consists of 95 ac (38 ha) of Forest Service land, 22 ac (9 ha) of BLM land, and 4,614 ac (1,867 ha) of private land. Subunit 13b contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from road maintenance and sand-mining operations (HELIX 2004, p. 1). As indicated above, the Secretary is exercising his discretion to exclude approximately 26 ac (11 ha) that are owned by or are under the jurisdiction of the permittees of the Western Riverside

County MSHCP. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Other Relevant Impacts section below for a detailed discussion). Subunit 13c Subunit 13c encompasses approximately 6.5 mi (10 km) of Wilson Creek from the confluence with Cahuilla Creek downstream to Vail Lake. As proposed, Subunit 13c included a total of 2,226 ac (901 ha). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Subunit 13c totaling 249 ac (101 ha). The portion of Subunit 13c we are designating as critical habitat totals 1,977 ac (800 ha), and is comprised entirely of private land. Subunit 13c contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from direct mortality and habitat degradation from off-highway vehicular traffic, and upstream sedimentation caused by urbanization, agriculture, or wildfire (R. Haase, MCAS Camp Pendleton, in litt. 2009b, p. 1). As indicated above, the Secretary is exercising his discretion to exclude approximately 249 ac (101 ha) that are owned by or are under the jurisdiction of the permittees of the Western Riverside County MSHCP. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Other Relevant Impacts section below for a detailed discussion).

Unit 14: Lower and Middle San Luis Rey River Basin (10,115 ac (4,093 ha)) This unit is located in northern San Diego County and encompasses approximately 30 mi (48 km) of the San Luis Rey River from the western edge of the La Jolla Indian Reservation downstream to the confluence with Guajome Creek near the City of Oceanside. It also includes approximately 3.4 mi (5.5 km) of Pala Creek and 1.7 mi (2.7 km) of Keys Creek upstream from the confluence with the San Luis Rey River. As proposed, Unit 14 included a total of 12,906 ac (5,223 ha). Of these lands, we have now removed approximately 58 ac (23 ha), as we determined that these lands do not contain the physical or biological features essential to the conservation of the arroyo toad (see numbers 9 and 20 in Summary of Changes from the 2009 Proposed Rule To Revise Critical Habitat section above for a detailed discussion). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Unit 14 totaling 2,733 ac (1,106 ha). The portion of Unit 14 we are designating as critical habitat consists of approximately 4 ac (2 ha) of BLM land, 10 ac (4 ha) of State land, and 10,101 ac (4,088 ha) of private land. This unit supports one of the largest contiguous river reaches that is occupied by the species. Unit 14 contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from dams and water diversions, intensive urbanization, agriculture, and nonnative predators and plants. As indicated above, the Secretary is exercising his discretion to exclude approximately 1,071 ac (433 ha) of Rincon Band of

Luisen˜o Mission Indians Tribal Lands and approximately 1,662 ac (673 ha) of Pala Band of Luisen˜ o Mission Indians Tribal Lands. These exclusions are based on our determination that the benefits of exclusion outweigh the benefits of inclusion, and that exclusion of these areas will not result in extinction of the species (See Exclusions Under Section 4(b)(2) of the Act—Tribal Lands section below.

Unit 15: Upper San Luis Rey River Basin (8,368 ac (3,386 ha)) This unit is located in northern San Diego County and encompasses: (1) Approximately 8.6 mi (14 km) of the West Fork of the San Luis Rey River from Barker Valley downstream to the upper end of Lake Henshaw, (2) approximately 3.5 mi (6 km) of Can˜ ada Aguanga from just below Lake Jean downstream to the confluence with the San Luis Rey River, (3) approximately 11.4 mi (18 km) of the upper San Luis Rey River from the Indian Flats area downstream to the upper end of Lake Henshaw, and (4) approximately 6.9 mi (11 km) of Agua Caliente Creek from the western edge of section 13 (T10S, R3E) to the confluence with the San Luis Rey River. As proposed, Unit 15 included a total of 12,977 ac (5,252 ha). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Unit 15 totaling 4,609 ac (1,865 ha). The portion of Unit 15 we are designating as critical habitat consists of 695 ac (281 ha) of Forest Service land and 7,673 ac (3,105 ha) of private land. This unit supports a unique assemblage of small, disjunct, high-elevation arroyo toad populations and one significant population on Agua Caliente Creek (Gergus 1992, in litt., p. 1; Ervin 2000, in litt., pp. 2–3, 5; CNDDB 2008, Element Occurrences (EOs) 27, 32) in an area where in-stream and overland dispersal between populations likely still is possible. Unit 15 contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from groundwater pumping on private lands, nonnative predators, feral pigs, and grazing (Winter in litt. 2010). As indicated above, the Secretary is exercising his discretion to exclude approximately 4,609 ac (1,865 ha) within the existing and proposed Remote Training Site Warner Springs. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Impacts to National Security section below for a detailed discussion).

Unit 16: Santa Ysabel Creek Basin (15,370 ac (6,220 ha)) This unit is located in north-central San Diego County and consists of two subunits totaling 6 ac (2 ha) of BLM land, 184 ac (74 ha) of Forest Service land, 175 ac (71 ha) of State land, 143 ac (58 ha) of local government land, and 14,862 ac (6,014 ha) of private land. This unit supports large amounts of suitable habitat connecting large populations with several additional populations, thereby promoting the long-term persistence of the species in the area. Subunit 16a Subunit 16a encompasses: (1) Approximately 16.9 mi (27 km) of Santa Ysabel Creek from the northwestern quarter of section 24 (T12S, R01E) in the Cleveland National Forest downstream to the confluence with the San Dieguito River, (2) approximately 10 mi (16.1 km) of Guejito Creek from the 2,000 ft (610 m)-elevation contour downstream to the confluence with Santa Ysabel Creek, (3) approximately 2.5

mi (4.0 km) of Boden Canyon upstream from the Santa Ysabel Creek confluence, (4) approximately 4.3 mi (7 km) of Temescal Creek from the northern edge of Pamo Valley to the confluence with Santa Ysabel Creek, (5) approximately 9.1 mi (15 km) of Santa Maria Creek from the west side of Ramona to the confluence with Santa Ysabel Creek, and (6) approximately 1 mi (2 km) of the San Dieguito River upstream from the confluence with Santa Ysabel Creek. As proposed, Subunit 16a included a total of 13,967 ac (5,653 ha). Of these lands, we have now removed approximately 101 ac (40 ha), as we determined that these lands do not contain the physical or biological features essential to the conservation of the arroyo toad (see number 10 in Summary of Changes from the 2009 Proposed Rule To Revise Critical Habitat section above for a detailed discussion). The subunit consists of 184 ac (74 ha) of Forest Service land, 6 ac (2 ha) of BLM land, 175 ac (71 ha) of State land, 143 ac (58 ha) of local government land, and 13,357 ac (5,405 ha) of private land. Subunit 16a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from grazing, nonnative predators, feral pigs, and urbanization (Tierra Environmental Services 2001, in litt.; CNDDB 2008, EOs 59, 61; Winter in litt. 2010). Subunit 16d Subunit 16d encompasses approximately 6.2 mi (10 km) of Santa Ysabel Creek about 0.5 mi (0.8 km) east of Highway 79 downstream to Sutherland Reservoir. As proposed, Subunit 16d included a total of 1,527 ac (609 ha). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, a portion of Subunit 16d totaling 23 ac (9 ha). The portion of Subunit 16b we are designating as critical habitat totals 1,504 ac (609 ha), and is comprised entirely of private land. Subunit 16d contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from grazing and feral pigs (CNDDB 2008, EO 62; Winter in litt. 2010). As indicated above, the Secretary is exercising his discretion to exclude approximately 23 ac (9 ha) of Mesa Grande Band of Diegueno Mission Indians Tribal Land. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion, and that exclusion of these areas will not result in extinction of the species (See Exclusions Under Section 4(b)(2) of the Act—Tribal Lands section below.

Unit 17: San Diego River Basin/San Vicente Creek (4,171 ac (1,688 ha)) This unit is located in central San Diego County and consists of three subunits totaling 35 ac (14 ha) of BLM land, 390 ac (158 ha) of Forest Service land, and 3,746 ac (1,516 ha) of private land. This unit supports suitable habitat for population expansion, thus increasing the probability of the longterm persistence of these populations. Subunit 17a Subunit 17a encompasses: (1) Approximately 8.7 mi (14 km) of the San Diego River from Temescal Creek downstream to the upper edge of El Capitan Reservoir, and (2) approximately 1 mi (2 km) of lower Cedar Creek. As proposed, Subunit 17a included a total of 1,241 ac (502 ha). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Subunit 17a totaling 92 ac (37 ha). The portion of Subunit 17a we are designating as critical habitat consists of 354 ac (143 ha) of Forest Service land, and 795 ac (322 ha) of private land. Subunit 17a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from urbanization, nonnative predators, and feral pigs (Winter in litt. 2010). As indicated above, the Secretary is exercising his discretion to exclude approximately 92 ac (37 ha) of Capitan Grande Band of Diegueno Mission Indians Tribal Lands. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion, and that exclusion of these areas will not result in extinction of the species (See Exclusions Under Section 4(b)(2) of the Act—Tribal Lands section below. Subunit 17b Subunit 17b encompasses approximately 7.2 mi (12 km) of the San Diego River downstream from El Capitan Reservoir. The subunit consists of 12 ac (5 ha) of BLM land, 36 ac (15 ha) of Forest Service land, and 1,817 ac (735 ha) of private land. Subunit 17b contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from urbanization, agriculture, nonnative predators, and harmful water releases (based on timing or amount) from the El Capitan Reservoir. Subunit 17d Subunit 17d encompasses approximately 7.6 mi (12 km) of San Vicente Creek upstream from San Vicente Reservoir. The subunit consists of 23 ac (9 ha) of BLM land and 1,134 ac (459 ha) of private land. Subunit 17d contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from urbanization, agriculture, nonnative predators, feral pigs, and harmful water releases (based on timing or amount) from the Sutherland/San Vicente Aqueduct (Varanus Biological Services, Inc. 1999, p. 20; RECON 2008, pp. 1, 3– 4; Winter in litt. 2010).

Unit 18: Sweetwater River Basin (4,624 ac (1,871 ha)) This unit is located in south-central San Diego County and consists of two subunits totaling 553 ac (224 ha) of Forest Service land, 3 ac (1 ha) of San Diego National Wildlife Refuge land, 1,659 ac (671 ha) of State land, and 2,410 ac (975 ha) of private land. This unit supports several large populations over large stretches of rivers and streams (Gergus 1992, in litt., p. 1; Ervin 1997, in litt., pp. 3–5; Varanus Biological Services, Inc. 1999, pp. 4–16; CNDDB 2008, EOs 38, 43, 67, 73, 77, 85, 99, 100). These populations may function as an important linkage between toads in the San Diego River Basin (Unit 17) to the north and Cottonwood Creek Basin (Unit 19) to the south. Subunit 18a Subunit 18a encompasses: (1) Approximately 26.6 mi (43 km) of the Sweetwater River from the top of Upper Green Valley in Cuyamaca Rancho State Park downstream to the top of Loveland Reservoir, (2) approximately 4.3 mi (7 km) of Viejas Creek from the western border of the Viejas Indian Reservation downstream to the confluence with the Sweetwater River, and (3) approximately 1.5 mi (2 km) of Peterson Canyon from just east of the Taylor Creek confluence downstream to the top of Loveland

Reservoir. The subunit consists of 553 ac (224 ha) of Forest Service land, 1,554 ac (629 ha) of State land, and 2,049 ac (829 ha) of private land. Subunit 18a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from vehicular traffic, including off- highway vehicular traffic; horse-riding activities; nonnative predators; reservoir inundation; feral pigs; and direct mortality from trampling or dumping trash (Varanus Biological Services, Inc. 1999, p. 14; Mendelsohn et al. 2005, pp. 10–11; Winter in litt. 2010). Subunit 18c Subunit 18c encompasses approximately 5.8 mi (9.3 km) of the Sweetwater River from immediately below Loveland Dam downstream to just above the Sycuan Resort. As proposed, Subunit 18c included a total of 627 ac (254 ha). Of these lands, we have now removed approximately 6 ac (2 ha), as we determined that these lands do not contain the physical or biological features essential to the conservation of the arroyo toad (see number 13 in Summary of Changes from the 2009 Proposed Rule To Revise Critical Habitat section above for a detailed discussion). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Subunit 18c totaling 152 ac (62 ha). The portion of Subunit 18c we are designating as critical habitat consists of 3 ac (1 ha) of San Diego National Wildlife Refuge land, 105 ac (42 ha) of State land, and 362 ac (146 ha) of private land. Subunit 18c contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from harmful water releases (based on timing or amount) from the Loveland Reservoir and gravel mining operations (MaddenSmith et al. 2003, pp. 15, 17). As indicated above, the Secretary is exercising his discretion to exclude approximately 152 ac (62 ha) of Sycuan Band of the Kumeyaay Nation Tribal Lands. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion, and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Tribal Lands section below).

Unit 19: Cottonwood Creek Basin (14,344 ac (5,804 ha)) Unit 19 is located in southern San Diego County and consists of five subunits totaling 190 ac (77 ha) of BLM land, 3,927 ac (1,588 ha) of Forest Service land, 1,476 ac (597 ha) of local government land, and 8,751 ac (3,541 ha) of private land. This unit encompasses a large number of arroyo toad occurrences (Gergus 1992, in litt.; Varanus Biological Services, Inc. 1999, pp. 2–3; Gergus 2000, in litt.; CNDDB 2008, EOs 20–22, 30, 40, 44, 63–65, 69, 79) in an area where in-stream and overland dispersal between populations likely still is possible and where there is room for population expansion. Additionally, this unit may function as an important linkage between toads in the Sweetwater River Basin (Unit 18) to the north and populations to the south in Mexico, as populations in this unit represent the most southern arroyo toad populations in the species' range within the United States. Subunit 19a Subunit 19a encompasses: (1) Approximately 7 mi (11.2 km) of Cottonwood Creek from Buckman Springs (near Interstate 8) downstream to Morena Reservoir, (2) approximately 2.8 mi (4.5 km) of Morena Creek downstream to the Cottonwood Creek confluence, (3) approximately 0.5 mi (1 km) of an unnamed tributary of Morena Creek in section 35 (T16S, R04E) downstream to the confluence with Morena Creek, (4) approximately 5 mi (8 km) of Kitchen Creek downstream to the Cottonwood Creek confluence, and (5) approximately 3.8 mi (6 km) of La Posta Creek downstream to the Cottonwood Creek confluence. As proposed, Subunit 19a included a total of 5,847 ac (2,366 ha). The Secretary is exercising his discretion to exclude from this final revised critical habitat designation, under section 4(b)(2) of the Act, portions of Subunit 19a totaling 31 ac (13 ha). The portion of Subunit 19a we are designating as critical habitat consists of 2,128 ac (861 ha) of Forest Service land, 1,476 ac (597 ha) of local government land, and 2,212 ac (895 ha) of private land. Subunit 19a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from grazing, recreational activities, and nonnative plants and predators (Ervin 2000, in litt.; TAIC 2005, p. 1; CNDDB 2008, EOs 20, 44, 69). As indicated above, the Secretary is exercising his discretion to exclude approximately 31 ac (13 ha) within Camp Morena. This exclusion is based on our determination that the benefits of exclusion outweigh the benefits of inclusion and that exclusion of these areas will not result in extinction of the species (see Exclusions Under Section 4(b)(2) of the Act—Impacts to National Security section below for a detailed discussion). Subunit 19b Subunit 19b encompasses approximately 12.7 mi (20 km) of Cottonwood Creek from immediately below Barrett Lake downstream to the U.S.–Mexico border and includes 10.3 mi (17 km) of Potrero Creek from approximately the 2,466-ft (752-m) elevation benchmark downstream to the confluence with Cottonwood Creek. The subunit consists of 80 ac (32 ha) of Forest Service land, 129 ac (52 ha) of BLM land, and 4,921 ac (1,991 ha) of private land. Subunit 19b contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from grazing, and nonnative plants and predators (Ervin 1997, in litt.; TAIC 2005, pp. 1, 3; CNDDB 2008, EOs 40, 64, 65, 79). Subunit 19c Subunit 19c encompasses: (1) Approximately 7.6 mi (12 km) of Pine Valley Creek from the north edge of section 12 (T15S, R4E) downstream to approximately 0.6 mi (1 km) south of Interstate 8, (2) approximately 0.6 mi (1 km) of Noble Creek downstream to the confluence with Pine Valley Creek, (3) approximately 2.4 mi (4 km) of Scove Canyon downstream to the confluence with Pine Valley Creek, and (4) approximately 1.3 mi (2 km) of an unnamed tributary upstream of Scove Canyon in sections 25 and 36 (T15S, R04E). The subunit consists of 809 ac (327 ha) of Forest Service land and 703 ac (284 ha) of private land. Subunit 19c contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from urbanization, vehicular traffic, and nonnative predators (Holland and Sisk 2001, p. 9; CNDDB 2008, EOs 21, 22, 30). Subunit 19d Subunit 19d encompasses approximately 8 mi (13 km) of Pine Valley Creek from the Nelson Canyon confluence downstream to Barrett Reservoir and approximately 1.6 mi (3 km) of Horsethief Canyon downstream to the confluence with Pine Valley Creek. The subunit consists of 910 ac (368 ha) of Forest Service land and 28 ac (11 ha) of private land. Subunit 19d contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from U.S. Border Patrol activities (Varanus Biological Services, Inc. 1999, p. 2). Subunit 19e Subunit 19e encompasses approximately 4.4 mi (7 km) of Campo Creek from Campo Lake downstream to the U.S.-Mexico border. The subunit consists of 61 ac (25 ha) of BLM land and 889 ac (360 ha) of private land. Subunit 19e contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from fire management activities along the U.S.– Mexico border (LEI 2008, p. 2).

Desert Recovery Unit: As described in the recovery plan (Service 1999, pp. 1–119), maintaining arroyo toad populations in the areas described by the following four unit descriptions is necessary to conserve the species in the desert recovery unit. Each of these units is isolated from each other and from any other recovery units, making the issues of inbreeding, fragmentation, and random negative impacts of great concern. However, this recovery unit also represents unique ecological conditions for arroyo toads, such as extremes in aridity, heat, and cold, and likely harbors important genetic diversity.

Unit 20: Upper Santa Ana River Basin/ Cajon Wash (1,775 ac (718 ha)) This unit is located in southwestern San Bernardino County and encompasses approximately 7.9 mi (13 km) of Cajon Wash from approximately 0.2 mi (0.3 km) north of United States Highway 138 downstream to approximately 0.3 mi (0.5 km) northwest of the Interstate 15 crossing. The unit consists of 711 ac (288 ha) of Forest Service land and 1,065 ac (431 ha) of private land. This unit supports a population that may represent some of the last vestiges of a much greater population that historically existed along the upper Santa Ana River Basin, but was almost entirely extirpated due to urbanization of the greater Los Angeles area. Therefore, this location is important to maintain the current geographic extent of the species. Unit 20 contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and nonbreeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from recreational activities.

Unit 21: Little Rock Creek Basin (612 ac (248 ha)) This unit is located in central Los Angeles County and encompasses: (1) Approximately 5.9 mi (9.5 km) of Little Rock Creek from the South Fork confluence downstream to the upper end of Little Rock Reservoir (in the vicinity of Rocky Point Picnic Ground), and (2) approximately 1.1 mi (1.8 km) of Santiago Creek upstream from the confluence with Little Rock Creek in the Little Rock Creek Basin. The unit consists of 612 ac (248 ha) of Forest Service land. This unit is on the periphery of the species' range in the Mojave Desert and geographically isolated from other known arroyo toad populations; therefore, it is important for maintaining the current geographic extent of the species. Unit 21 contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from recreational activities.

Unit 22: Upper Mojave River Basin (5,602 ac (2,267 ha)) This unit is located in San Bernardino County and consists of one subunit totaling 2,143 ac (867 ha) of Federal land, 47 ac (19 ha) of State land, and 3,412 ac (1,381 ha) of private land. Subunit 22a Subunit 22a includes: (1) Approximately 9.3 mi (18 km) of Deep Creek from near Holcomb Creek downstream to the confluence with the West Fork; (2) approximately 4 mi (6 km) of Little Horsethief Creek upstream from its confluence with Horsethief Creek; (3) approximately 4 mi (6 km) of Horsethief Creek from approximately 1 mi (1.6 km) above the Little Horsethief Creek confluence downstream to the West Fork confluence; (4) approximately 6 mi (10 km) of the West Fork of the Mojave River from Highway 173 downstream to Mojave River Forks Dam; (5) approximately 1 mi (1.6 km) of the Mojave River below Mojave River Forks Dam; (6) approximately 1.4 mi (2.2 km) of Grass Valley Creek upstream from the confluence with the West Fork; and (7) approximately 2.8 mi (4.5 km) of Kinley Creek upstream from the Deep Creek confluence. Subunit 22a consists of 2,143 ac (867 ha) of Federal land, 3,412 ac (1,381 ha) of private land, and 47 ac (19 ha) of State land. This subunit contains Summit Valley, which encompasses the lower portions of Horsethief Creek and the West Fork of the Mojave River, a broad, flat, alluvial valley that supports a substantial arroyo toad population (Ramirez 2003, pp. 16– 17). Additionally, the downstream portion of this subunit contains the driest conditions of any unit proposed for arroyo toad critical habitat (Teale Data Center 1998, p. 1; CIMS 2000, p. 1), Subunit 22a contains the physical and biological features that are essential to the conservation of the species, including aquatic habitat for breeding and non-breeding activities (PCEs 1, 2, and 3) and upland habitat for foraging and dispersal activities (PCE 4). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative species, urban development, and recreation. Based on information submitted by Summit Valley Ranch during the initial public comment period from October 13, 2009, to December 14, 2009, we removed approximately 82 ac (33 ha) of private land from Subunit 22a. The lands in question are located north of State Road 138 on Summit Valley Ranch, San Bernardino County. We included this area in the proposed revised critical habitat designation because we believed it contained suitable upland habitat for arroyo toads; however, it has come to our attention that (1) surveys have never detected arroyo toads in the area, (2) the area lacks the PCEs for the arroyo toad, and (3) State Route 138 serves as a barrier for arroyo toads to disperse into the area. Consequently, we determined that the area north of State Route 138 does not contain the physical and biological features essential to the conservation of arroyo toads and therefore does not meet the definition of critical habitat for the arroyo toad. Additionally, we removed Subunit 22c (approximately 234 ac (915 ha)) within Unit 22 from our revised critical habitat designation.

Subunit 22c is within the geographical area occupied at the time of listing; however, this subunit was erroneously included in the proposed revised rule (74 FR 52612; October 13, 2009). Although we were not aware of this issue when we published the proposed rule, the existence of Cedar Springs Dam upstream of this subunit has altered the hydrology of the 1-mi (1.6-km) reach of the upper West Fork of the Mojave River above Silverwood Lake that extends to the upper end of the lake to such an extent that it does not contain the features essential to the conservation of the species and therefore does not meet the definition of critical habitat for the arroyo toad.

Unit 23: Whitewater River Basin We removed Unit 23 (approximately 1,355 ac (548 ha)) from the final revised critical habitat designation. This unit was erroneously included in the proposed revised rule (74 FR 52612; October 13, 2009). Following examination of data used to map Unit 23 in the proposed rule and discussions with species experts regarding identification records, we determined that these records are not arroyo toads and do not support a determination that this area meets the definition of critical habitat. Therefore, Unit 23 is not included in this final revised critical habitat rule.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura Counties, California. Within these areas, the primary constituent elements for the arroyo toad consist of four components:

(i) Rivers or streams with hydrologic regimes that supply water to provide space, food, and cover needed to sustain eggs, tadpoles, metamorphosing juveniles, and adult breeding toads. Breeding pools must persist a minimum of 2 months for the completion of larval development. However, due to the dynamic nature of southern California riparian systems and flood regimes, the location of suitable breeding pools may vary from year to year. Specifically, the conditions necessary to allow for successful reproduction of arroyo toads are: (A) Breeding pools that are less than 6 inches (15 centimeters) deep; (B) Areas of flowing water with current velocities less than 1.3 feet per second (40 centimeters per second); and (C) Surface water that lasts for a minimum of 2 months during the breeding season (a sufficient wet period in the spring months to allow arroyo toad larvae to hatch, mature, and metamorphose).

(ii) Riparian and adjacent upland habitats, particularly low-gradient (typically less than 6 percent) stream segments and alluvial streamside terraces with sandy or fine gravel substrates that support the formation of shallow pools and sparsely vegetated sand and gravel bars for breeding and rearing of tadpoles and juveniles; and adjacent valley bottomlands that include areas of loose soil where toads can burrow underground, to provide foraging and living areas for juvenile and adult arroyo toads.

(iii) A natural flooding regime, or one sufficiently corresponding to natural, that: (A) Is characterized by intermittent or near-perennial flow that contributes to the persistence of shallow pools into at least mid-summer; (B) Maintains areas of open, sparsely vegetated, sandy stream channels and terraces by periodically scouring riparian vegetation; and (C) Also modifies stream channels and terraces and redistributes sand and sediment, such that breeding pools and terrace habitats with scattered vegetation are maintained.

(iv) Stream channels and adjacent upland habitats that allow for movement to breeding pools, foraging areas, overwintering sites, upstream and downstream dispersal, and connectivity to areas that contain suitable habitat.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

The area designated as revised critical habitat may require some level of management or protection to address current and future threats to the arroyo toad and maintain the physical and biological features essential to the conservation of the species. Special management may be required in all units to ensure that aquatic and riparian upland habitats provide abundant breeding and non-breeding areas, prey species, shelter, and connectivity within the landscape.

Maintaining the physical and biological features essential to the conservation of the arroyo toad may require special management considerations or protection to reduce effects that may result from the following threats, among others: Habitat destruction and alteration due to shortand long-term changes in river hydrology, including construction of dams and water diversions that alter natural water flow regimes; agriculture and urbanization; construction of roads; off-highway vehicle use and other recreational activities; mining activities; introduced nonnative predators (such as bullfrogs and predatory fish); drought; periodic fires and fire suppression activities; unseasonal water releases from dams; livestock grazing; and light and noise pollution from adjacent developments and campgrounds. These threats may cause habitat alteration, degradation, or fragmentation and the direct or indirect loss of arroyo toad eggs, juveniles, or adults.

Life History

Food/Nutrient Resources

Food Source

Adult: The diet of the arroyo toad includes snails, crickets, beetles, and ants; they sometimes also cannibalize newly metamorphosed individuals. Toadlets and juvenile arroyo toads feed on ants almost exclusively, but by the time they reach 1.7 to 2.3 cm (0.7 to 0.9 in.) in length, they also feed on beetles (NatureServe 2015; USFWS 2009).

Competition

Adult: Competition from nonnative species.

Food/Nutrient Narrative

Adult: Arroyo toads are opportunistic feeders. Adults eat snails, crickets, beetles, and ants, and sometimes cannibalize newly metamorphosed individuals; all of these are widely distributed throughout their environments. Toadlets and juvenile arroyo toads feed on ants almost exclusively, but by the time they reach 0.7 to 0.9 in (1.7 to 2.3 cm) in length, they also feed on beetles. Tadpoles feed by inserting their heads in the substrate and ingesting loose organic material such as detritus, interstitial algae, bacteria, and diatoms. For several days before metamorphosis, arroyo toad larvae cease feeding and aggregate in shallow water along the edges of gravel or sand bars, often under or along stranded algal mats. Arroyo toads hibernate and are nocturnal except during breeding season. They are also inactive during cold temperatures, and are most active at temperatures of 22 to 35°C (71 to 95°F). Newly metamorphosed individuals are active during daylight hours (NatureServe 2015; USFWS 1999; USFWS 2009).

Reproductive Strategy

Adult: R-selection, demersal spawning.

Lifespan

Adult: Approximately 5 years (USFWS 1999).

Breeding Season

Adult: From late January or February to early July, although it can be extended depending on weather conditions (USFWS 1999).

Key Resources Needed for Breeding

Adult: Arroyo toads require shallow, slow-moving stream or riparian habitats that are disturbed naturally on a regular basis, primarily by flooding. This specialization makes their life history and ecological traits different from the typical pattern associated with other species in the genus in the western United States, which often use ponds and other standing water rather than streams and rivers. For breeding, adult arroyo toads use open sites such as overflow pools, old flood channels, and pools with shallow margins. Heavily shaded pools are generally unsuitable for larval and juvenile arroyo toads, because of lower water and soil temperatures and poor algal mat development. Episodic flooding is critical to keep the low stream terraces relatively vegetation-free, and the soils friable enough for juvenile and adult toads to create burrows. Shallow pools (less than 30 cm [12 in.] deep) with clear water are favored by adults for breeding. Water of 15 cm (6 in.) or less in depth is required for reproductive success; egg strands or portions of strands that end up in water over this depth are often attacked by fungus, and fail to hatch. Egg clutches are laid entirely or mostly in water less than 10 cm (4 in.) deep with minimal current velocity, because egg strands are not attached to any substrate features and can be swept away by even very small currents. Breeding sites generally have flow rates less than 5 cm per second (0.2 foot per second), and bottoms composed of sand or well-sorted fine gravel; although a significant component of large gravel or cobble may be present (76 FR 7246; USFWS 1999; USFWS 2009).

Other Reproductive Information

Adult: Embryos hatch in 4 to 6 days when water temperatures are ideal, at 12 to 16°C (54 to 59°F). Larvae may take 8 to 14 days to become free-swimming. The larval period for arroyo toads lasts about 65 to 85 days (USFWS 1999). Metamorphosis may occur at any time between April and the beginning of September, depending on the time of breeding, weather, and water quality. Peak metamorphosis occurs from the end of June to mid-July in the northern part of the toad's range, and from late April to mid-May in southern California. If conditions permit, juvenile arroyo toads remain along the margins of the breeding pools for up to 6 months. Female arroyo toads must feed for a minimum of approximately 2 months to develop the fat reserves needed to produce a clutch of eggs. Eggs are deposited and tadpoles develop in shallow pools with minimal current and little or no emergent vegetation. The substrate in these pools is generally sand or fine gravel overlain with silt. Adult males give a soft, high, whistled trill, generally lasting from 4 to 10 seconds. Males usually begin calling when water temperatures reach 14°C (57°F), and may breed with several females during the course of the season. Calling activity generally begins within 1 hour after sunset, and may continue after sunrise; but the peak calling period usually occurs several hours after sunset. The receptive females seek out calling males based on the size of the male and the sound of his call (USFWS 1999)

Reproduction Narrative

Adult: Arroyo toads have an R-selective and reproductive strategy. Male arroyo toads become sexually mature at around 1 year, and females are mature around 2 years of age. Female arroyo toads must feed for a minimum of approximately 2 months to develop the fat reserves needed to produce a clutch of eggs. Arroyo toads breed once per year, but females may skip a year if they do not have enough fat storage to breed. Breeding season occurs from late January or February to early July, although it can be extended depending on weather conditions. Males usually begin calling when water temperatures reach 14°C (57°F), and may breed with several females during the course of the season. Adult males give a soft, high, whistled trill, generally lasting from 4 to 10 seconds. Calling activity generally begins within 1 hour after sunset, and may continue after sunrise; but the peak calling period usually occurs several hours after sunset. The receptive females seek out calling males based on the size of the male and the sound of his call.The female will lay 2,000 to 10,000 eggs, and embryos hatch in 4 to 6 days if water temperatures are ideal, at 12 to 16°C (54 to 59°F). Larvae may take 8 to 14 days to become free-swimming. The larval period for arroyo toads lasts about 65 to 85 days. Tadpoles develop in shallow pools with minimal current and little or no emergent vegetation. The substrate in these pools is generally sand or fine gravel overlain with silt. Metamorphosis may occur at any time between April and the beginning of September, depending on the time of breeding, weather, and water quality. Peak metamorphosis occurs from the end of June to mid-July in the northern part of the toad's range, and from late April to mid-May in southern California. If conditions permit, juvenile arroyo toads remain along the margins of the breeding pools for up to 6 months.Arroyo toads require shallow, slow-moving stream habitats, and riparian habitats that are disturbed naturally on a regular basis, primarily by flooding. This specialization makes their life history and ecological traits different from the typical pattern associated with other species in the genus in the western United States, which often use ponds and other standing water rather than streams and rivers. Water of 15 cm (6 in.) or less in depth is required for reproductive success; egg strands or portions of strands that end up in water over this depth are often attacked by fungus, and fail to hatch. Egg clutches are laid entirely or mostly in water less than 10 cm (4 in.) deep with minimal current velocity, because egg strands are not attached to any substrate features and can be swept away by even very small currents.For breeding, adult arroyo toads use open sites such as overflow pools, old flood channels, and pools with shallow margins. Heavily shaded pools are generally unsuitable for larval and juvenile arroyo toads, because of lower water and soil temperatures and poor algal mat development. Episodic flooding is critical to keep the low stream terraces relatively vegetation-free, and the soils friable enough for juvenile and adult toads to create burrows. Shallow pools (less than 30 cm [12 in.] deep) with clear water are favored by adults for breeding. Breeding sites generally have flow rates less than 5 cm per second (0.2 foot per second), and bottoms composed of sand or well-sorted fine gravel; although a significant component of large gravel or cobble may be present (76 FR 7246; NatureServe 2015; USFWS 1999; USFWS 2009; USFWS 2014).

Habitat Type

Adult: Both (Terrestrial and Aquatic): Arroyo toads are found in washes, streams, arroyos, riparian woodlands (willow, cottonwood, sycamore, and/or coast live oak), and their adjacent uplands in California. They are also found along rivers that have shallow gravelly pools adjacent to sandy terraces (NatureServe 2015). Outside of the breeding season, arroyo toads are essentially terrestrial and are known to use a variety of upland habitats including but not limited to: sycamore-cottonwood woodlands, oak woodlands, coastal sage scrub, chaparral, and grassland (USFWS 2009).

Habitat Vegetation or Surface Water Classification

Adult: Riverine and riparian areas; woodlands, chaparral, and grasslands.

Dependencies on Specific Environmental Elements

Adult: Arroyo toads require shallow, slow-moving stream or riparian habitats that are disturbed naturally on a regular basis, primarily by flooding. Heavily shaded pools are generally unsuitable for larval and juvenile arroyo toads, because of lower water and soil temperatures and poor algal mat development. Episodic flooding is critical to keep the low stream terraces relatively vegetation-free, and the soils friable enough for juvenile and adult toads to create burrows. Water of 15 cm (6 in.) or less in depth is required for reproductive success; egg strands or portions of strands that end up in water over this depth are often attacked by fungus, and fail to hatch. Egg clutches are laid entirely or mostly in water less than 10 cm (4 in.) deep with minimal current velocity, because egg strands are not attached to any substrate features and can be swept away by even very small currents (76 FR 7246; USFWS 1999; USFWS 2009).

Geographic or Habitat Restraints or Barriers

Adult: Arroyo toads are limited by busy highways that toads rarely, if ever, cross successfully. In addition, roads with barriers to toad movement and urbanized areas dominated by buildings and pavement are geographic restraints to arroyo toad habitat (USFWS 1999).

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Moderate

Tolerance Ranges/Thresholds

Adult: Low/moderate

Site Fidelity

Adult: High

Habitat Narrative

Adult: Arroyo toads are found in streams, arroyos, and adjacent uplands (desert, shrubland), and on sandy banks in riparian woodlands in California. They are also found along rivers that have shallow gravelly pools adjacent to sandy terraces. Arroyo toads are limited by busy highways that toads rarely, if ever, cross successfully. In addition, roads with barriers to toad movement and urbanized areas dominated by buildings and pavement are geographic restraints to arroyo toad habitat. Although arroyo toads may be found along relatively long stretches of some creeks and rivers, suitable breeding or upland habitat may not occur throughout the entire distance. The proportion of suitable habitat for the arroyo toad may change during the year and from year to year, depending on climatic conditions, fires, or other natural or human-related events. The arroyo toad has specialized requirements for breeding habitats. Arroyo toads require shallow, slow-moving stream or riparian habitats that are disturbed naturally on a regular basis, primarily by flooding. For breeding, adult arroyo toads use open sites such as overflow pools, old flood channels, and pools with shallow margins. Heavily shaded pools are generally unsuitable for larval and juvenile arroyo toads, because of lower water and soil temperatures and poor algal mat development. Episodic flooding is critical to keep the low stream terraces relatively vegetation-free, and the soils friable enough for juvenile and adult toads to create burrows. Water of 15 cm (6 in.) or less in depth is required for reproductive success; egg strands or portions of strands that end up in water over this depth are often attacked by fungus, and fail to hatch. Egg clutches are laid entirely or mostly in water less than 10 cm (4 in.) deep with minimal current velocity, because egg strands are not attached to any substrate features and can be swept away by even very small currents (76 FR 7246; USFWS 1999; USFWS 2009; NatureServe 2015; USFWS 1999).

Dispersal/Migration

Motility/Mobility

Adult: Somewhat mobile.

Dispersal

Adult: Eggs take 4 to 5 days to hatch, and tadpoles are essentially immobile for an additional 5 to 6 days. They then begin to disperse from the pool margin into the surrounding shallow water, where they spend an average of 10 weeks. After metamorphosis (June and July), toadlets and juvenile arroyo toads remain on the bordering gravel bars until the pool dries out (usually from 8 to 12 weeks depending on the site and rainfall). Adult toads have dispersal movements up to 3 kilometers (2 miles) from the breeding stream (USFWS 2009).

Dispersal/Migration Narrative

Adult: Arroyo toads are somewhat mobile in their environments and are locally migrant. The arroyo toad migrates between nonbreeding terrestrial habitats and breeding pools. Little is known of the seasonal and annual movements of adults, but data suggest that some subadults and some adult toads have dispersal movements as far as 3 kilometers (2 miles) from the breeding stream. Adult arroyo toads migrate from upland habitat to breeding pools in late January, and return to upland habitats in early July. Tadpoles disperse from the pool margin into the surround shallow water 5 to 6 days after they hatch. After metamorphosis (June and July), toadlets and juvenile arroyo toads remain on the bordering gravel bars until the pool dries out (usually from 8 to 12 weeks depending on the site and rainfall) (NatureServe 2015; USFWS 1999).

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Species Trends:

Declining (USFWS, 2023)

Population Growth Rate:

Declining

Number of Populations:

7 Populations: Northern Recovery Unit 10 Populations: Southern Recovery Unit 2 Populations: Desert Recovery Unit (USFWS, 2023)

Population Size:

There are 2,500 to 10,000 individuals. The total estimated breeding population is fewer than 3,000 individuals. Only six of 22 extant populations south of Ventura are known to contain more than a dozen adults (NatureServe 2015).

Resistance to Disease:

Low. Mostly affected by chytridiomycosis (a fungal disease caused by Batrachochytrium dendrobatidis) (USFWS 1999).

Adaptability:

Low

Population Narrative:

Currently, arroyo toad populations are estimated to be between 2,500 and 10,000 individuals. The total estimated breeding population is fewer than 3,000 individuals, and arroyo toad populations are decreasing. The short-term trend of arroyo toad populations is a decrease of 10 to 30 percent, and the long-term trend is a population decrease of 50 to 90 percent. Only six of 22 extant populations south of Ventura are known to contain more than a dozen adults. Arroyo toad populations are thought to remain in five drainages in nine counties in California, but only five viable populations may occur. Due to their small populations, arroyo toads have low resiliency, representation, and redundancy. The arroyo toad is affected by chytridiomycosis (an infectious disease of amphibians, caused by the chytrid [Batrachochytrium dendrobatidis]), and it is clear from research that arroyo toads can be infected and killed by this nonhyphal zoosporic fungus; therefore, chytrid fungus must be considered a serious threat (NatureServe 2015; USFWS 1999). The arroyo toad recovery plan describes three recovery units: the Northern Recovery Unit, Southern Recovery Unit, and Desert Recovery Unit (Service 1999, pp. 70–74). The Northern Recovery Unit for arroyo toad contains seven populations (Figure A-1), all of which are currently believed to be extant (Hitchcock et al. 2022, entire). The Southern Recovery Unit contains ten populations (Figure A-2), all of which are currently believed to be extant (Hitchcock et al. 2022, entire). In June 2023, a new arroyo toad occurrence was discovered within the Southern Recovery Unit northeast of Sawyer Spring near Long Canyon (southwestern Riverside County, California; 76 FR 7246–7467; Kudla in litt. 2023, entire). The Desert Recovery Unit contains two populations (Figure A-3), both of which are currently believed to be extant (Hitchcock et al. 2022, entire). New information since the 1999 recovery plan found that the Pinto Wash population (within the Jacumba Wilderness Area [In-Ko-Pah Mountains] in Imperial County, California) is no longer considered part of the Desert Recovery Unit. The individuals at this location were misidentified as arroyo toads and erroneously ascribed to the Desert Recovery Unit at the time of the recovery plan (76 FR 7252; Service 2015, p. 97). These findings are supported by Ervin and Beaman (2010, p. 4) and Ervin et al. (2013, p. 202) and Ervin et al. (2013, pp. 199–203). Present-day arroyo toad recovery units and occurrences are summarized in Table 1, and current status of arroyo toad occurrences is displayed in Figure 1 (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction
Exposure: Grazing, water diversion, urban development, mining.
Response: Reduction in habitat.
Consequence: Reduction in population numbers.
Narrative: Because the arroyo toad has specialized breeding habitat requirements, it is particularly vulnerable to habitat destruction and alteration due to short- and long-term changes in river hydrology. The arroyo toad is also impacted by the alteration of riparian wetland habitats from agriculture and urbanization, construction of roads, site-specific damage by off-highway vehicle use and other recreational activities, overgrazing, and mining activities. Dams: Nearly half of the arroyo toad extirpations prior to listing can be attributed to the initial effects of dam building and operations. Dam construction results in the immediate destruction of arroyo toad habitat through inundation; and by regulated stream flows that destroy sand bars used during the breeding season, reconfigure and in some cases eliminate suitable breeding pools, and disrupt

clutch and larval development. Suitable upstream habitat is often flooded out by reservoir water, destroying both arroyo toad breeding and upland habitats. Downstream habitat is often also destroyed or severely altered. Mining: Although mining operations are not widespread, impacts at affected locations can be substantial. Mining operations adjacent to rivers can result in sediment or other contaminant runoff; and can increase water temperature and turbidity, and destroy breeding habitat. Instream gravel mining (suction-dredge mining) removes gravel from the stream channel, interrupting natural sediment transport processes, deepening and degrading the channel, and creating noise disturbance. It also increases water temperature and turbidity, and destroys breeding habitat. Urban development: At the time of listing, habitat loss from development projects in riparian wetlands caused permanent losses of riparian habitats. Urban development was the most conspicuous factor in the decline of the arroyo toad at the time of listing, because the loss of arroyo toad breeding habitat was permanent. Habitat loss and degradation are extensive in rivers of southern California as a result of agricultural and urban development. In addition, vehicles can disturb or run over arroyo toads; crush and uproot riparian plants; spread seeds of invasive plants; and disturb soils, contributing to erosion and sedimentation of aquatic habitats. Toad mortality on roadways is also a factor, especially on sandy, unpaved roads where increased food sources lure toads out at night, and where toads burrow during the day. Grazing: The effects of livestock grazing on arroyo toads include directly crushing individuals and burrows; trampling of stream banks, resulting in soil compaction, loss or reduction in vegetative bank cover, stream bank collapse, and increased instream water temperatures from loss of shade; and added sedimentation of stream segments at crossings or other stream areas used by livestock for watering or grazing on riparian vegetation (USFWS 2009; USFWS 2014.)

Stressor: Nonnative plants and animals
Exposure: Introduction of nonnative plant and animal species.
Response: Predation, illness, mortality.
Consequence: Reduction in population numbers.
Narrative: Nonnative plant species, particularly tamarisk (Tamarix spp.) and giant reed (Arundo donax), alter the natural hydrology of stream drainages by eliminating sandbars, breeding pools, and upland habitats. Nonnative predators have caused substantial reductions in the sizes of extant populations of arroyo toads, and have caused arroyo toads to disappear from large portions of historically occupied habitat. Predatory species, many of which have used the aqueduct to colonize these river basins, include green sunfish (Lepomis cyanellus), largemouth bass (Micropterous salmoides), black bullhead (Ictalurus nebulosus), prickly sculpin (Cottus asper), stocked rainbow trout (Oncorhynchus mykiss), oriental gobies (Tridentiger sp.), red shiners (Notropis lutrensis), and crayfish (i.e., Pacifasticus leniusculus and Procambarus clarki). All of these species prey on arroyo toad tadpoles. Bullfrogs (Lithobates catesbeianus) in particular are known to be a major predator of arroyo toads (USFWS 2009; USFWS 2014).

Stressor: Drought
Exposure: Drought
Response: Poor habitat quality, mortality.
Consequence: Reduction in population numbers.

Narrative: Depending on severity and duration, drought is potentially a threat to arroyo toads, because it can result in serious impacts to the riparian habitats on which species depends. Drought causes soil degradation and increased erosion, which damages aquatic and riparian habitat; drought-stressed plants become diseased more easily; vegetation dries out and becomes highly flammable, causing uncontrolled fires; and the lack of water and lack of food stresses wildlife and plant species. A major concern regarding the effect of drought and water diversion on arroyo toads is that female toads may not be able to find sufficient insect prey to build up enough fat storage for egg production in time to find a mate, resulting in no reproduction for that year. In addition, if streams dry up too early in the breeding season, arroyo toad tadpoles may not have enough time to reach metamorphosis (USFWS 2009; USFWS 2014).

Stressor: Wildfires
Exposure: Wildfire
Response: Reduction in quality habitat, mortality, toxins present in environment.
Consequence: Reduction in population numbers.
Narrative: In recent decades, large fires in California have become more frequent, more widespread, and potentially more deadly. Wildfire has always been part of the cycle of natural dynamics that influences the composition of our forests. However, recently there has been a shift to more severe fires in some locations, and wildfire effects are often exacerbated by drought and insect attack. Fires adversely affect arroyo toads by causing direct mortality, destroying streamside vegetation, and eliminating vegetation that sustains the watershed. Other effects include increased water temperature (as a result of canopy loss), smoke and fire-retardant effects to water chemistry, increased sedimentation in streams and ponds that negatively impact reproduction and recruitment, and the effects of fire and post-fire conditions on arroyo toad terrestrial movements. In addition, wildfires often generate a substantial increase in erosion potential following the loss of protective ground cover and root anchors (USFWS 2009; USFWS 2014).

Stressor: Chytrid fungus
Exposure: Chytrid fungus is a water-borne fungus that can be spread through direct contact between aquatic animals or by spores that can move short distances through the water.
Response: Illness, mortality.
Consequence: Reduction in population numbers.
Narrative: Chytridiomycosis, an infectious amphibian disease caused by a fungus (Batrachochytrium dendrobatidis), has been clearly linked to massive amphibian declines and extinctions worldwide. The fungus only attacks the parts of an amphibian's skin that have keratin (thickened skin), such as the mouth parts of tadpoles and the toes of adults. The fungus can decimate amphibian populations, causing fungal dermatitis, which usually results in death in 1 to 2 weeks, but not before infected animals may have spread the fungal spores to other ponds and streams. Once a pond has become infected with chytrid fungus, the fungus stays in the water for an undetermined amount of time. The arroyo toad is affected by chytrid, and it is clear from research that arroyo toads can be infected and killed by this nonhyphal zoosporic fungus; therefore, chytrid fungus must be considered a serious threat to the Arroyo toad populations (USFWS 2009).

Stressor: Mining and Prospecting (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Instream gravel mining (suction-dredge mining) removes gravel from the stream channel, which interrupts natural sediment-transport processes and deepens and degrades the stream channel. Such mining and prospecting may also increase stream water temperatures and turbidity that can degrade or destroy arroyo toad breeding habitat. Suction dredges pull sedimentary material up from a stream bottom and, after separating the minerals out, redeposit the material back onto the streambed, which increases suspended sediments in the stream that may also suffocate arroyo toad tadpoles. Larvae can also be entrained in the suction pump. Use of vacuum- or suctiondredge equipment, otherwise known as suction dredging, has been prohibited and deemed unlawful in the State of California since January 1, 2016 (California Fish and Game Code § 5653.1). At the time of this 5-year status review, and due to the 2016 prohibition of suction dredging and ongoing regulation of out-of-stream mining across California, mining and prospecting represents little to no threat to arroyo toad recovery (USFWS, 2023).

Recovery

Reclassification Criteria:
The arroyo toad will be considered for reclassification from endangered to threatened status when management plans have been approved and implemented on federally managed lands to provide for conserving, maintaining, and restoring the riparian and upland habitats used by arroyo toads for breeding, foraging, and wintering habitat (USFWS 1999).

In addition, these measures must maintain at least 20 self-sustaining metapopulations or subpopulations of arroyo toads at the following locations (minimum number of populations for each agency and targeted river basins is indicated in parentheses): Fort Hunter Liggett Army Reserve Training Center (1: San Antonio River basin); Marine Corps Base Camp Joseph H. Pendleton (2: San Mateo/San Onofre Creek basins, Santa Margarita River basin); Los Padres National Forest (4: Sisquoc River basin, Upper Santa Ynez River basin [including Indian and Mono Creeks], Sespe Creek basin, Piru Creek basin); Angeles National Forest (3: Castaic Creek basin, Los Angeles River basin [including Big Tujunga and Alder Creeks], Little Rock Creek basin); San Bernardino National Forest (1: Mojave River basin [including West Fork of the Mojave River, Little Horsethief Canyon, and Deep Creek]); Cleveland National Forest (8: San Juan Creek basin, San Mateo Creek basin, Upper Santa Margarita River basin, San Luis Rey River basin, San Dieguito River basin, San Diego River basin, Sweetwater River basin, Tijuana River basin); and Jacumba (In-Ko-Pah Mountains) Wilderness Study Area (1: Pinto Wash basin) managed by the Bureau of Land Management. Self-sustaining populations or metapopulations are those documented as having successful recruitment (i.e., inclusion of newly matured individuals into the breeding population) equal to 20 percent or more of the average number of breeding adults in 7 of 10 years of average to above average rainfall amounts with normal rainfall patterns. Self-sustaining populations or metapopulations require little or no direct human assistance such as captive breeding or rearing, or translocation of toads between sites (USFWS 1999).

Downlisting Criterion #1: Management plans have been approved and implemented on federally managed lands to provide for securing the genetic and phenotypic variation of the arroyo toad in each recovery unit by conserving, maintaining, and restoring the riparian and upland habitats used by arroyo toads for breeding, foraging, and wintering habitat (USFWS, 2023).

Downlisting Criterion #2: At least 20 self-sustaining metapopulations or populations at the locations below must be maintained. Self-sustaining populations are those documented as having successful recruitment (i.e., inclusion of newly matured individuals into the breeding population) equal to 20 percent or more of the average number of breeding adults in 7 of 10 years of average to above average rainfall amounts with normal rainfall patterns. Such recruitment would be documented by statistically valid trend data indicating stable or increasing populations. In addition, self-sustaining metapopulations or populations require no direct human assistance (e.g., captive breeding or rearing, or translocation of toads between sites). This does not include activities such as patrolling or closing roads, campgrounds or recreational areas, or maintaining stream crossings or fencing (USFWS, 2023).

Delisting Criterion: The arroyo toad will be considered for delisting when the genetic and phenotypic variation of the arroyo toad throughout its range in California is secured by maintaining 15 additional self-sustaining populations of arroyo toads in coastal plain, coastal slope, desert slope, and desert river basins, including known populations outside of Federal jurisdiction (USFWS, 2023).

Recovery Priority Number: 8

Delisting Criteria:
The arroyo toad will be considered for delisting when the genetic and phenotypic variation of the arroyo toad, throughout its range in California, is secured by maintaining 15 additional self-sustaining subpopulations or metapopulations of arroyo toads on coastal plain, coastal slope, desert slope, and desert lands, including known subpopulations and metapopulations outside of federal jurisdiction in the Mojave River basin (San Bernardino County); the Whitewater River basin (Riverside County); the San Juan Creek basin (Orange and Riverside Counties); Santa Margarita River basin (San Diego and Riverside Counties); and the San Luis Rey River, San Dieguito River/Santa Ysabel Creek, San Diego River, Sweetwater River, Otay River/Dulzura Creek, and Tijuana River basins (in San Diego County) (USFWS 1999).

Recovery Actions:
- Stabilize and maintain populations throughout the range of the arroyo toad in California by protecting sufficient breeding and nonbreeding habitat (USFWS 1999).
- Monitor the status of existing populations to ensure that recovery actions are successful (USFWS 1999).
- Identify and secure additional suitable arroyo toad habitat and populations (USFWS 1999).

- Conduct research to obtain data to guide management efforts and determine the best methods for reducing threats (USFWS 1999).
- Develop and implement an outreach program (USFWS 1999).
- The following steps and measures should be taken on all projects within the current and historic range of the arroyo toad where habitat conditions are suitable for the species. Each project must be evaluated to assess the need for further conservation measures or restrictions.
- As early as possible in the project design phase, assess the potential for the work site to support the arroyo toad or other sensitive species. Such assessments shall be conducted by qualified biologists using approved methods or protocols.
- Request input from the U.S. Fish and Wildlife Service (USFWS) and other relevant regulatory agencies early in the project design phase. Staff from these agencies can provide project proponents with technical assistance on measures to reduce the project's impacts on arroyo toads and habitat. For certain types of projects, proper project design or timing may avoid effects to the extent that authorization for incidental take is not necessary. Therefore, the project proponent may save considerable time in receiving approval from USFWS. Projects that are well designed from the early stages can be efficient for both the proponent and USFWS by reducing the time, number of meetings, and the number of times project proposals are reviewed. Well-designed projects also may benefit the species.
- Measures to avoid or reduce impacts by projects vary on a case-by-case basis. However, the following measures have become standard for a majority of projects that are conducted in arroyo toad habitat. USFWS may modify some of the measures as appropriate for each given case, and additional measures may be included as appropriate. Adherence to these recommendations does not preclude the need for take authorization. The take authorization or permit issued by USFWS may incorporate some or all of the protection measures presented. The take authorization or permit may include measures specific to the needs of the project, and those requirements supersede any requirements presented.
- A qualified biologist shall conduct a training session for all project personnel prior to proposed activities. At a minimum, the training shall include a description of the arroyo toad and its habitats, the general provisions of the Endangered Species Act (ESA), the need to adhere to the provisions of the ESA, the penalties associated with violating the provisions of the ESA, the general measures that are being implemented to conserve the listed species as they relate to the project, and the access routes to and project site boundaries within which the treatments may be accomplished.
- Access to sites shall be via pre-existing access routes to the greatest extent possible. Project-related vehicle travel should be limited to daylight hours, because arroyo toads use roadways primarily during nighttime hours.
- The footprint of disturbance shall be minimized to the maximum extent feasible.
- A water pollution control plan shall be developed that describes sediment and hazardous materials control, dewatering or diversion structures, fueling and equipment management practices, and other factors deemed necessary by reviewing agencies.
- The upstream and downstream limits of project disturbance plus lateral limits of disturbance on either side of the stream shall be clearly defined and marked in the field, and reviewed by the biologist prior to initiation of work.
- Projects should be designed to avoid the placement of equipment and personnel in the stream channel or on sand and gravel bars, banks, and adjacent upland habitats used by toads.

- Projects that cannot be conducted without placing equipment or personnel in sensitive habitats should be timed to avoid the breeding season of the arroyo toad (generally March through August) when eggs and tadpoles are present. To minimize further effects to breeding populations and to reduce sedimentation and erosion, such projects should be timed so that work in or near the stream channel is conducted during the dry season, when flows are at their lowest or are nonexistent.
- When stream flows must be diverted, the diversions shall be conducted using sandbags or other methods requiring minimal instream impacts. Silt fencing or other sediment trapping materials shall be installed at the downstream end of construction activity to minimize the transport of sediments off site. Settling ponds where sediment is collected shall be cleaned out in a manner that prevents the sediment from reentering the stream. Care shall be exercised when removing silt fences, as feasible, to prevent debris or sediment from returning to the stream.
- Equipment storage, fueling, and staging areas shall be located on upland sites with minimal risks of direct drainage into riparian areas or other sensitive habitats. All necessary precautions shall be taken to prevent the release of cement or other toxic substances into surface waters. All project-related spills of hazardous materials shall be cleaned up immediately, and contaminated soils shall be removed to approved disposal areas.
- Erodible fill material should not be deposited into watercourses. Brush, loose soils, or other similar debris material shall not be stockpiled in the stream channel or on its banks.
- The project biologist shall visit the work site periodically throughout the duration of the project to ensure that all practicable measures are being employed to avoid incidental disturbance of stream habitat and any listed species. The project biologist should be empowered to halt work activity if necessary, and to confer with staff from USFWS to ensure the proper implementation of species and habitat protection measures.
- The removal of native vegetation should be minimized. The work site should be returned to pre-existing contours, and revegetated with appropriate native species.
- Bullfrogs and other exotic species that prey upon or displace listed species should be permanently removed from the wild.
- To avoid attracting predators of the arroyo toad, the project site shall be kept as clean of debris as possible. All food-related trash items shall be enclosed in sealed containers and regularly removed from the site(s). Pets of project personnel shall not be allowed on site where they may come into contact with any listed species.
- To minimize the injury to or mortality of individual arroyo toads, USFWS may authorize qualified project biologists to relocate individual arroyo toads out of harm's way to nearby suitable habitat. Such authorization would be granted only through a biological opinion, prepared by USFWS, pursuant to Section 7 of the ESA, or through the issuance of an incidental take permit by USFWS, pursuant to Section 10(a)(1)(B) of the ESA. Recovery permits are not appropriate to authorize the take associated with the relocation of listed species to avoid project-related effects.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS In this section, we make recommendations that will aid in the recovery and conservation of the arroyo toad. 1. Conduct spatiotemporally replicated surveys at historical and recent arroyo toad occurrences using USGS's (2023, unpubl. data) site-prioritization tool to assess arroyo toad population status—including quantification of various life stages (e.g., larvae, juveniles, adults)—and initiate conservation efforts (e.g., habitat restoration). 2. Implement rangewide genetic and genomic studies to evaluate arroyo toad population structure (i.e., hierarchical, population-metapopulation dynamics) as well as arroyo toad genetic diversity, fitness consequences of future headstarting and translocations, and effective population size (Ne) to inform status of current genetic and phenotypic variation in arroyo toad on existing Federal lands and evaluate maintenance of populations between recovery units. 3. Implement functional-flow studies and management experiments (e.g., pulsed water releases) within dammed streams—during periods of prolonged drought—to control nonnative species and sustain arroyo toad populations over time. 4. Establish new conservation easements for the benefit of the arroyo toad across the Northern, Desert, and Southern Recovery Units, and deploy USGS's (2023, unpubl. data) site-prioritization tool to support associated decision making about strategic land acquisitions. 5. Evaluate arroyo toad population- and individual-level responses to wildfire, drought, and climate change, and conduct arroyo toad headstarting and translocations (e.g., via assisted migration and reintroduction; i.e., population enhancement) to house captive-breeding stock, augment the abundance of wild populations, and preserve genetic diversity under a Best Management Practices' framework to address threats from wildfire, drought, and climate change (USFWS, 2023).

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SPECIES ACCOUNT: *Anaxyrus canorus* (Yosemite toad)

Species Taxonomic and Listing Information

Commonly-used Acronym: YOTO

Listing Status: Threatened

Physical Description

Yosemite toads range in size from 4.5 centimeters (cm) to 7 cm (1¾ inches [in.] to 2¾ in. in size. Females are larger, lighter in color, and have many dark spots on top of a light green back. Males range in color from yellowish green or olive, with few or no spots. The throat and belly are pale on both sexes. Yosemite toads are stocky, have bumpy skin, and have flat oval parotid glands. The dorsal strip is usually absent or very faint. These toads move by walking instead of hopping (USFWS 2015).

Taxonomy

The Yosemite toad, first discovered in Yosemite National Park, was formally known as Bufo canorus until being renamed Anaxyrus canorus in 2006 by Frost et al. The name was changed to place the North American "Bufo" into the new genus Anaxyrus (USGS 2015). Currently, Yosemite toads are recognized as a single taxonomic unit, but more research is needed to determine whether more than one lineage exists within the unit. Further research is also needed to examine the relationship between Yosemite toads and their closest relatives, Anazyrus boreas (western toad). There is a clear difference between Yosemite toads and western toads.

Historical Range

Yosemite toads are endemic to California. Historically, Yosemite toads ranged from the Alpine County to Fresno County in areas above 1,980 to 3,414 meters (m) (6,300 to 11,380 feet [ft.]). The majority of the Yosemite toad population is found between 2,590 and 3,048 m (8,500 and 10,000 ft.). Areas where the toad was found included Grass Lake, Blue Lake, and Ebbetts Pass.

Current Range

Currently, the Yosemite toad is found in scattered locations throughout its historic range. Its current habitat covers only 50 percent of its historic range. Yosemite toads only occur in the Sierra Nevada (IUCN 2015).

Critical Habitat Designated

Yes; 8/26/2016.

Legal Description

On August 26, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for the Sierra Nevada yellow-legged frog (Rana sierrae), the northern distinct population segment (DPS) of the mountain yellow-legged frog (Rana muscosa), and the Yosemite toad (Anaxyrus canorus) under the Endangered Species Act of 1973, as amended (Act). There is significant overlap in the critical habitat designations for these three species. The designated area, taking into account overlap in the critical habitat designations for these three species, is in total approximately 733,357 hectares (ha) (1,812,164 acres (ac)) in Alpine, Amador, Calaveras, El Dorado, Fresno, Inyo, Lassen, Madera, Mariposa, Mono, Nevada, Placer, Plumas, Sierra, Tulare, and Tuolumne Counties, California. All critical habitat units and subunits are occupied by the respective species.

Critical Habitat Designation

303,889 ha (750,926 ac) are designated as critical habitat for the Yosemite toad. This area represents approximately 28 percent of the historical range of the Yosemite toad in the Sierra Nevada. All units designated as critical habitat are considered occupied (at the unit level) and include lands within Alpine, Tuolumne, Mono, Mariposa, Madera, Fresno, and Inyo Counties, California.

Unit 1: Blue Lakes/Mokelumne This unit consists of approximately 14,884 ha (36,778 ac), and is located in Alpine County, California, north and south of Highway 4. Land ownership within this unit consists of approximately 13,896 ha (34,338 ac) of Federal land and 987 ha (2,440 ac) of private land. The Blue Lakes/ Mokelumne unit is predominantly within the Eldorado, HumboldtToiyabe, and Stanislaus National Forests, including lands within the Mokelumne and Carson-Iceberg Wilderness Areas. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit represents the northernmost portion of the Yosemite toad’s range and constitutes an area of high genetic diversity. The Blue Lakes/Mokelumne unit is an essential component of the entirety of this critical habitat designation due to the genetic and distributional area this unit encompasses. The physical or biological features essential to the conservation of the Yosemite toad in the Blue Lakes/ Mokelumne unit may require special management considerations or protection due to inappropriate grazing and recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 2: Leavitt Lake/Emigrant This unit consists of approximately 30,803 ha (76,115 ac), and is located near the border of Alpine, Tuolumne, and Mono Counties, California, predominantly south of Highway 108. Land ownership within this unit consists of approximately 30,789 ha (76,081 ac) of Federal land and 13 ha (33 ac) of private land. The Leavitt Lake/ Emigrant unit is predominantly within the Stanislaus and Humboldt-Toiyabe National Forests, including lands within the Emigrant and Hoover Wilderness Areas, and Yosemite National Park. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit is considered essential to the conservation of the species because it contains a high concentration of Yosemite toad breeding locations and represents a variety of habitat types utilized by the species. The Leavitt Lake/Emigrant unit provides continuity of habitat between adjacent units, as well as providing for a variety of habitat types necessary to sustain Yosemite toad populations under a variety of climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Leavitt Lake/ Emigrant unit may require special management considerations or protection due to inappropriate grazing and recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 3: Rogers Meadow This unit consists of approximately 11,797 ha (29,150 ac) of Federal land located entirely within HumboldtToiyabe National Forest, including area within the Hoover Wilderness and Yosemite National Park. The Rogers Meadow unit is located along the border of Tuolumne and Mono Counties, California, north of Highway 120. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations, is located in a relatively pristine ecological setting, and represents a variety of habitat types utilized by the species. The Rogers Meadow unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units as well as providing for a variety of habitat types necessary to sustain Yosemite toad populations under various climate regimes. This unit has no manageable threats (note that disease, predation, and climate change are not considered manageable threats). However, the physical or biological features with this unit require special protection because of the unit’s value as occupied habitat that provides geographic connectivity to allow for Yosemite toad metapopulation persistence and resilience across the landscape to changing climate.

Unit 4: Hoover Lakes This unit consists of approximately 2,303 ha (5,690 ac) of Federal land located entirely within the Inyo and Humboldt-Toiyabe National Forests, including area within the Hoover Wilderness and Yosemite National Park. The Hoover Lakes unit is located along the border of Mono and Tuolumne Counties, California, east of Highway 395. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains Yosemite toad populations with a high degree of genetic variability east of the Sierra crest within the central portion of the species’ range. This unit contains habitats that are important to the Yosemite toad facing an uncertain climate future. The Hoover Lakes unit is an essential component of the entirety of this critical habitat designation because it provides a continuity of habitat between adjacent units, provides for the maintenance of genetic variation, and provides habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of Yosemite toad in the Hoover Lakes unit may require special management considerations or protection due to recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 5: Tuolumne Meadows/Cathedral This unit consists of approximately 56,530 ha (139,688 ac), and is located within Tuolumne, Mono, Mariposa, and Madera Counties, California, both north and south of Highway 120. Land ownership within this unit consists of approximately 56,477 ha (139,557 ac) of Federal land and 53 ha (131 ac) of private land. The Tuolumne Meadows/ Cathedral unit is predominantly within the Inyo National Forest, with area within the Hoover

Wilderness and Yosemite National Park. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations, represents a variety of habitat types utilized by the species, has high genetic variability, and, due to the long-term occupancy of this unit, is considered an essential locality for Yosemite toad populations. The Tuolumne Meadows/ Cathedral unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, as well as providing for a variety of habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Tuolumne Meadows/Cathedral unit may require special management considerations or protection due to recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 6: McSwain Meadows This unit consists of approximately 6,472 ha (15,992 ac) of Federal land located entirely within Yosemite National Park. The McSwain Meadows unit is located along the border of Tuolumne and Mariposa Counties, California, north and south of Highway 120 in the vicinity of Yosemite Creek. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This contains Yosemite toad populations located at the western edge of the range of the species within the central region of its geographic distribution. This area contains a concentration of Yosemite toad localities, as well as representing a wide variety of habitat types utilized by the species. This unit contains habitats that are essential to the Yosemite toad facing an uncertain climate future. The McSwain Meadows unit is an essential component of the entirety of this critical habitat designation because it provides a unique geographic distribution and variation in habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of Yosemite toad in the McSwain Meadows unit may require special management considerations or protection due to recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 7: Porcupine Flat This unit consists of approximately 1,701 ha (4,204 ac) of Federal land located entirely within Yosemite National Park. The Porcupine Flat unit is located within Mariposa County, California, north and south of Highway 120 and east of Yosemite Creek. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a concentration of Yosemite toad localities in proximity to the western edge of the species' range within the central region of its geographic distribution and provides a wide variety of habitat types utilized by the species. The Porcupine Flat unit is an essential component of the entirety of this critical habitat designation due to its proximity to Unit 6, which allows Unit 7 to provide continuity of habitat between Units 5 and 6, and its geographic distribution and variation in habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Porcupine Flat unit may require special management considerations or protection due to recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 8: Westfall Meadows This unit consists of approximately 1,859 ha (4,594 ac) of Federal land located entirely within Yosemite National Park. The Westfall Meadows unit is located within Mariposa County, California, along Glacier Point Road. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. The Westfall Meadows unit contains Yosemite toad populations located at the western edge of the species' range within the central region of its geographic distribution, and south of the Merced River. Given that the Merced River acts as a dispersal barrier in this portion of Yosemite National Park, it is unlikely that there is genetic exchange between Unit 8 and Unit 6; thus Unit 8 represents an important geographic and genetic distribution of the species essential to conservation. This unit contains habitats essential to the conservation of the Yosemite toad, which faces an uncertain climate future. Unit 8 is an essential component of the entirety of this critical habitat designation because it provides a unique geographic distribution and variation in habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Westfall Meadows unit may require special management considerations or protection due to recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 9: Triple Peak This unit consists of approximately 4,377 ha (10,816 ac) of Federal land located entirely within the Sierra National Forest and Yosemite National Park. The Triple Peak unit is located within Madera County, California, between the Merced River and the South Fork Merced River. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations and represents a variety of habitat types utilized by the species. The Triple Peak unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, specifically east-west connectivity, as well as habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Triple Peak unit may require special management considerations or protection due to recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 10: Chilnualna This unit consists of approximately 6,212 ha (15,351 ac) of Federal land located entirely within Yosemite National Park. The Chilnualna unit is located within Mariposa and Madera Counties, California, north of the South Fork Merced River. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations and represents a variety of habitat types utilized by the species. The Chilnualna Unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, as well as habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Chilnualna unit may require special management considerations or protection due to recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 11: Iron Mountain This unit consists of approximately 7,706 ha (19,043 ac), and is located within Madera County, California, south of the South Fork Merced River. Land ownership within this unit consists of approximately 7,404 ha (18,296 ac) of Federal land and 302 ha (747 ac) of private land. The Iron Mountain unit is predominantly within the Sierra National Forest and Yosemite National Park. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations and represents a variety of habitat types utilized by the species. Further, this unit contains the southernmost habitat within the central portion of the range of the Yosemite toad. The Iron Mountain unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, as well as habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of Yosemite toad in the Iron Mountain unit may require special management considerations or protection due to inappropriate grazing, timber harvest and fuels reduction, and recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 12: Silver Divide This unit consists of approximately 39,987 ha (98,809 ac), and is located within Fresno, Inyo, Madera, and Mono Counties, California, southeast of the Middle Fork San Joaquin River. Land ownership within this unit consists of approximately 39,986 ha (98,807 ac) of Federal land and 1 ha (2 ac) of private land. The Silver Divide unit is predominantly within the Inyo and Sierra National Forests, including lands within the John Muir and Ansel Adams Wilderness Areas. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations and represents a variety of habitat types utilized by the species. The Silver Divide unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, as well as habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Silver Divide unit may require special management considerations or protection due to inappropriate grazing and recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 13: Humphrys Basin/Seven Gables This unit consists of approximately 20,666 ha (51,067 ac), and is located within Fresno and Inyo Counties, California, northeast of the South Fork San Joaquin River. Land ownership within this unit consists of approximately 20,658 ha (51,046 ac) of Federal land and 8 ha (21 ac) of private land. The Humphrys Basin/Seven Gables unit is predominantly within the Inyo and Sierra National Forests, including area within the John Muir Wilderness. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations and represents a variety of habitat types utilized by the species. The Humphrys Basin/Seven Gables unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, as well as habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Humphrys Basin/ Seven Gables unit may require special management considerations or protection due to recreation activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 14: Kaiser/Dusy This unit consists of approximately 70,978 ha (175,390 ac), and is located in Fresno County, California, between the south fork of the San Joaquin River and the north fork of the Kings River. Land ownership within this unit consists of approximately 70,670 ha (174,629 ac) of Federal land and 308 ha (761 ac) of private land. The Kaiser/Dusy unit is predominantly within the Sierra National Forest. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations, represents a variety of habitat types utilized by the species, and is located at the southwestern extent of the Yosemite toad range. The Kaiser/Dusy unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, as well as habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Kaiser/Dusy unit may require special management considerations or protection due to inappropriate grazing, timber harvest and fuels reduction, and recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Unit 15: Upper Goddard Canyon This unit consists of approximately 14,905 ha (36,830 ac) of Federal land located entirely within Kings Canyon National Park and the Sierra National Forest. The Upper Goddard Canyon unit is located within Fresno and Inyo Counties, California, at the upper reach of the South Fork San Joaquin River. This unit is currently occupied and contains the physical or biological features essential to the conservation of the species. This unit contains a high concentration of Yosemite toad breeding locations, represents a variety of habitat types utilized by the species, and is located at the easternmost extent within the southern portion of the Yosemite toad's range. The Upper Goddard Canyon unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, as well as habitat types necessary to sustain Yosemite toad populations under various climate regimes. This unit has no manageable threats (note that disease, predation, and climate change are not considered manageable threats). However, the area requires special protection because of its value as occupied habitat that provides geographic connectivity to allow for Yosemite toad metapopulation persistence and resilience across the landscape to changing climate.

Unit 16: Round Corral Meadow This unit consists of approximately 12,711 ha (31,409 ac), and is located in Fresno County, California, south of the North Fork Kings River. Land ownership within this unit consists of approximately 12,613 ha (31,168 ac) of Federal land and 97 ha (241 ac) of private land. The Round Corral Meadow unit is predominantly within the Sierra National Forest. This unit contains a high concentration of Yosemite toad breeding locations, represents a variety of habitat types utilized by the species, and encompasses the southernmost portion of the range of the species. The Round Corral Meadow unit is an essential component of the entirety of this critical habitat designation because it provides continuity of habitat between adjacent units, represents the southernmost portion of the range, and provides habitat types necessary to sustain Yosemite toad populations under various climate regimes. The physical or biological features essential to the conservation of the Yosemite toad in the Round Corral Meadow unit may require special management considerations or protection due to inappropriate grazing and recreational activities. This unit also has threats due to disease, predation, and climate change. Climate change is not considered a manageable threat. The need for special management considerations or protection due to disease and predation is currently undefined due to uncertainty regarding the extent and magnitude of these particular stressors.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Alpine, Tuolumne, Mono, Mariposa, Madera, Fresno, and Inyo Counties, California. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of the Yosemite toad consist of two components:

(i) Aquatic breeding habitat. (A) This habitat consists of bodies of fresh water, including wet meadows, slow-moving streams, shallow ponds, spring systems, and shallow areas of lakes, that: (1) Are typically (or become) inundated during snowmelt; (2) Hold water for a minimum of 5 weeks, but more typically 7 to 8 weeks; and (3) Contain sufficient food for tadpole development. (B) During periods of drought or less than average rainfall, these breeding sites may not hold surface water long enough for individual Yosemite toads to complete metamorphosis, but they are still considered essential breeding habitat because they provide habitat in most years.

(ii) Upland areas. (A) This habitat consists of areas adjacent to or surrounding breeding habitat up to a distance of 1.25 kilometers (0.78 miles) in most cases (that is, depending on surrounding landscape and dispersal barriers), including seeps, springheads, talus and boulders, and areas that provide: (1) Sufficient cover (including rodent burrows, logs, rocks, and other surface objects) to provide summer refugia, (2) Foraging habitat, (3) Adequate prey resources, (4) Physical structure for predator avoidance, (5) Overwintering refugia for juvenile and adult Yosemite toads, (6) Dispersal corridors between aquatic breeding habitats, (7) Dispersal corridors between breeding habitats and areas of suitable summer and winter refugia and foraging habitat, and/or (8) The natural hydrologic regime of aquatic habitats (the catchment). (B) These upland areas should also maintain sufficient water quality to provide for the various life stages of the Yosemite toad and its prey base

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries of designated critical habitat on September 26, 2016.

The features essential to the conservation of the Yosemite toad may require special management considerations or protection to reduce the following threats: Impacts associated with timber harvest and fuels reduction activity; impacts associated with inappropriate livestock grazing; the spread of pathogens; and intensive use by recreationists, including packstock camping and grazing.

Management activities that could ameliorate the threats described above include (but are not limited to) physical habitat restoration and responsible management practices covering potentially incompatible beneficial uses such as timber harvest and fuels management, water supply development and management, livestock and packstock grazing, and other recreational uses. These management activities will protect the PCEs for the Yosemite toad by reducing the stressors currently affecting population viability. Additionally, management of critical habitat lands will help maintain or enhance the necessary environmental components, foster recovery, and sustain populations currently in decline.

Life History

Food/Nutrient Resources

Food Source

Larvae: Algae, zooplankton, plant material, bottom detritus (Davidson et al. 2005).

Juvenile: Various small invertebrates such as flies, spiders, ants, and beetles (Davidson et al. 2005)

Adult: Various small invertebrates such as flies, spiders, ants, and beetles.

Competition

Larvae: No information available.

Juvenile: No information available.

Adult: No information available.

Food/Nutrient Narrative

Larvae: No information available.

Juvenile: Juvenile Yosemite toads hunt for food in waterbodies as well as on land. Juveniles wait for an invertebrate to come to them, and then use their sticky tongue to capture it. Juveniles eat various small invertebrates such as flies, spiders, ants, and beetles (USFWS 2015) (Davidson et al. 2005).

Adult: Adult Yosemite toads hunt for food in waterbodies as well as on land. Adults wait for an invertebrate to come to them, and then use their sticky tongue to capture it. Adults eat various small invertebrates such as flies, spiders, ants, and beetles (USFWS 2015).

Reproductive Strategy

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: R-selected

Lifespan

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: Up to 15 years for females and 12 years for males.

Dependency on Other Individuals or Species

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: None

Breeding Season

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: May through July, occasionally August.

Key Resources Needed for Breeding

Larvae: Water that does not evaporate within 5 to 7 weeks (Davidson et al. 2005).

Juvenile: Not applicable.

Adult: Still or slow moving water habitat and sufficient cover. Eggs often are attached to vegetation.

Other Reproductive Information

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: No information available.

Reproduction Narrative

Larvae: After hatching, tadpoles metamorphose within 5 to 7 weeks. There can be a high mortality rate with metamorphosis. Tadpoles are preyed upon, and pools of water can evaporate or freeze, which can cause death (Davidson et al. 2005).

Juvenile: Tadpoles metamophose within 5 to 7 weeks after hatching. Males reach reproductive maturity at 3-5 years, females at 4-6 years. Juveniles also can have high overwinter mortality rates (USDA et al. 2015) (USDA et al. 2015).

Adult: Breeding for Yosemite toads occurs from May to July, depending on the snow melt. Males appear at the breeding site pond a few days before females, and some defend a small breeding territory. Breeding occurs in shallow edges of pools, lakes, flooded meadows, and slow-moving streams. The male climbs on the female's back and fertilizes the eggs as they are laid. Females lay 1,500 to 2,000 eggs, once every 2 to 4 years. Eggs are laid in clear, jelly-like strings. Occasionally, the water in the breeding site will evaporate before the eggs can hatch, causing death (Davidson et al. 2015, USFWS 2015).

Habitat Type

Larvae: Ponds, lakes, meadows, and slow moving streams. (Davidson et al. 2005).

Juvenile: Meadows, riparian habitats, borders of forest. (Davidson et al. 2005)

Adult: Yosemite toads can be found in riparian habitats, shallow water, moist meadows, borders of forest, and grassland.

Habitat Vegetation or Surface Water Classification

Larvae: Riverine and lacustrine. (Davidson et al. 2005).

Juvenile: Riparian vegetation, riparian woodlands, subalpine conifers, and lush meadows. (Davidson et al. 2005)

Adult: Riparian vegetation, riparian woodlands, subalpine conifers, and lush meadows.

Dependencies on Specific Environmental Elements

Larvae: Tadpoles need still to slow moving waters associated with shallow waterbodies after hatching. (Davidson et al. 2005).

Juvenile: Juveniles use moist meadows, meadow edges, and terrestrial upland habitats for foraging; they burrow in soil, debris, or rodent burrows. (Davidson et al. 2005)

Adult: Breeding is limited to still or slow-moving waters, along shallow edges of pools. Adult Yosemite toads use moist meadows and terrestrial upland habitats for foraging; they burrow in soil, debris, or rodent burrows.

Geographic or Habitat Restraints or Barriers

Larvae: Tadpoles do not leave the waterbody until metamorphosis occurs. (Davidson et al. 2005).

Juvenile: An individual Yosemite toad does not have a large area for its habitat and does not often move far from a stable pond and water source (USDA et al. 2015). (Davidson et al. 2005)

Adult: An individual Yosemite toad does not have a large area for its habitat and does not often move far from a stable pond and water source (USDA et al. 2015).

Spatial Arrangements of the Population

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: No information available.

Environmental Specificity

Larvae: Narrow (Davidson et al. 2005).

Juvenile: Narrow

Adult: Narrow

Tolerance Ranges/Thresholds

Larvae: Low threshold. (Davidson et al. 2005).

Juvenile: Low threshold.

Adult: Yosemite toads are inactive during hot, dry, and cold weather due to a low tolerance of temperature ranges. Yosemite toads will burrow underground if it is too hot or too cold. If they are exposed to hot or freezing temperatures, it can cause death. Yosemite toads overwinter in underground burrows for 6 to 8 months (USDA et al. 2015.)

Site Fidelity

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: Yosemite toad adults show high fidelity, because they often return to the same pond when breeding. Some toads have been noted to repeatedly use the same two or three terrestrial sites during nonbreeding season (USDA et al. 2015).

Dependency on Other Individuals or Species for Habitat

Larvae: Not applicable.

Juvenile: Not applicable.

Adult: The species is not dependent on other individuals or species.

Habitat Narrative

Larvae: Tadpoles stay in shallow pools of water until metamorphosis is complete. (Davidson et al. 2005).

Juvenile: Yosemite toads are found in moist environments that include meadows, edges of forest, grasslands, and shallow pools of water, and are often in sunny spots. Juveniles burrow in soil, leaf litter, and underground rodent burrows from October through April or May. Yosemite toads emerge from their burrows after the snow has melted. (Davidson et al. 2005)

Adult: Yosemite toads are found in moist environments that include meadows, edges of forest, grasslands, and shallow pools of water, and are often in sunny spots. Adults burrow in soil, leaf litter, and underground rodent burrows from October through April or May. Yosemite toads emerge from their burrows after the snow has melted.

Dispersal/Migration

Motility/Mobility

Larvae: None

Juvenile: Low (Davidson et al. 2005)

Adult: Low

Dispersal

Larvae: Dispersal does not take place during the tadpole life stage. (Davidson et al. 2005).

Juvenile: Juveniles disperse from meadows to meadow/forest edges (Davidson et al. 2005)

Adult: During the breeding season, Yosemite toads move up to 0.78 mile to reach a breeding pond. During the nonbreeding season, they return to the uplands (USFWS 2013, USDA et al. 2015).

Dependency on Other Individuals or Species for Dispersal

Larvae: None

Juvenile: None

Adult: None

Dispersal/Migration Narrative

Larvae: Tadpoles do not migrate. (Davidson et al. 2005).

Juvenile: Yosemite toads migrate to and from their breeding pond and nonbreeding habitat. Yosemite toads will locally migrate close distances to breeding ponds and further upland to nonbreeding locations where they can burrow and forage for food. (Davidson et al. 2005)

Adult: Yosemite toads migrate to and from their breeding pond and nonbreeding habitat. Yosemite toads will locally migrate close distances to breeding ponds and further upland to nonbreeding locations where they can burrow and forage for food.

Additional Life History Information

Larvae: No information available.

Juvenile: No information available.

Adult: None

Population Information and Trends

Population Trends:

Declining

Species Trends:

Declining

Population Growth Rate:

Declining

Number of Populations:

Unknown, at least 50 percent lower than historic numbers.

Population Size:

Unknown

Minimum Viable Population Size:

No information available.

Resistance to Disease:

Research is being conducted on the resistance of Yosemite toads to disease, especially Bd, but they are not thought to be very resistant.

Adaptability:

Low

Additional Population-level Information:

No information available.

Population Narrative:

Yosemite toad populations are declining; they now exist in only 50 percent of historically known sites, even in unaltered habitat. Remaining populations are small and scattered in comparison to historic conditions. Remaining populations consist of a small number of breeding adults.

Threats and Stressors

Stressor: Habitat loss
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Yosemite toads are declining because of habitat loss. Habitat loss and fragmentation has been caused by construction of new roads, parking lots, water diversion, and cattle grazing. In addition, many of the waterbodies have been heavily polluted by human recreation and now have degraded water quality. Riverbanks have been damaged; this has caused disruption of vegetation and erosion along the banks, in turn resulting in excess sedimentation in the lakes, streams, and ponds. These conditions are either unsuitable for the Yosemite toad to live in, or render the habitat unable to provide the type of vegetation or protection that the Yosemite toad

requires. Habitat loss, damage, and fragmentation are killing Yosemite toads; they are unable to adapt to poor water quality conditions, limiting the amount of quality habitat available to them (USDA, 2015).

Stressor: Amphibian Chytrid fungus (Batrachochytrium dendrobatidis, Bd)
Exposure:
Response:
Consequence:
Narrative: Bd is a known cause for amphibian declines worldwide. Although its specific effects on the Yosemite toad are still being researched, the disease has been found in dead Yosemite toads. Because many species closely related to the Yosemite toad have been negatively affected by Bd, it is thought that the fungus will have a detrimental effect on the Yosemite toad population. One species that is being exterminated by this disease is the mountain yellow-legged frog, which is found in environments overlapping those of the Yosemite toad, exposing Yosemite toads to this disease. In addition, Bd thrives in cold temperatures; the fungus spores are spread through waterbodies across the Sierra Nevada, where the Yosemite toad is found (Davidson et al. 2015, California Herps 2015, IUCN 2015, USDA 2015).

Stressor: Climate Change
Exposure:
Response:
Consequence:
Narrative: Yosemite toads have a low tolerance for both extreme cold and hot temperatures—meaning that any climate shift, even slight, could have a negative effect on Yosemite toad populations. In addition, Yosemite toads breed in shallow pools of water, and changes to the temperatures can have an effect on the hydrologic cycle. Decreases in water availability can be detrimental to the continuation of Yosemite toad populations, because such changes can result in stranding and death of eggs and tadpoles. This has already been found to cause death in an entire year’s cohort when the water evaporates rapidly. Adults will be affected by climate change, because a reduction in melting snow packs has the potential to lead to a loss of foraging, breeding, and refugia habitat. Severe winters may force extended overwintering, which can kill toads through stress, a reduction of feeding and breeding time, and a reduction in resources needed to survive, especially for an extended hibernation (USDA et al. 2015).

Stressor: Livestock grazing
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Livestock grazing has the potential to affect all life stages of Yosemite toads. Cattle eat and trample the meadows where adult Yosemite toads are found, eliminating vegetation, compacting the ground, decreasing site productivity, and causing habitat damage. Livestock have also created water quality degradation and nitrogen pollution; destroyed banks; or made banks unstable and susceptible to erosional forces. Both adults and eggs have been crushed by cattle. Theses alterations and damages create unsuitable living conditions for the Yosemite toad, and

destroy the habitat in which they can be found (Davidson et al. 2015, California Herps 2015, IUCN 2015, USDA 2015).

Stressor: UV-B radiation
Exposure:
Response:
Consequence:
Narrative: The contribution of ultraviolet (UV-B) radiation to amphibian decline is currently being debated in the scientific community. The depletion of atmospheric ozone has led to an increase in UV-B radiation, which can affect and destroy egg embryos. Most scientists say that current levels of UV-B radiation do not affect Yosemite toads; but if the ozone becomes weaker, it could have a pronounced effect on the species (Davidson et al. 2015, USDA 2015.)

Stressor: Pesticides
Exposure:
Response:
Consequence:
Narrative: Yosemite toads are very sensitive to water quality issues. A variety of pesticides are used in large quantities in California's central valley. These pesticides can affect suitable habitats for the toad frog when wind, acid rain, and storms conduct in contact with the drift line of the pesticides. Pesticides can harm eggs and larval or adults as a direct toxin or by causing developmental mutations, malformations, sterilization, and weakened immune systems (Davidson et al. 2015, California Herps 2015, IUCN 2015, USDA 2015).

Stressor: Roads
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Many roads have been created in the Sierra Nevadas as the number of visitors has increased. Roads fragment Yosemite toad habitat, creating pollution and run-off that affect water quality. In addition, there are high amphibian mortalities caused by automobile traffic, especially during spring storms when amphibians can often be found on roadways (USDA 2015).

Recovery

Reclassification Criteria:
No information available.

Delisting Criteria:
No information available.

Recovery Actions:
- No information available.
- No recovery plan has been created for the Yosemite toad.

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SPECIES ACCOUNT: *Batrachoseps aridus* (Desert slender salamander)

Species Taxonomic and Listing Information

Listing Status: Endangered; June 4, 1973 (38 FR 14678).

Physical Description

The desert slender salamander (Batrachoseps aridus) is a small, subterranean amphibian from the Plethodontidae (lungless salamander family). Species from this family breathe entirely through their thin moist skin, and have a unique tooth pattern (family name meaning "many teeth"). Slender salamanders (Batrachoseps sp.) are sometimes referred to as "worm salamanders" due to their slim form, segmented appearance, and small limbs. Adult desert slender salamanders are less than 10.2 centimeters (cm) (4 inches [in.]) in total length, with a snout-to-vent (body) length of about 4.8 cm (1.9 in.), and a tail length of approximately 4.8 cm (1.9 in.). The short tail has 16 to 19 costal grooves (18 on average), with 3.5 to 6.5 costal folds between adpressed limbs. Desert slender salamanders are sexually dimorphic in that the female is slightly larger and the male possesses papillate (minute protuberance) vents. The desert slender salamander is distinguished from other species by a distinctive ventral (underside) color of blackish maroon on the belly and gular area, contrasted with a flesh-colored tail venter (underside or abdominal area). The dorsum (upper side) is blackish maroon with a suffusion of silver- to brass-colored iridophores (shiny flecks) interspersed with larger patches of metallic golden-orange iridophores. Young are black to dark brown, and typically lack the brassy tint of adults. Other distinguishing characteristics include a large, rounded head (6.5 millimeters [mm] [0.25 in.] wide; 10.8 mm [0.43 in.] long), and relatively longer legs when compared with those of the nearest congener, the garden slender salamander (Batrachoseps major major) (USFWS 2014).

Taxonomy

The desert slender salamander was initially described as Batrachoseps aridus and was listed as such in 1973 (38 FR 14678). Genetic analysis and morphological assessments of specimens collected from one of the two known populations indicate that the taxon is better treated as one of two subspecies of southern California slender salamanders (B. major), resulting in the recommended reclassification of desert slender salamander as B. m. aridus, and the more widely distributed garden slender salamander as B. m. major. Currently, the desert slender salamander is listed in the Code of Federal Regulations (CFR) at 50 CFR 17.11 as a species, Batrachoseps aridus. As part of the completion of the U.S. Fish and Wildlife Service's 5-Year Review, the Carlsbad Fish and Wildlife Office will submit a recommendation that 50 CFR 17.11 be amended to indicate that the desert slender salamander is recognized as B. major aridus, a subspecies. Recognition at the rank of subspecies does not alter the description or range of the listed entity (USFWS 2014).

Historical Range

No information is available on the historical distribution of the desert slender salamander (USFWS 1982). The desert slender salamander is known from only two canyons on the lower desert slopes of the eastern Santa Rosa Mountains in Riverside, California, in the Santa Rosa and San Jacinto Mountains National Monument Area: Hidden Palm Canyon, and Guadalupe Canyon (USFWS 2014).

Current Range

There are two known localities: an area of less than 0.4 hectare (ha) (1 acre [ac.]) at around 850 meters (m) (2,800 feet [ft.]) in Hidden Palm Canyon, a tributary of Deep Canyon south of Palm Desert, Riverside County, California; and nearby Guadalupe Canyon (NatureServe 2015). The desert slender salamander is presumed to be extant, but as of the 5-Year Review, the species has not been observed since 1997 (USFWS 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: Arthropods found in moist, dark places, including flies (Drosophilia spp.) and ants (Formicidae family) and other soil invertebrates (USFWS 1982; USFWS 2014).

Food/Nutrient Narrative

Adult: Adult and juvenile desert slender salamanders are generalist, opportunistic carnivores/invertivores that prey on arthropods, including flies (Drosophilia spp.) and ants (Formicidae family) and other soil invertebrates, using a special projectile tongue typical of those possessed by other plethodontids (USFWS 1982; USFWS 2014). Prey are found in moist, dark places; it is believed that leaf litter creates a deep, loamy moist soil layer within which a diverse array of soil invertebrates likely serve as a food source for desert slender salamander (USFWS 2014). Whether the emergence or abundance of any arthropod affects the activity or limits the size of the salamander population is unknown (USFWS 1982).The salamanders are presumed nocturnal, though their activity period is poorly understood (NatureServe 2015). Salamanders in the Batrachoseps genus are generally sedentary and exhibit a limited home range (USFWS 2014).

Reproductive Strategy

Adult: Oviparity; direct development; courtship, mating, and oviposition occur on land, and young emerge from eggs as miniature versions of adults (USFWS 2014).

Dependency on Other Individuals or Species

Adult: May use communal nesting (USFWS 2014).

Breeding Season

Adult: Courtship and breeding take place immediately after the first heavy rains of the winter (USFWS 2014).

Key Resources Needed for Breeding

Adult: Desert slender salamander probably lay their egg clutches underground, likely deep within gaps in limestone where moisture is consistently present (USFWS 2014).

Other Reproductive Information

Adult: The eggs of the desert slender salamander have never been observed (USFWS 1982).

Reproduction Narrative

Adult: Most of what is known of the desert slender salamander's reproductive behavior is based on observations of other slender salamander species. Slender salamanders exhibit direct development, whereby courtship, mating, and oviposition occur on land, and young emerge from eggs as miniature versions of adults, bypassing the larval stage that most amphibians exhibit. It is estimated that sexual maturity is reached at 31 mm (1.2 in) (snout-to-vent length) in males, and at a slightly larger size in females. Age at sexual maturity is unknown (USFWS 2014). The eggs of the desert slender salamander have never been observed (USFWS 1982). Egg clutch size is unknown, though the estimated clutch size of garden slender salamander (B. m. major) is 13 to 20 eggs, and other species average about 12 eggs (NatureServe 2015; USFWS 2014). Desert slender salamanders' courtship and breeding take place immediately after the first heavy rains of the winter, and they may use communal nesting. For the California slender salamander (B. attenuatus), 158 hatchlings were observed emerging from one crack after heavy rains in January. Desert slender salamander probably lay their egg clutches underground, likely deep within gaps in limestone where moisture is consistently present (USFWS 2014).

Habitat Type

Adult: The desert slender salamander occurs along small permanent desert springs and creeks with riparian vegetation, under stones, wood, limestone slabs, and talus; and in crevices in rocks and moist soil. In late winter and early spring, the desert slender salamander may occasionally be found under rocks and other objects on canyon floor. Habitat of known locations at Hidden Palm Canyon and Guadalupe Canyon spans an elevational range of approximately 760 to 1,170 m (2,493 to 3,839 ft.) (USFWS 2014).

Habitat Vegetation or Surface Water Classification

Adult: Riverine, spring; palustrine, riparian (USFWS 2014).

Dependencies on Specific Environmental Elements

Adult: Perpetuation of a moist habitat is essential for survival (USFWS 2014).

Geographic or Habitat Restraints or Barriers

Adult: The desert slender salamander is limited to moist habitat such as perennial seeps and springs (USFWS 2014).

Spatial Arrangements of the Population

Adult: The desert slender salamander primarily lives in moist subterranean spaces such as porous soil, bedrock fractures, crevices under limestone sheets, talus (a sloping mass of rock debris) above seeps, and in animal burrows (USFWS 2014).

Environmental Specificity

Adult: Narrow/specialist; community with some key requirements scarce (NatureServe 2015).

Tolerance Ranges/Thresholds

Adult: Soil moisture levels are thought to be of critical importance to facilitate physiological processes, create movement opportunities, provide underground retreats from predators, trigger reproduction, and provide an adequate prey base. This lungless amphibian requires adequate moisture to absorb all the oxygen it needs through thin, highly vascular, moist skin (USFWS 2014).

Site Fidelity

Adult: High; low mobility/home range (USFWS 2014).

Dependency on Other Individuals or Species for Habitat

Adult: None

Habitat Narrative

Adult: The desert slender salamander is a reclusive species found along small permanent desert springs and creeks with riparian vegetation, where it occurs under stones, wood, limestone slabs, and talus, and in crevices in rocks and moist soil. Habitat of known locations at Hidden Palm Canyon and Guadalupe Canyon spans an elevational range of approximately 760 to 1,170 m (2,493 to 3,839 ft.) (USFWS 2014).In late winter and early spring they may occasionally be found under rocks and other objects on canyon floors. The perpetuation of a moist habitat is essential to the desert slender salamander's survival; it primarily lives in moist subterranean spaces such as porous soil, bedrock fractures, crevices under limestone sheets, talus (a sloping mass of rock debris) above seeps, and in animal burrows. Broken limestone sheets and honeycombed limestone were the primary habitat for this species at Hidden Palm Canyon. This area has since been eroded away by storms. The most recent sighting, in 1996, was in a nearly vertical bank of ferns (USFWS 2009).Plants typical of desert oases occupy desert slender salamander habitat, including California fan palm (Washingtonia filifera), narrow-leaved willow (Salix exigua), creosote bush (Larrea tridentata), screw bean mesquite (Prosopis pubescens), and cottonwood (Populous fremonti) (USFWS 2014). Soil moisture levels are thought to be of critical importance to facilitate physiological processes, create movement opportunities, provide underground retreats from predators, trigger reproduction, and provide an adequate prey base. This lungless amphibian requires adequate moisture to absorb all the oxygen it needs through thin, highly vascular, moist skin. Given their necessary association with moist environs in a desert environment, the desert slender salamander has a low mobility and home range, and therefore exhibits high site fidelity (USFWS 2014).

Dispersal/Migration

Motility/Mobility

Adult: Low, due to sedentary habits and dependence on moist environs in a desert environment (USFWS 2014).

Dispersal

Adult: Long-distance movement and daily activities are limited (USFWS 2014).

Dependency on Other Individuals or Species for Dispersal

Adult: No

Dispersal/Migration Narrative

Adult: The activity and movement patterns of desert slender salamander are mostly surmised through use of surrogate species, such as other taxa from the slender salamander (Batrachoseps sp.). Slender salamander shows low mobility/motility due to its sedentary habits and dependence on moist environs in a desert environment, and presumed small home range. Soil moisture levels are thought to be of critical importance to create movement opportunities (USFWS 2014). As a result, long-distance movement and daily activities are limited. Using Batrachoseps genus as a surrogate species, slender salamanders are sedentary, with an average recapture distance of 6 m (19.8 ft.). A study of California slender salamander (B. attenuatus) found that 59 percent of 133 animals never changed shelter (USFWS 2014).

Additional Life History Information

Adult: Using other slender salamander (Batrachoseps sp.) as a surrogate species, slender salamanders are sedentary, with an average recapture distance of 6 m (19.8 ft.) (USFWS 2014).

Population Information and Trends

Population Trends:

Stable; however, this status is precarious at best, given that no more than three individuals have been seen at any one time since 1976 (NatureServe 2015).

Species Trends:

Stable; however, this status is precarious at best, given that no more than three individuals have been seen at any one time since 1976 (NatureServe 2015).

Number of Populations:

Two populations are known in the Santa Rosa and San Jacinto Mountains National Monument Area: at Hidden Palm Canyon and Guadalupe Canyon (USFWS 2014).

Population Size:

One to 1,000 individuals (NatureServe 2015). The Hidden Palm Canyon population is limited to less than 0.4 ha (1 ac.), and the Guadalupe Canyon population is limited to two small patches that together equal an estimated 0.6 ha (1.5 ac.) (USFWS 2014). The total population size and density are unknown (NatureServe 2015).

Resistance to Disease:

Low

Adaptability:

Low

Additional Population-level Information:

The two populations at Hidden Palm Canyon and Guadalupe Canyon are located approximately 7.2 kilometers (4.5 miles) from each other (USFWS 2014).The last detailed study of desert slender salamander at Hidden Palm Canyon was during 1977 and 1978. In all, 343 salamander sightings were made over the course of the study. Based on length, a large proportion of the salamanders detected during most months of the year were juveniles, indicating a reproducing population at the time. No abundance data have been collected for the Guadalupe Canyon population since a study performed in 1984 and 1985, when 30 salamanders were detected in a patchy distribution over 15 nights of sampling (USFWS 2014).

Population Narrative:

Desert slender salamander population and species-level trends are reportedly stable; however, this status is precarious at best, given that no more than three individuals have been seen at any one time since 1976 (NatureServe 2015). Two desert slender salamander populations are known in the Santa Rosa and San Jacinto Mountains National Monument Area: at Hidden Palm Canyon and Guadalupe Canyon (USFWS 2014). The Hidden Palm Canyon population is limited to less than 0.4 ha (1 ac.), and the Guadalupe Canyon population is limited to two small patches that together equal an estimated 0.6 ha (1.5 ac.) (USFWS 2014). The total population size and density are unknown, but are estimated to be between one and 1,000 individuals (NatureServe 2015; USFWS 2014). Only a small percentage of the population occurs outside of their underground refuges at any one time, making an accurate census difficult (NatureServe 2015). The last detailed study of desert slender salamander at Hidden Palm Canyon was during 1977 and 1978. In all, 343 salamander sightings were made over the course of the study. Based on length, a large proportion of the salamanders detected during most months of the year were juveniles, indicating a reproducing population at the time. No abundance data have been collected for the Guadalupe Canyon population since a study performed in 1984 and 1985, when 30 salamanders were detected in a patchy distribution over 15 nights of sampling (USFWS 2014).Given the species' comparatively limited, fragmented, and isolated distribution across the landscape, their poor ecological diversity and variation across their range, and their sensitivity to environmental changes, the species shows a low resilience to withstand stochastic events, has a low representation to adapt to changing environmental conditions across the landscape, a low redundancy to withstand catastrophic events, a low resistance to disease, and low adaptability.

Threats and Stressors

Stressor: Erosion
Exposure: Direct/indirect.
Response: Erosion and removal of suitable habitat.
Consequence: Habitat degradation and loss.
Narrative: Erosion of the habitat is the primary threat to desert slender salamander at Hidden Palm Canyon, and is not known to be a concern at Guadalupe Canyon. Gabions were installed at Hidden Palm Canyon in the 1970s to reduce the expansion of this threat, though it appears these have been ineffective in the long term. Sizable storm events threaten to modify the watershed hydrology of occupied canyons and washes where suitable habitat (talus, limestone sheets, and limestone honeycomb) erode away down to the bedrock as a result of sediment scour and flash floods. Erosion of the substrate is considered a persistent threat due to the topography of the site, which itself magnifies the potential violence of large storm events. The desert slender salamander population was known from an area below a large cliff-like drop in the wash, an area that desert flash floods and associated sediment would scour. In 2006, the continued scouring was evidenced by a complete lack of five-stamen tamarix (Tamarix chinensis), which had been previously known to occur at the site. The 2009 5-year review stated that the construction of Highway 74, which bisects the surface watershed of Hidden Palm Canyon, may have modified the hydrology and resulted in the more destructive, sediment-laden flows that have eroded desert slender salamander habitat in recent history. Substantial down-cutting, several feet in some places, is apparent in the washes entering Hidden Palm Canyon. The effect is subtle, but may indicate that more sediment is being flushed through (USFWS 2009; USFWS 2014).

Stressor: Nonnative plants
Exposure: Indirect
Response: Groundwater reduction and elimination, increased salinity of occupied water source, increased fire frequency, and reduction and replacement of native plant populations.
Consequence: Habitat degradation and loss.
Narrative: The presence of five-stamen tamarix (Tamarix chinensis) has been reported in Hidden Palm Canyon and Guadalupe Canyon. This invasive nonnative plant has rapid reproductive and dispersal rates, allowing it to outcompete native plant species. In doing so, this invasive plant could significantly reduce or eliminate groundwater and surface water, increase the salinity of occupied water sources, and increase fire frequency where it occurs. The nonnative grass foxtail brome (Bromus madritensis ssp. rubens) has been identified in the habitat surrounding Hidden Palm Canyon; the primary concern associated with this species is its ability to increase fire frequency in desert shrublands (USFWS 2014).

Stressor: Disease
Exposure: Vectors include biological surveyors and equipment, and California tree frogs.
Response: See narrative.
Consequence: Potential population decline and extirpation.
Narrative: The fungal pathogen, Batrachochytrium dendrobatidis (Bd), which causes the amphibian disease chytridiomycosis, is a potential concern for desert slender salamander. This disease has caused alarming declines in amphibian populations worldwide. The incidence and effect of Bd on each desert slender salamander population is unknown. This disease could

devastate the small, isolated populations of desert slender salamander. Surveys could introduce this pathogen through infected clothing (e.g., muddy boots) or equipment if proper precautions are not implemented. Prohibited public access to the reserve helps to minimize the potential threat from this disease. However, Bd is already known from the nearby San Jacinto Mountains, which are adjacent to the Santa Rosa Mountains, and the California tree frog (Pseudacris cadaverina), a potential vector species for the disease, occurs in Hidden Palm Canyon. Therefore, there is some possibility that Bd is already in Hidden Palm Canyon. Additional research is needed to further evaluate the potential risk of this disease relative to desert slender salamander.

Stressor: Drought and climate change
Exposure: Indirect
Response: Higher susceptibility to habitat degradation and loss.
Consequence: Mortality and extirpation, reduction in population numbers, and decreased reproductive success.
Narrative: The key risk factor for climate change impacts to desert slender salamander is likely the interaction between increasing temperatures, potentially reduced precipitation, and the relative inability of individuals to disperse into more favorable habitat conditions, given their high site fidelity and the disjunct moist environments within which they already occur. Thus, an increase in the frequency, magnitude, and duration of droughts caused by global warming may have compounding effects with respect to already small, isolated populations of desert slender salamander (USFWS 2014).

Stressor: Small populations
Exposure: Direct/indirect.
Response: Higher susceptibility to habitat degradation and loss, and susceptibility to inbreeding.
Consequence: Mortality and extirpation, reduction in population numbers, and decreased reproductive success.
Narrative: Currently, desert slender salamander is at risk of extinction from the limited number of populations, the small size of each population, and the isolation of each from one another. Furthermore, one of the two known populations (Hidden Palm Canyon) has not been seen since 1997, and a substantial amount of habitat lost at the site indicates this population may either be extirpated, or may be very small at this time. The loss of individual populations increases the risk of extinction to the subspecies as a whole. Chance events outside the range of natural variability can substantially reduce or eliminate small populations and increase the likelihood of extinction. Small populations are more vulnerable to environmental, demographic, and genetic stochastic events (random, natural occurrences), and unforeseen catastrophes. Natural catastrophes such as large storms, or fires followed by large flooding events, could further reduce the suitable habitat available or result in extirpation of small populations. Habitat alterations caused by natural catastrophes have direct effects (exposure to fire, or flooding individuals from the habitat), and indirect effects (scouring and removal of canyon habitat), all of which can result in mortality of individuals. The previously occupied area at Hidden Palm Canyon has already experienced massive scouring following multiple large storm events. There is no opportunity for off-channel refuge at this site. Natural catastrophes occurring directly in desert slender salamander habitat

can have significant effects to this taxon, due to the small, isolated populations available to support recovery (USFWS 2014).

Recovery

Reclassification Criteria:
To downlist to threatened, several actions or objectives similar to recovery criteria are suggested (USFWS 2009; USFWS 2014):

Identify at least two populations, and ensure that they will remain self-sustaining in the long term. a. If one of those populations is at the Hidden Palm Canyon site, evaluate the long-term sustainability of the water source for the spring, and ensure that it will remain stable and sufficient for the salamanders' needs. Also evaluate whether hydrology can be modified so that storm flows are not so violent. b. Verify that the Guadalupe Canyon population is still distributed as before. c. Identify suitable habitat and survey for additional populations of desert slender salamander (USFWS 2009; USFWS 2014).

Restore the habitat at Hidden Palm Canyon. If determined to be beneficial, construct and install additional supporting structures, such as posts, wire fencing, gabions, or a finer fencing material to hold surface material against the side of the canyon. The material held up by posts could be a mixture of gravel, cobble, and organic material (e.g., leaves). The rock would create a matrix of internal spaces for salamanders to live and hide, and the organic material would hold moisture and supply an invertebrate food source. Such structures would have to be periodically repaired after storm events (USFWS 2009; USFWS 2014).

Delisting Criteria:
The Recovery Plan (USFWS 1982) does not contain formal threats-based recovery criteria; however, it does contain a step-down outline for objectives that need to be addressed to minimize further decline of the desert slender salamander and degradation to its habitat (USFWS 2009; USFWS 2014). Delisting criteria have not been established for this species.

Recovery Actions:
- The Recovery Plan (USFWS 1982) does not contain formal threats-based recovery criteria; however, it does contain a step-down outline for objectives that need to be addressed to minimize further decline of the desert slender salamander and degradation to its habitat. This outline is not explicitly related to the five listing factors; however, these actions would benefit the conservation of this species by helping to reduce or eliminate threats addressed by the listing factors. Once threats have been removed or minimized and habitats are restored, adequately protected, and properly managed, reclassification may be considered. The broad objectives to accomplish reclassification or delisting of desert slender salamander, discussed in the Recovery Plan are as follows:
- Protect and manage Hidden Palms Ecological Reserve (USFWS 1982; USFWS 2009; USFWS 2014).
- Develop and implement management plans for other naturally occurring populations of the desert slender salamander (USFWS 1982; USFWS 2009; USFWS 2014).

- Assess feasibility and necessity of introducing the desert slender salamander at particular sites (USFWS 1982; USFWS 2009; USFWS 2014).
- Minimize unauthorized disturbance to the desert slender salamander and its habitat(s) (USFWS 1982; USFWS 2009; USFWS 2014).
- Determine the number and sizes of populations necessary for reclassifying the species to Threatened and to delist (USFWS 1982; USFWS 2009; USFWS 2014).
- Survey Hidden Palm Canyon and Guadalupe Canyon to determine whether these populations are extant, and to evaluate habitat suitability. Identify the distribution and abundance of each population in the remaining habitat (USFWS 2009; USFWS 2014).
- Survey Guadalupe Canyon to gain information on the status of that population. Repeat measurements to determine changes in habitat suitability. Determine if tamarisk is present in substantial numbers, and remove if necessary (USFWS 2009).
- Determine whether nonnatives (e.g. Tamarix spp.) are impacting desert slender salamander habitat in Hidden Palm Canyon or Guadalupe Canyon, and implement a plan for their removal when detected (USFWS 2014).
- If a population remains at Hidden Palm Canyon, evaluate and implement habitat restoration options. Perform hydrological evaluation of Hidden Palm Canyon to better understand and prevent future impacts of erosion, and monitor groundwater levels in the drainage (USFWS 2009; USFWS 2014).
- Consider permitting nonlethal DNA collection (e.g., toe clips) to aid further evaluation of the subspecies' taxonomic placement (USFWS 2014).
- Survey other sites with likely suitable habitat characteristics for additional populations (USFWS 2009; USFWS 2014).
-

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue to improve non-invasive survey techniques Non-invasive survey techniques are needed to evaluate occupancy of populations at Hidden Palms Canyon and Guadalupe Canyon. The fragile condition of the habitat, especially in Hidden Palms, makes anything beyond a surface search potentially destructive to the already degraded habitat. Nocturnal surveys should be conducted when possible and the feasibility of utilizing eDNA survey techniques should be explored to gain knowledge on the presence of the desert slender salamander. 2. Perform an evaluation of the habitat and hydrology of occupied areas An evaluation of appropriate habitat should be performed in order to gain a greater understanding of the species needs. The hydrology of the habitat should be evaluated in order to better understand and prevent impacts from erosion. Groundwater levels should be monitored and evaluated to support the persistence of the desert slender salamander at Hidden Palms Canyon and Guadalupe Canyon. 3. Identify other habitats that may support the desert slender salamander Determine if additional populations of the desert slender salamander exist through surveys based on appropriate habitat characteristics. (USFWS, 2020)

Additional Threshold Information:

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SPECIES ACCOUNT: *Bufo houstonensis* (Houston toad)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1970; Southwest Region (R2) (USFWS, 2016)

Physical Description

The Houston toad is one of six members of the Americanus Group (Forstner 2003). They are generally brown and speckled, although individual toad coloration can vary considerably. Some may appear light brown, others almost black, and they may also have a slightly reddish, yellowish, or greyish hue. Two dark bands extend down from each eye to the mouth, and their legs are also banded with darker pigment. A variable white stripe streaks along the sides of the Houston toad's body. The underside is usually pale with small, dark spots. Males have dark throats, which appear bluish when distended. Adult Houston toads are 2 to 3.5 inches long, are covered with raised patches of skin that resemble warts, and have two parotoid glands that contain chemicals that make the toad distasteful and sometimes poisonous to predators (Brown 1971). Although Houston toads are similar in appearance to the closely-related Gulf Coast toad (Bufo valliceps) and Woodhouse's toad (B. woodhouseii), the species can be discerned by physical characteristics (Brown 1971).

Taxonomy

Treated as a subspecies of B. americanus in older literature. Natural hybridization with B. valliceps and with B. woodhousii has been recorded (Brown 1973). A study of the taxonomic relationship between B. houstonensis and B. americanus charlesmithi was underway in 1990 (USFWS 1990). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Houston toad populations occur only in Texas and typically only along two parallel bands of geologic formations. According to the Bureau of Economic Geology, one band runs through Bastrop, Lee, Burleson, Milam, Robertson, Leon, and Freestone Counties and includes the Carrizo, Queen City, Reklaw, Sparta, and Weches formations. The other band runs through Austin, Colorado, and Lavaca Counties and includes the Willis and Goliad formations. These geologic formations form various sandy soils, including loamy fine sands and fine sandy loams. Current and historic ranges are shown in Figure 2. Surveys conducted by Yantis from 1989 to 1992 found Houston toads occurring in Bastrop, Burleson, Lee, Milam, Robertson, Leon, Lavaca, Colorado, and Austin Counties. There are also historical records from Fort Bend, Harris, and Liberty Counties, but extensive surveys and documentation of the extent of habitat loss and degradation have confirmed the Houston toad's extirpation from these three counties (Hillis et al. 1984, Yantis 1989, 1990, 1991, 1992a). Houston toads have not been found at the critical habitat site (Woodrow Lake) in Burleson County since 1983, although other populations have been found in the county (Dixon 1983, Yantis 1989, 1990, 1991, 1992a, 1992b). Range-wide surveys conducted in 2009 indicate that Houston toads may currently be found in as few as six counties (Bastrop, Austin, Milam, Colorado, Leon, and Lee), although only two or possibly three of these counties were thought to have breeding populations.

Critical Habitat Designated

Yes; 1/31/1978.

Legal Description

On January 31, 1978, the Service determined critical habitat for the Houston toad (Bufo houstonensis) in a portion of its range (43 FR 4022 - 4026). This rule requires all Federal agencies to insure that actions autzed, funded, or carried out by them do not adversely affect this Critical Habitat.

Critical Habitat Designation

The areas determined as critical habitat are located in Bastrop and Burleson Counties, Tex.

(1) Bastrop County. From the junction of a line corresponding to 30"12'00" N. and Texas State Highway 95 east along a line corresponding to 30"12'00' N. to where it intersects a line corresponding to 97"7'30" W. and south along a line corresponding to 97'7'30" W. to where it intersects the Colorado River, west and northwest along the north bank of the Colorado River to the due southward extension of Texas State Highway 95, and north along that extension and Texas State Highway 95 to where it intersects a line corresponding to 30'12'0O" N.

(2) Burleson County. A circular area with a 1-mile radius, the center being the north entrance to Lake Woodrow from Texas FM 2000.

Primary Constituent Elements/Physical or Biological Features

Not available

Special Management Considerations or Protections

Not available

Life History

Food/Nutrient Resources

Food Source

Adult: beetles, flies, lacewings and moths.

Food/Nutrient Narrative

Adult: Houston toads feed on a variety of insects and other invertebrates. Bragg (1960) reported that captive Houston toads favored many small to medium-sized carabids (ground beetles), several small beetles of unknown families, several dipteral (flies), green lacewings, and many types of small moths. Houston toad tadpoles are known to ingest algae and pollen. Hillis et al.

(1984) reported tadpoles consuming the jelly envelopes of recently hatched Houston toad eggs (none were observed eating eggs before they hatched) as well as pine pollen. Tadpoles remain on the bottom of the ponds during the day, and at night they feed on material attached to vegetation in water and along the pond's edge (Hillis et al. 1984). Once they leave the pond after metamorphosis, juvenile Houston toads presumably feed on small invertebrates found on the forest floor.

Reproductive Strategy

Adult: Oviparity

Lifespan

Adult: ~ 3 years (Price 1992)

Breeding Season

Adult: Two or three primary breeding periods separated by two to six week intervals occur at suitable ponds, and males may mate during more than one breeding episode (Hillis et al. 1984). Reported egg-laying dates in the field range from February 18 to June 26 (Kennedy 1962, Dixon 1982, Hillis et al. 1984).

Reproduction Narrative

Adult: The life expectancy of the Houston toad is at least three years and perhaps longer (Price 1992). Captive individuals at the Houston Zoo facility are known to live to 5 years or more (Paul Crump, pers. comm.). Males reach sexual maturity at about one year, but females require one to two years to achieve reproductive maturity (Quinn 1981). In mark-recapture surveys of Houston toads in Bastrop County, observed sex ratios of males to females have been highly skewed in favor of males, ranging from 3:1 to 10:1 (Dixon et al. 1990; Forstner 2002a, 2002b, 2003; Hillis et al. 1984; Swannack and Forstner 2004a, 2007), with Swannack and Forstner hypothesizing the observed male-bias is most likely due to the difference in age at first reproduction. The Houston toad is an "explosive" breeder, appearing in large numbers at breeding ponds where the males call to attract females over a period of a few nights throughout the breeding season (Dixon 1982). Houston toads chorus from January to June (Kennedy 1962, Hillis et al. 1984), with a peak in breeding in February and March. Large numbers of males congregate at a single location while only small numbers of individuals may appear at nearby ponds. Many locations in Bastrop County have failed to reach numbers of chorusing males likely to attract females (Forstner 2002b). Chorusing from individual ponds lasts from three to five days, and may not be synchronized with other ponds in the area. Two or three primary breeding periods separated by two to six week intervals occur at suitable ponds, and males may mate during more than one breeding episode (Hillis et al. 1984). Reported egg-laying dates in the field range from February 18 to June 26 (Kennedy 1962, Dixon 1982, Hillis et al. 1984). Under suitable environmental conditions, pairs remain in amplexus, the copulatory embrace for toads and frogs, for six hours at minimum and eggs are laid in the early morning hours among vegetation or debris near the bank (Hillis et al. 1984). Reported clutch sizes per female vary from 512 to 6,199 eggs (Kennedy 1962, Quinn and Mengden 1984, Quinn et al. 1987). In wet years, breeding may occur wherever sufficient standing water is present. This species typically uses ephemeral rain pools for breeding, although it has been known to breed in flooded fields and permanent ponds. Often, the most reliable breeding sites for locating Houston toads are stock ponds and similar impoundments, since they are permanent water bodies. Unfortunately, permanent water bodies tend to support more predators, such as fish, turtles, bullfrogs (Rana catesbeiana), aquatic invertebrates, and snakes (Forstner 2001) that prey on Houston toads. For successful breeding, water must persist for at least 60 days to allow for egg hatching, tadpole maturation, and emergence of toadlets (Hillis et al. 1984, Price 1992). Development rates of Houston toads vary depending on temperature and other factors. Eggs may hatch within seven days and tadpoles may remain in the pond for 40 to 80 days depending on environmental conditions. Metamorphosis of tadpoles in a given pond generally occurs at approximately the same time over a period of a few hours, resulting in post-metamorphic aggregations of toadlets that remain at the edge of the pond for seven to ten days or more (Hillis et al. 1984, Dixon et al. 1990, Forstner 2002a). Hillis et al. (1984) observed large numbers of toadlets moving as far as 330 feet in daylight from their natal ponds along the same gulleys used by adult toads during the breeding season. Mortality in young is extremely high due to predation and drying of breeding sites, and less than one percent of eggs laid are believed to survive to adulthood (Quinn 1981; Price 1992; Forstner 2002a, 2002b, 2003; Greuter and Forstner 2004). The results from field surveys in 2006 found the Houston toad juvenile survival rate to be approximately 0.03 percent (Forstner 2006). Forstner (2002c) has documented instances of chorusing that did not appear to result in eggs or toadlets; therefore, successful chorusing may not mean successful breeding.

Habitat Type

Adult: Sandy Soil Pine and/or oak woodlands (Service, Unpublished data)

Spatial Arrangements of the Population

Adult: Clumped (inferred from (Laan and Verboom 1990, Rudolph and Dickson 1990, Welsh 1990, deMaynadier and Hunter 1998, Gibbs 1998, Knutson et al. 1999).

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Houston toads are associated with sandy soils. Based on 1997 satellite imagery (Service unpublished data), aerial photographs, U.S. Geological Survey topographic maps, and 1977 land cover maps (Texas Department of Water Resources 1978), all of the current known Houston toad populations and a historic locality in Liberty County are associated with tracts of forests dominated by pines and oaks, and other deciduous trees. Historically, localities in Harris County were characterized as coastal prairie (Brown and Thomas1982). At present, Houston toad habitat consists of rolling uplands characterized by pine and/or oak woodlands underlain by deep, sandy soils (Forstner 2003). Tree species vary from one region to the next, but typically include loblolly pine (Pinus taeda), post oak (Quercus stellate), blackjack oak (Q. marilandica), and/or sandjack oak (Q. incana). Although Houston toad occurrence does not appear to be correlated with the presence of a particular tree species, loblolly pine is dominant in the Lost Pines region of Bastrop County and occurs in other counties within the Houston toad’s range.

The Lost Pines is the most extensive stand of loblolly pines outside of the East Texas pine belt about 100 miles to the east, geographically separated by intervening prairie and savannah. Forests provide habitat partitioning that reduces competition with other toad species, cover to escape from predators and harsh climatic conditions, shade to prevent heating of the sandy soils, and food supplies. Forests also provide habitat continuity needed to maintain dispersal corridors between breeding and terrestrial habitats (Laan and Verboom 1990, Rudolph and Dickson 1990, Welsh 1990, deMaynadier and Hunter 1998, Gibbs 1998, Knutson et al. 1999). Like the loblolly pines, Houston toads are found in areas of sandy soils (no more than 20 percent clay), which form over the Sparta, Queens City, Carrizo, Willis, Weches, Reklaw, and Goliad formations (Yantis 1991, Forstner 2003). These sandy soils effectively catch rainfall, and little is lost to runoff (Soil Conservation Service 1979). The Calvert Bluff Formation, which is a mudstone with varying amounts of sandstone, lignite, and ironstone, is not known to be associated with Houston toad breeding locations. However, breeding ponds have been found on the Calvert Bluff close to the Carrizo Sand (Forstner 2003). Like most amphibians, the Houston toad and its skin are highly vulnerable to desiccation. To aid against desiccation, they become dormant during harsh weather conditions. They seek protection from the winter cold (hibernation) and summer heat and drought (aestivation) by burrowing into moist sand or hiding under rocks, leaf litter, logs, or in abandoned animal burrows (Forstner 2003). Terrestrial juveniles are found in areas with shade and leaf litter (Greuter and Forstner 2004). The presence of water is important for the Houston toad. Rainfall may stimulate breeding (Kennedy 1962, Price 1992) and movement (Quinn et al. 1994), prevents desiccation, and provides pools of water for reproduction. Alternately, an abundance of man-made surface water, presently above the historic condition, may be contributing to reduced aggregations of chorusing males, thus negatively affecting reproduction (Gaston et al. 2010). Breeding occurs in shallow, rain-fed puddles and pools that persist long enough (about 60 to 80 days) for the eggs laid to hatch into tadpoles and metamorphose into toadlets (Hillis et al. 1984, Price 1992). Houston toads have also been documented as breeding in permanent ponds and stock tanks within suitable habitat, although stock tanks and ponds with heavily impacted margins caused by frequent cattle disturbance are not used by the toads (Forstner 2001). Shading has been known to decrease pond temperatures, prolong metamorphosis, and delay emergence (Greuter and Forstner 2004).

Dispersal/Migration

Motility/Mobility

Adult: High (for adults)

Dispersal

Adult: Travel to different sites during breeding.

Dispersal/Migration Narrative

Adult: Many amphibians occupy upland sites at substantial distances from the nearest breeding pond, and members of the Bufo genus are among the most terrestrial anurans. They live on land following metamorphosis and return to water only briefly during the breeding season (Christein and Taylor 1978). Houston toads may range widely throughout upland habitats (Price 1990a, 1992; Dixon et al. 1990; Yantis 1994). Breeding is often followed by aestivation, a state of dormancy, but toads are known to emerge and be active during the non-breeding season (Dodd and Cade 1998, Dixon et al. 1990, Dronen 1991, Forstner 2002a). However, because of the toad's secretive nature, little is known about its distribution and activities during this period. Dronen (1991) reported frequent captures of small (approximately 1.5 inches in body length) Houston toads in pitfall traps during the fall (September through early November) and late winter (late January and early February). Toads were generally captured when temperatures were mild (59 to 77 degrees F) and following periods of rainfall. No Houston toads were captured during colder weather conditions. Forstner (2000, 2001, 2002a) has collected Houston toads throughout the year. Adults were mainly collected between February and May, during the breeding season. However, one male toad was collected in December, which Forstner (2002a) believes is due to a warming that typically occurs in December. Juveniles were collected in all months except January and February. Dixon et al. (1990), Price (1990a), and Yantis (1994) found that during the breeding season adult Houston toads would travel over a mile, sometimes across inhospitable areas such as roads, gravel soils, and pastures. However, telemetry and pit fall trap data indicates that adult Houston toads do not move more than about 49 feet away from forested canopy cover (Swannack et al. 2004, Swannack and Forstner 2004b). During the breeding season, adult Houston toads travel between different sites. A marked adult male traveled a minimum of 4,469 feet each way back and forth between two ponds in a two-year period. Another marked individual in the same study covered 1,592 feet within a 24-hour period (Price 1992). Price (unpublished data, 2001) has documented the same individually-marked male and female Houston toads using breeding ponds that are over one mile apart (straight-line distance) and in different watersheds. Mark-recapture studies have documented individual Houston toads traveling up to 3,900 feet to breeding ponds through areas that included gravel roads, divided highways, and pastures (Dixon et al. 1990, Price 1990a, Yantis 1994). Juvenile dispersal of 4,400 feet in a 5 week period has been documented utilizing genetic mark-recapture techniques (Vandewege et al. 2012).

Population Information and Trends

Population Trends:

Decreasing (Crump et al. 2010)

Population Growth Rate:

This species is believed to have undergone a substantial decline in range extent, area of occupnacy, population size, and habitat qunatity and quality. Decline of 50-90% (NatureServe, 2015)

Number of Populations:

1 - 20 (NatureServe, 2015)

Population Size:

300 - 2000 individuals (Bastrop County) (Crump et al, 2010))

Population Narrative:

Population estimates for the Houston toad are difficult to develop because of the non-random nature of historical surveys, lack of access to private lands to conduct surveys, lack of methods to extrapolate breeding counts to the population as a whole, and the difficulty in locating the toad in times other than the breeding season (Forstner 2003, Forstner 2006, Forstner et al. 2007). Houston toad numbers in Bastrop State Park have shown an overall, long-term negative trend (Price 2003). The Lost Pines region experienced a severe drought in the 1990's, which may have greatly contributed to the decline, and the region again experienced drought conditions in 2005 and 2006. Low numbers of Houston toads observed during Bastrop County survey efforts in 2006 and 2007 indicate this species continues to decline with regard to abundance over the long-term (Forstner 2006, Forstner et al. 2007). This decline has continued to the present day despite additional intensive countywide survey efforts in 2009 and in 2012 following the BCCF (Forstner and Dixon 2011, Forstner et al. 2012). The record statewide drought of 2011, for example, resulted in the detection of 8 individuals in Bastrop County during the 2011 breeding season and no reproductive events (Forstner et al. 2012). Detections for 2012 and 2013 were increased from the 2011 surveys, but still at numbers that suggest the species continues a decline toward extinction Available data indicate that the Lost Pines region in Bastrop and Lee Counties continues to support the largest known and best studied population of Houston toads (Sanders 1953; Brown 1971; Yantis 1989, 1990, 1991, 1992a; Dixon 1982; Price 1990a, 1990b, 1990c, 1992, 1993; Forstner 2002a, 2002b, 2003, 2006, Forstner et al. 2007, Forstner and Dixon 2011). The Bastrop County Houston toad population is likely historically part of a larger biologically relevant subpopulation occurring in the area bounded by the Colorado River on the south and extending well into Lee County on the north (Forstner 2003, 2006, Forstner et al. 2007). Houston toad habitat was found north of the critical habitat delineation in Bastrop County and into Lee County in 2000-2001; however, much of this habitat was cleared and converted into pasture by the end of 2001 (Forstner 2006, Forstner et al. 2007). Past estimates of population size in Bastrop County have ranged from 300 to 2,000 (Brown 1975, Seal 1994) based on data collected primarily at Bastrop State Park. However, the observed sex ratio is on the order of five males to one female, so the effective population size may be much smaller (Forstner 2002a, Forstner 2003, Swannack and Forstner 2004a, Forstner 2006, Forstner et al. 2007, Swannack and Forstner 2007), with possibly only two or three counties in the range thought to have effective breeding populations (Forstner et al. 2007). In 2010, survey results confirmed this assumption by identifying and collecting 21 wild egg strands from three counties (Crump et al. 2010). Eggs were collected from four locations within Bastrop County, one location in Austin County, and one location in Leon County (Crump et al. 2010).

Threats and Stressors

Stressor: Habitat Destruction and Landscape Fragmentation
Exposure:
Response:
Consequence:
Narrative: Habitat conversion and fragmentation make the Houston toad more vulnerable to predation, competition, and hybridization. Removal of trees acts to exacerbate the effect of

drought on a local scale by increasing heat at ground level and consequent moisture loss from the soil, making the deforested area unsuitable for Houston toads that need to burrow to escape desiccation (Forstner 2003). Excavation and impoundment of seasonal or ephemeral drainages or wetland areas creates permanent open water as opposed to ephemeral ponds and pools. Permanent water is more likely to harbor predators such as birds, mammals, snakes, turtles, fish, aquatic invertebrates, and bullfrogs (Quinn and Ferguson 1983, Dixon et al. 1990) and potential competitors such as Woodhouse's and Gulf Coast toads (Hillis et al. 1984). Habitat disturbance also encourages the establishment and proliferation of red-imported fire ants. Fire ants are known to prey on newly-metamorphosed toadlets (Freed and Neitman 1988, Dixon et al. 1990, Forstner 2002a), as well as on the invertebrate community that is an important part of the toad's food base (Bragg 1960). Fire ants are associated with open habitats disturbed as a result of human activity (such as old fields, lawns, roadsides, ponds, and other open, sunny habitats), but are absent or rare in late succession or climax communities such as mature forest (Tschinkel 1988). Thus, maintaining large, undisturbed areas of woodlands may help control the spread of fire ants (Porter et al. 1991) and protect native ant populations (Porter et al. 1988, 1991; Suarez et al. 1998). Paved roads can prevent or hinder dispersal and effectively isolate populations of some invertebrates, small mammals (Mader 1984, Mader et al. 1990), and amphibians (Van Gelder 1973, Reh and Seitz 1990, Soulé et al. 1992, Fahrig et al. 1995, Yanes et al. 1995, Findlay and Houlahan 1997, Gibbs 1998, Vos and Chardon 1998, Knutson et al. 1999). Highways can have serious demographic consequences by increasing mortality and reducing connectivity and migration among remnant habitat patches. Surveys along a 5-mile stretch of Highway 21 adjacent to breeding ponds near Bastrop State Park during 1990 reported 67 percent mortality of Houston toads (12 of 18 individuals) observed in the right-of-way during the breeding season (Dixon 1990, Price 1990c). Agricultural production may contribute to habitat loss by converting forests to pasture or cropland; draining, filling, or deepening of wetlands; and compacting the soil. Plowing, mowing, applying herbicides, pesticides, and fertilizers, and disturbing aestivating toads can result in direct toad mortalities (Knutson et al. 1999, Little et al. 2002). Habitat conversion to cropland or pasture also encourages the establishment of fire ants. Livestock and hay production are common land uses throughout much of the Houston toad's range (Yantis 1989, 1991). Dense sod-forming grasses, such as Bermuda grass can inhibit the Houston toad's mobility (Yantis 1989). Although Houston toads may migrate across cleared areas (Dixon et. al. 1990), they are rarely found far from a forested edge (Swannack and Forstner 2004b). Livestock grazing is a common use of woodlands within the range of the Houston toad. Livestock can trample egg clutches, larvae, toadlets, and wetland vegetation in and around breeding pools, and juveniles, adult toads, and vegetation may be crushed by livestock (Dr. Forstner pers. com.). Forstner (2001) reported a dramatic return of wetland vegetation and an increase in Houston toad breeding success with the removal of cattle. As conversion of forested areas to pastureland continues to occur and more grazing operations are established, landowners are becoming more dependent on permanent water sources. Often times these water sources are created stock ponds. Although the Houston toads utilize permanent water bodies as breeding locations, numerous ponds on the landscape can affect the density of small populations. Smaller or less dense breeding aggregations may attract fewer females, thereby reducing mating probability for males attending smaller choruses, and may have subsequent negative population impacts (Gaston et. al. 2010).

Stressor: Competition and Hybridization
Exposure:
Response:
Consequence:
Narrative: Competitors of the Houston toad include Woodhouse's toad and the Gulf Coast toad. All three species are found in areas of deep, sandy soils. Breeding activity in the Gulf Coast toad has been observed after the peak in Houston toad breeding activity (Swannack et al. 2004). This temporal difference in breeding activity likely reduces competition between the two species. While the Woodhouse's toad has a breeding season that is similar to the Houston toad, the Woodhouse's toad is found more often in open areas. Hybridization with these species has been documented (Hillis et al. 1984). Most hybrids have been found where the habitat of the Houston toad has been altered from woodlands to pasture or suburban development, allowing invasion by the other species (Hillis et al. 1984; Yantis 1991; Forstner 2002a, 2003). Based on a 2012 county-wide survey following the BCCF in September of 2011, post-fire occurrences of Gulf Coast toads in the catastrophically burned area increased significantly as these animals rapidly colonized previously unoccupied areas in the burn zone (Dr. Forstner, pers. comm.).

Stressor: Wildfire and Fire Suppression
Exposure:
Response:
Consequence:
Narrative: Frequent and/or severe forest fires may be detrimental to the Houston toad, particularly for small, fragmented populations. Fire suppression is of primary concern, particularly in the wake of the 2011 catastrophic BCCF, but this issue has been regarded as significant at least as early as the recovery plan (Service 1984). On the other hand, periodic controlled burns may be necessary to reduce fuel loads, prevent catastrophic fires, and improve habitat conditions beneath the forest canopy (Yantis 1989, Price 1993). Although necessary to determine the short and long-range effects of various fire regimes, little research has addressed the effects of fire on amphibians (deMaynadier and Hunter 1995). Direct mortality to the Houston toad resulting from wildfires is thought to be low, as amphibians have been shown to survive fire by moving under the soil or seeking refuge within the burrows of other animals (Russell et al. 1999). Short term juvenile amphibian capture and body condition changes post-fire have been recently examined (Brown et al. 2011) and results indicate that fire does not appear to negatively impact short term terrestrial juvenile amphibian survivorship or health. The most considerable effects to the Houston toad from catastrophic wildfire are the adverse changes to its habitat. The loss of understory vegetation, surface debris (leaf litter and logs), and canopy cover can lead to increased exposure to temperature extremes and predation, loss of habitat availability, and reduced dispersal and foraging capabilities. Soil erosion, which is a typical occurrence following wildfires (Kocher et al. 2009, p. 3), can affect Houston toad breeding habitat by decreasing water quality in ponds.

Stressor: Pesticide, Fertilizer, and Contaminant Impacts
Exposure:

Response:
Consequence:
Narrative: Because of their semi-permeable skin, development of their eggs and larvae in water, and their position in the food web, amphibians are vulnerable to waterborne and airborne pollutants, such as heavy metals, certain insecticides (particularly cyclodienes, such as endosulfan, endrin, toxaphene, and dieldrin), nitrites, salts, certain organophosphates (such as parathion and malathion), and petroleum hydrocarbons (Harfenist et al. 1989, Little et al. 2002). Pesticides can also change the quality and quantity of amphibian food and habitat (Bishop and Pettit 1992). No progress has been made to evaluate the effects of pesticides or herbicides specifically on the Houston toad (Forstner and Dixon 2011).

Stressor: Mineral Production Impacts
Exposure:
Response:
Consequence:
Narrative: Oil and gas fields occur throughout much of the Houston toad's range. The installation of oil and gas wells, roadways, staging areas, pipelines, and the subsequent maintenance of these facilities can result in toad mortality, habitat loss, and fragmentation. Trenching or construction in areas inhabited by aestivating toads and trapping toads in open trenches or pits can result in toad mortality and reproduction can be disrupted by destroying breeding sites. In addition to oil and gas production, mining operations (including lignite, gravel, and sand) can also result in severe, if not total, habitat loss in areas occupied by the Houston toad. Direct mortality of Houston toads and complete destruction of their habitat may occur in the mine area. In addition, Dixon (1982) identified possible indirect impacts from lignite mining: dewatering may draw down surface waters and dry out the subsurface moisture, which may reduce the carrying capacity of permanent surface ponds and/or ephemeral pools; and leaching of sulphur and weak carbonic acids from the mine may produce poor water quality downstream in areas used by the Houston toad.

Stressor: Drought
Exposure:
Response:
Consequence:
Narrative: Drought conditions can have a severe effect on the Houston toad as breeding ponds fail to fill or dry up before eggs or tadpoles can metamorphose. The low numbers of chorusing males recorded in the late 1990s compared to the numbers encountered in 1989-1990 may be the result of the mid-1990s drought (Price 2003, Forstner 2000), while a 2005-2006 drought may have led to reduced numbers of chorusing males in 2006 and 2007 (Forstner et al. 2007). In 2005-09, central Texas experienced harsh drought conditions with only a single wet year in 2007. Compared to historical droughts of the 20th and 21st centuries, the 2008-2009 Texas drought was one of the most severe droughts on record from a precipitation standpoint alone (Nielsen-Gammon and McRoberts 2009). With a brief respite from significant rains in 2010, 2011 brought an unprecedented lack of rainfall since records began being kept in 1895 (Nielsen-Gammon 2011). Both 2012 and 2013 were closer to "normal" precipitation years during the spring

breeding season, but the south central portion of Texas remained in a “moderate” drought in the spring of both 2012 and 2013 (Texas Water Development Board 2013). Although Houston toads persisted through droughts in prehistoric times, habitat loss from anthropogenic impacts has reduced the number of subpopulations and total number of individuals found range-wide (Dr. Michael Forstner, pers. comm.; McHenry and Forstner 2009). This is especially important because low abundance, recruitment, and survivorship of Houston toads significantly affect their ability to rebound from factors that negatively affect their environment (Soulé et al. 1992). Smaller populations are thus at higher risk of extirpation during episodes of drought and may not be recolonized (Blaustein et al. 1994, Forstner 2008). This is especially important as the sex ratio results from Bastrop County indicating fewer females than males exacerbate the situation (Swannack and Forstner 2007). Much of central Texas, including Bastrop County and other portions of the Houston toad’s range, has been experiencing extreme drought conditions from 2008 to 2011. Drought can severely impact Houston toad breeding habitat and reduce the survivorship of juvenile toads.

Recovery

Reclassification Criteria:
A total of 12,141 ha (30,000 ac) of forested Houston toad habitat is conserved through a combination of land acquisition, conservation easements, or other conservation mechanisms appropriate to the land status, to prevent future development to minimize habitat destruction, modification, and fragmentation. The protected habitat must occur within two of the six management units (6,070 ha (15,000 ac) in each) and contain at least three large, (at least 2,023 ha (5,000 ac) areas of suitable Houston toad habitat to minimize edge effects (e.g., reduced threat from fire ants, hybridization, and competition). These undisturbed areas within each management unit must be interconnected by dispersal corridors to reduce threats of small population size and isolation and contain suitable breeding habitat consisting of approximately 1 pond per 81-162 ha (200-400 ac). (USFWS, 2022)

Two or more management units have established Houston toad metapopulations, each consisting of at least three interconnected subpopulations (see Downlisting Criterion 1 above). Each metapopulation must support a minimum of 1,000 adult female Houston toads, as documented by annual surveys for five consecutive years. Counting egg strands the morning following a Houston toad breeding event can be used as a method to measure female abundance, if needed, due to the difficulties of documenting females. (USFWS, 2022)

Delisting Criteria:
At total of 30,351 ha (75,000 ac) of forested Houston toad habitat (including the 12,141 ha (30,000 ac) required for Downlisting Criterion 1), is conserved through a combination of land acquisition, conservation easements, or other conservation mechanisms appropriate to the land status, and protected from future development to further minimize habitat destruction, modification, and fragmentation. The protected habitat must occur within five of the six management units (6,070 ha (15,000 ac) in each) and contain sufficiently large (at least 2,023 ha (5,000 ac) areas of suitable Houston toad habitat to minimize edge effects (e.g., reduced threat

from fire ants, hybridization, and competition). These undisturbed areas within each management unit must be interconnected by dispersal corridors to reduce threats of small population size and isolation. (USFWS, 2022)

Five or more management units have established self-sustaining Houston toad metapopulations, each consisting of at least three interconnected Houston toad subpopulations (see Delisting Criterion 1 above). Each metapopulation must also support a minimum of 1,000 adult female Houston toads, asdocumented by annual surveys over five consecutive years. Counting egg strands the morning following a Houston toad breeding event can be used as a method to measure female abundance, if needed, due to the difficulties of documenting females. (USFWS, 2022)

All established Houston toad metapopulations (see Delisting Criterion 2) must also have at least two percent juvenile Houston toad survivorship within each subpopulation, as documented by annual monitoring over five consecutive years. (USFWS, 2022)

Recovery Actions:

- Relatively consistent rangewide survey and monitoring efforts for the Houston toad have been ongoing continuously with the current group of researchers since the late 1990s with a focus on the largest remaining population in Bastrop County. A robust research effort has led to numerous contributions on the species' genetics (McHenry & Forstner 2009), habitat modeling (Buzo 2008), ecological monitoring (Swannack et al. 2009), abundance estimates (Duarte et al. 2011), response to prescribed fire (Brown et al 2011), response to red imported fire ants (Brown et al, 2012), etc. In accord with the draft revised Houston Toad Recovery Plan (unpublished data), the Houston Toad Recovery Team has identified four "focus areas" to concentrate on-the-ground recovery actions for the Houston toad. The geographic extent of these areas is based on habitat suitability models completed for each county within the Houston toad's range utilizing variables of cover, soils, and distance to water (Buzo 2008). A Houston toad headstarting program was initiated in 2007 by Texas State University, Houston Zoo, Service, and Texas Parks and Wildlife Department (TPWD). The first Breeding and Transfer Plan for the Houston toad has been finalized (Crump and Schad 2012). These actions culminated in the Service, in cooperation with the Houston Zoo, Texas State University, TPWD, and other partners, completing in 2013, the first rounds of captive breeding and re-introductions, continuing headstarting of wild egg strands, and identifying a new location of the Houston toad. Captive breeding and release of Houston toads is not a novel action as the Houston Zoo had a captive breeding program dating back to the 1980s. However, funding and monitoring issues plagued that effort. The Zoo undertook the current attempts of captive breeding in 2012 and information on captive breeding has been updated and revised in each subsequent attempt, leading up to the successes of the spring 2013 captive breeding which resulted in approximately 36k eggs being released into the wild in Bastrop County. Additionally, the Service and partners have been focused on identifying private landowners to enlist in habitat restoration and recovery actions, including releases. Those efforts are rangewide and currently gaining momentum through a number of landowner outreach events, educator education, and the efforts of the Houston Zoo's media relations. A number of section 7 actions in the last 2 years have also added to our understanding of the species and promoted recovery.

- Priority 1 Actions 1. Conserve, Restore, and Protect Habitat (addresses Factor A): Conserve and protect habitat through, for example, Safe Harbor Agreements, conservation banks, Section 6 non-traditional land acquisition, and expansion of current preserves (e.g., Bastrop State Park) within the six management units (Figure 6). Identify areas that could be ideal for conservation and restoration opportunities. Restore habitat using the habitat management guidelines (U.S. Fish and Wildlife Service, 2017). 2. Captive Propagation and Supplementation (addresses Factors A, C, and E): This may include a multi-year supplementation plan. Increase the size of captive populations and the production of eggs and tadpoles for release or add captive populations at one or more additional zoos or other facilities to increase population supplementation capacity. 3. Outreach and Private Land Engagement (addresses Factors A and E): Coordinate with recovery partners to host workshops and outreach events with an emphasis on actionable items. These efforts will focus on private landowners with Houston toad habitat or populations present on their property to achieve consistent and long-term engagement with private lands. 4. Establish a Monitoring Program (addresses Factors C and E): Monitor areas known to support Houston toads and areas where toads have been supplemented. Standardized monitoring will include surveys for adult females; calculations of juvenile survivorship; and evaluation of habitat conditions. 5. Research (addresses Factors A and E): Research topics may include, within the six management units (Figure 6), juvenile movement and dispersal, adult toad home range size, population viability analysis, resistance to dispersal and movement through varying habitat types, effective engagement with landowners, and a revised suitable habitat model. (USFWS, 2022)
- Priority 2 Actions 1. Expand Monitoring (addresses Factors C and E): Identify and survey areas likely to support Houston toads that have not or are not normally surveyed, and survey counties without confirmed observations of Houston toads that have suitable habitat adjacent to counties in the current known range. 2. Community Education (addresses Factors A and E): Coordinate and plan with recovery partners to host education-based workshops, outreach events, and social media to increase the awareness of the general public. 3. Identify Effective Habitat Management Strategies (addresses Factors A, C, and E): Assess effectiveness of restoration and management of Houston toad habitat, including: yaupon removal, tree planting and thinning, prescribed fires, native grass restoration, fire ant control and eradication, and feral hog control and eradication within the management units (Figure 6). Adjust the habitat management guidelines as appropriate (U.S. Fish and Wildlife Service, 2017). (USFWS, 2022)
- Effective Planning and Coordination (addresses Factors A, C, and E): Coordinate and plan with recovery partners, implement and review Recovery Implementation Strategies, track recovery implementation progress and success, and implement adaptive management. (USFWS, 2022)

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SPECIES ACCOUNT: *Cryptobranchus alleganiensis alleganiensis* (Eastern hellbender)

Species Taxonomic and Listing Information

Listing Status: Endangered

Physical Description

The Eastern Hellbender is a large, entirely aquatic salamander that commonly exceeds 50 centimeters (cm) (20 inches (in)) in length (Green and Pauley 1987, p. 45). Large adults may grow up to 74 cm (29 in) (Fitch 1947, p. 210; Petranka 1998, p. 140). Eastern Hellbenders have a large, flat head; small, lidless eyes; a wide neck; heavily wrinkled body; and a keeled tail (Green and Pauley 1987, pp. 45-46). Their short limbs have four toes on the front feet and five toes on the hind feet (Green and Pauley 1987, p. 46). A fold of skin extends along the side of the body between the fore and hind limbs (Green and Pauley 1987, p. 45; Petranka 1998, p. 140). Coloration is variable but is generally dark green, olive, or gray. Irregular, dark spots, brownish or black in color, are often present on the dorsal surface (Cope 1889, p. 41; Bishop 1941, pp. 41, 49; Green and Pauley 1987, p. 46; Petranka 1998, p. 140) (USFWS, 2018).

Taxonomy

The Eastern Hellbender (Cryptobranchus alleganiensis alleganiensis) belongs to the Order Caudata, family Cryptobranchidae. This family contains three extant species belonging to two living genera of salamanders: Andrias, which occurs in Japan and China, and Cryptobranchus, which occurs in parts of the eastern United States. The genus Cryptobranchus is monotypic and currently contains two recognized subspecies: C. alleganiensis alleganiensis and C. alleganiensis bishopi. However, the taxonomic differentiation between hellbender subspecies is not well agreed upon by experts and discussion continues on whether C. a. alleganiensis and C. a. bishopi are distinct species or subspecies (USFWS, 2018).

Historical Range

Historically, the species was widespread across 15 states from northeastern Mississippi, northern Alabama, and northern Georgia northeast to southern New York, with disjunct populations occurring in east-central Missouri (USFWS, 2018).

Current Range

Missouri DPS: MO; Niangua River, Gasconade River, and Meramec River watersheds in Missouri

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: Adult Eastern Hellbenders eat crayfish and, to a lesser degree, small fish (Smith 1907, p. 12; Swanson 1948, p. 363; Peterson et al. 1989, p. 440). Other occasional food items include insects and larval and adult frogs (Green 1935, p. 36; Pfingsten 1990, p. 49; Foster 2006, p. 74)..Cannibalism of all life stages has been documented (Smith 1907, pp. 18, 36; Nickerson and Mays 1973, p. 22; Humphries et al. 2005, p. 428; Phillips and Humphries 2005, p. 649, Groves and Williams 2014, p. 109) (USFWS, 2018).

Reproductive Strategy

Adult: Oviparous

Lifespan

Adult: Eastern Hellbender maximum age is not known with certainty. Longevity records in captivity include 29 years (Nigrelli 1954, p. 297) and 30 years (Groves 2012, pers. comm.). Some estimates suggest that they can live at least 25-30 years in the wild (Taber et al. 1975, p. 635; Peterson et al. 1988, p. 298). However, the longest-term study of growth to date (11 years) suggests that many adults captured during the study were at least 50 years old (Horchler 2010, p. 19) (USFWS, 2018).

Breeding Season

Adult: Eastern Hellbenders generally breed between late August and early October (USFWS, 2018)

Key Resources Needed for Breeding

Adult: Nests have been found in bedrock fissures (Nickerson and Tohulka 1986, p. 66) but are typically excavations beneath partially embedded large flat rocks (USFWS, 2018).

Reproduction Narrative

Adult: Eastern Hellbenders reproduce via external fertilization (females deposit eggs under a nest rock and males fertilize the egg clutch) after which a single male defends the nest from other hellbenders. Survival and successful recruitment require abundant prey (primarily crayfish but also small fish, insects, and frogs) and large (greater than 30 cm), flat rocks, partially embedded with a single opening facing downstream, for nests and shelter. (USFWS, 2020)

Habitat Type

Larvae: Aquatic

Juvenile: Aquatic

Adult: Aquatic

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2018)

Habitat Narrative

Larvae: Larvae can be found under large rocks (Groves et al. 2015, p. 70; Nickerson et al. 2003, p. 624; Hect-Kardasz et al. 2012, p. 232) but are more often associated with the interstices of cobble and gravel (Nickerson et al. 2003, p. 624; Keitzer 2007, pp. 16-17; Foster et al. 2008, p. 184), which may be due to the increased presence of macroinvertebrates that provide a food source (Keitzer 2007, pp. 16-17) (USFWS, 2018).

Juvenile: Juveniles have been found in the interstices of cobble piles (Foster 2006, pp. 73-74) and under large rocks (L. Williams 2012, pers. comm.; Foster 2006, pp. 73-74) (USFWS, 2018).

Adult: Boulders, especially large slab rocks, act as cover and are consistently identified as the most important indicator of adult Eastern Hellbender habitat (Lipps 2009c, p. 9; Humphries 2005, p. 10; Bothner and Gottlieb 1991, p. 45). Shelter rocks are typically partially embedded with a single opening facing downstream (Smith 1907, p. 7). Other shelter types, such as fissures in bedrock, are sometimes used (Nickerson and Tohulka 1986, p. 66; Peterson 1987, p. 199; L. Williams 2012, pers. comm.). Adult Eastern Hellbenders are typically found singly under shelter rocks, which they defend from other Eastern Hellbenders (Smith 1907, pp. 24-25; Swanson 1948, p. 362; Hillis and Bellis 1971, p. 125; Humphries and Pauley 2005, p. 138) (USFWS, 2018).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Adults are primarily nocturnal (Green 1934, p. 28), remaining beneath cover during the day although some diurnal activity has been observed (Nickerson and Mays 1973, pp. 40-41; Noeske and Nickerson 1979, p. 94), especially during the breeding season (Smith 1907, p. 6; Foster 2006, p. 25). The Eastern Hellbender moves by walking on stream bottoms (Smith 1907, p. 9) but can swim short distances quickly, presumably to avoid predators (Nickerson and Mays 1973, p. 41). The extended time required to recover from lactacidosis (lactic acid buildup in tissues) caused by exercise restricts them to a lifestyle of minimal activity (Ultsch and Duke 1990, pp. 256-257). Studies have documented relatively small home ranges, with estimates ranging from approximately 30 square meters (m2) (322 square feet (ft2)) to approximately 2,212 m2 (23,810 ft2) (Hillis and Bellis 1971, p. 124; Coatney 1982, p. 23; Peterson and Wilkinson 1996, p. 126; Humphries and Pauley 2005, p. 137; Burgmeier et al. 2011a, p.139). Despite having generally restricted home ranges, hellbenders are capable of long distance movements and have been documented moving up to 12.9 kilometers (km) (8 miles (mi)) (Petokas 2011, pers. comm.; Foster 2012, pers. comm.) (USFWS, 2018).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2021)

Resiliency:

Given the current (83%) and projected (71% - 94%) loss of healthy populations, Eastern Hellbender resiliency in the OACU is substantially lower than historical conditions and will likely remain so in the future. Despite these losses, the current and projected geographic spread of populations is such that we expect from 15 to 71 healthy populations to persist across spatially heterogeneous environmental conditions and a diversity of stream orders and temperature regimes. However, OACU-wide extirpation is still plausible within the next 25 years due to the threat from a disease epidemic under the RWP scenario (USFWS, 2018).

Representation:

Eastern Hellbender representation is a function of both genetic and adaptive diversity. As described in Chapter 1, genetic diversity is important because it can delineate evolutionary lineages that may harbor unique genetic variation, including adaptive traits, and can also indicate gene flow, migration, and dispersal. Adaptive diversity is important because it provides the variation in phenotypes and ecological settings on which natural selection acts. By maintaining these two sources of diversity across the species' range, as well as the processes that drive evolution (gene flow, natural selection, mutations, and genetic drift), the responsiveness and adaptability of the Eastern Hellbender over time is preserved (USFWS, 2018).

Redundancy:

Species-level redundancy is best achieved by having multiple, widely distributed populations of Eastern Hellbenders relative to the spatial occurrence of catastrophic events. As further explained in Chapter 5, we identified disease and chemical spill events as the most likely catastrophic factors. Although a species' ability to withstand catastrophic events can be influenced by its health (i.e., a demographically robust population is more likely to withstand disease), it is most strongly influenced by exposure to such events. Exposure is a function of both the number of populations (the more populations, the less likely all will be exposed) and the distribution of populations (the more widely distributed, the less likely all will be exposed). 22 Thus, generally speaking, the greater the number of populations and the more widely distributed, the more redundancy the species possesses. In addition to guarding against a single or series of catastrophic events extirpating all populations of the Eastern Hellbender, redundancy is important to protect against losing irreplaceable sources of genetic and adaptive diversity. Having multiple Eastern Hellbender populations within each evolutionary lineage (see "Representation" section below) will guard against losses of adaptive diversity due to catastrophic events. Thus, Eastern Hellbender redundancy is described as having multiple, healthy populations widely distributed across the breadth of genetic and adaptive diversity relative to the spatial occurrence of catastrophic events (USFWS, 2018).

Number of Populations:

3 (USFWS, 2023)

Resistance to Disease:

Disease can act as a stressor on Eastern Hellbender populations and has the potential to cause catastrophic loss of ACUs. Based on current information, the diseases that could impact hellbenders are described below. Batrachochytrium dendrobatidis (Bd): Batrachochytrium dendrobatidis is a fungal pathogen which can cause chytridiomycosis, a highly infectious amphibian disease associated with mass die-offs, population declines and extirpations, and potentially species extinctions on multiple continents (USFWS, 2018). Batrachochytrium salamandrivorans: Another fungal pathogen, B. salamandrivorans (Bsal), invaded Europe from Asia around 2010 and is responsible for causing mass die-offs of fire salamanders (Salamandra salamandra) in northern Europe (Martel et al. 2014, p. 631; Fisher 2017, p. 300-301). Ranaviruses. (USFWS, 2018).

Additional Population-level Information:

Recovery potential is also considered high because approximately 814 eastern hellbender larvae/juveniles are currently being reared in captivity. These individuals will be used to augment wild populations and investigate potential threats contributing to population declines. (USFWS, 2021). Within Missouri, the eastern hellbender occurs in the northern portion of the Ozark Highlands in the Niangua River, Gasconade River, Osage Fork of the Gasconade River, Big Piney River, Meramec River, Huzzah Creek, Courtois Creek, and Big River (Fig. 1). We consider the DPS to consist of 3 populations, with each population defined as all of the occupied rivers within a watershed flowing into either the Missouri or Mississippi rivers (Fig. 1). Thus, the Niangua River population consists of individuals in the Niangua River; the Gasconade River population consists of individuals from the Gasconade River, Osage Fork of the Gasconade River, and Big Piney River; and the Meramec River population consists of individuals from the Meramec River, Huzzah Creek, Courtois Creek, and Big River (USFWS, 2023).

Population Narrative:

Eastern Hellbender abundance has decreased in many parts of the range, with reduced numbers observed as early as 1948 (Swanson 1948, p. 363). Population declines have subsequently been documented in several states throughout the range (Gates et al. 1985, p. 4; Gottlieb 1991, p. 47; Wheeler et al. 2003, p. 153; Burgmeier et al. 2011c, pp. 198-200), with declines often characterized as severe or drastic (Wheeler et al. 2003, p. 155; Briggler et al. 2007, p. 85; Burgmeier et al. 2011c, p.198). Density estimates since 2000 range from 0.06 to 1.2 hellbenders per 100 m2 (328 ft2) in areas where declines have been documented (Humphries and Pauley 2005, p. 137; Foster et al. 2009, p. 583; Burgmeier et al. 2011c, p. 196). Declines in density are often accompanied by a shift to older individuals, with young (small) individuals making up a significantly smaller proportion of the samples (Gottlieb 1991, p. 47; Wheeler et al. 2003, p. 155). This shift to older individuals indicates poor recruitment in these populations. In some areas, however, Eastern Hellbender appears abundant with a size class structure indicative of successfully recruiting populations (Horchler 2010, p. 20; Hecht-Kardasz et al. 2012, pp. 231, 238; Freake and DePerno 2017, pp. 6-7). New populations have also been discovered since 2000 (Gowins, et al. 2014, p. 12; Wethington 2017, pers. comm.; Williams 2016, pers. comm.; Lipps 2010, Chapman 2017, pers. comm.; Godwin, pers. comm. 2016). However, most of these discoveries were observations of a single individual or detection via eDNA. A lack of data regarding abundance or size class structure in these populations precludes assessments of population trends.. Currently, there are 393 extant populations, 68 extirpated populations, and 109 populations with unknown status (Table 4.2). Of the extant populations, 9% are healthy (SR), 15% have evidence of recruitment but no trend data (UR), 14% are declining (D), and 62% have an unknown trend (UT) (Table 4.2) (USFWS, 2018).

Threats and Stressors

Stressor: Sedimentation
Exposure:
Response:
Consequence:
Narrative: For all ACUs, sedimentation was identified by experts as the factor most impacting the status of the Eastern Hellbender and has been identified as an ongoing threat in every major river system in the range of the species (USFWS, 2018).

Stressor: Water Quality Degradation
Exposure:
Response:
Consequence:
Narrative: Compared to other influences, degraded water quality was estimated as having the second highest impact on the status of the Eastern Hellbender. Degraded water quality can cause direct mortality to sensitive species, such as the Eastern Hellbender and, at sub-lethal levels, can alter physiological processes and increase vulnerability to other threats (Maitland 1995, p. 260, also see Synergistic Effects). Major sources of aquatic pollutants include domestic wastes, agricultural runoff, coal mining activities, and unpermitted industrial discharges, all of which have been identified as threats to Eastern Hellbenders. Additionally, chemical spills can extirpate populations. There are a few documented cases of Eastern Hellbender kills (Williams, Chapman, and Floyd 2017, pers. comm.; Feller and Thompson 2011, entire) and many examples of fish and mussel kills from chemical pollution within the Eastern Hellbender range (USFWS 2013, pp. 59279-59284; Henley et al. 2002, entire). However, there is no information available to estimate how frequently chemical pollution events occur or the likelihood of this causing catastrophic decline in an ACU. There are several databases tracking reported chemical spill events, 303(d) listed streams3 , and chemical pollution; however, the effects of chemicals on Eastern Hellbender remain largely unknown (Burgmeier et al. 2011b, p. 836; Pugh et al. 2015, pp. 105-6). While it is unlikely that a chemical spill could cause catastrophic loss of an entire ACU, it is possible if multiple spills occur in an ACU with low redundancy (USFWS, 2018).

Stressor: Habitat Destruction and Modification: Impoundments
Exposure:
Response:
Consequence:
Narrative: Construction of artificial impoundments (dams) modifies Eastern Hellbender habitat in multiple ways. Impoundments reduce upstream streamflow, increasing sedimentation in the impounded reaches (Baxter 1977, p. 260; Bhowmik and Adams 1989, pp. 17-18) and subsequently lowering dissolved oxygen. Sedimentation from reduced stream flow also reduces available substrate for both hellbenders and their prey (Williams et al. 1981a, p. 99; Santucci et

al. 2005, pp. 986-987). In some cases, impoundments can create unsuitable conditions for Eastern Hellbenders downstream due to low DO, cold hypolimnion releases, and variable flow rates. In addition, dams can create a barrier to Eastern Hellbender movement by isolating populations, and limiting gene flow and recolonization of formerly occupied habitat, thereby exacerbating local population declines and extirpations. Dams have been constructed in every major stream system in the range of the Eastern Hellbender and have contributed to population declines and local extirpations, especially in large streams used for navigation (e.g., Ohio, Cumberland, and Tennessee rivers), and are currently restricting movement among some populations and into some previously occupied habitats (USFWS, 2018).

Stressor: Disease
Exposure:
Response:
Consequence:
Narrative: Disease can act as a stressor on Eastern Hellbender populations and has the potential to cause catastrophic loss of ACUs. Based on current information, the diseases that could impact hellbenders are described below. There are two avenues by which disease could result in a catastrophic event for Eastern Hellbender. The first is through the introduction of novel pathogens and the second is through mortality events caused by existing pathogens and triggered by additional stressors. While it is difficult to predict the likelihood that existing pathogens will lead to catastrophic losses in the ACUs within the next 25 years, it does seem likely that the introduction of novel pathogens could result in catastrophic losses in one or more ACUs in that time frame because emerging infectious diseases (EIDs), especially fungal EIDs in wildlife, are on the rise and salamanders are especially susceptible given the high magnitude of legal and illegal trade in herpetofauna. Given the long-lived environmental stages of fungi, a novel fungal pathogen could cause mass mortality in Eastern Hellbenders if it is introduced and spread rapidly through the stream environment (as demonstrated by Batrachochytrium dendrobatidis (Bd)). Thus an EID could cause catastrophic loss of the species on a broad scale (i.e., the ACU scale) (USFWS, 2018).

Stressor: Small Populations, Population Fragmentation, and Isolation
Exposure:
Response:
Consequence:
Narrative: Populations of the Missouri DPS of eastern hellbender are small and isolated from one another by impoundments and large reaches of unsuitable habitat. This isolation restricts movement among populations and precludes natural recolonization from other populations (Dodd 1997, p. 178; Benstead et al. 1999, pp. 662– 664; Poff and Hart 2002, p. 660) (USFWS, 2021).

Stressor: Increased Abundance of Species of Predators
Exposure:
Response:
Consequence:

Narrative: Some native predators of the eastern hellbender, such as raccoons, have increased in abundance due to anthropogenic influences, while others have recently been reintroduced into hellbender streams within the range of the Missouri DPS (e.g., river otters) (Briggler et al. 2007, p. 17). Nonnative predators are also present within a large portion of the Missouri DPS of eastern hellbender's range and include predatory fish stocked for recreation, such as rainbow trout (Oncorhynchus mykiss) and brown trout (Salmo trutta) (Mayasich et al. 2003, p. 20). Species experts presume nonnative trout species directly impact eastern hellbenders by predating on eggs, larvae, and subadults (Briggler et al. 2007, p. 23) (USFWS, 2021).

Stressor: Direct Mortality or Permanent Removal of Animals
Exposure:
Response:
Consequence:
Narrative: Large numbers of eastern hellbenders have historically been removed from some streams within the Missouri DPS for scientific and educational purposes (Peterson 1985, p. 59; Ingersol 1991, pp. 61, 63) (USFWS, 2021).

Stressor: Synergistic Effects
Exposure:
Response:
Consequence:
Narrative: In some instances, effects from one threat may increase effects of another threat, resulting in what is referred to as synergistic effects. Synergistic effects often include an increased susceptibility to predation (Moore and Townsend 1998, pp. 332–333), disease (Kiesecker and Blaustein 1995, pp. 11050–11051; Taylor et al. 1999, pp. 539–540), or parasites (Kiesecker 2002, pp. 9902– 9903; Gendron et al. 2003, pp. 472–473). In addition, chronic, increased levels of stress hormones have been shown to inhibit immune response (Rollins-Smith and Blair 1993, pp. 156–159; Romero and Butler 2007, pp. 93–94). Other stressors present in the eastern hellbender's environment (e.g., habitat modification, degraded water quality) could reduce immune response and thereby increase vulnerability to disease and parasites (USFWS, 2021).

Recovery

Recovery Actions:

- Recovery Priority Number The eastern hellbender is assigned a recovery priority number of 3 on a scale of 1C (highest) to 18 (lowest; the "C" indicates the potential for conflict with human economic activities). The ranking is based on a high degree of threat, high potential for recovery, and taxonomic status as a subspecies (USFWS 1983a, b). The magnitude of threat is currently high given continued population declines, spread of amphibian chytrid fungus, potential predation by non-native fish, and reduced recruitment and population size in the wild. Recovery potential is considered high because most of the potential threats can ultimately be managed or abated. These threats include habitat degradation from sedimentation, degraded water quality; unauthorized collection; and potential predation by non-native predators. A threat that may not be possible to manage is amphibian chytrid fungus because there is currently no known method to control the fungus in the wild.

Recovery potential is also considered high because approximately 814 eastern hellbender larvae/juveniles are currently being reared in captivity. These individuals will be used to augment wild populations and investigate potential threats contributing to population declines. We do not presently anticipate implementation of recovery actions to conflict with construction or other forms of economic activity (USFWS, 2021).

- Below are the primary actions that are anticipated, including ongoing conservation measures identified under Past and Current Conservation Efforts and described in Appendix A. 1) Propagate eastern hellbenders in captivity to augment declining, wild populations. 2) Monitor population status to assess long-term trends. 3) Augment habitat to improve the availability of refugia and nesting habitat. 4) Protect populations and habitat by reviewing projects that could cause impacts and by refraining from disclosing specific locations of hellbenders to protect against illegal collection. Land protection may also occur through land acquisition, conservation easements, or other such programs, if appropriate. 5) Investigate diseases to minimize or prevent impacts to eastern hellbenders. 6) Investigate potential water quality issues to identify and address areas of concern. 7) Reduce sediment and gravel input into rivers to improve habitat 8) Conduct other research as needed to identify or address population declines. (USFWS, 2021)

Conservation Measures and Best Management Practices:

- Conservation measures for the species include habitat restoration and management, and captive propagation, augmentation, and reintroduction. Long-term success of reintroductions, however, is unknown.

References

U.S. Fish and Wildlife Service. 2018. Species status assessment report for the Eastern Hellbender (Cryptobranchus alleganiensis alleganiensis). 104 pp. U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants

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SPECIES ACCOUNT: *Eurycea tonkawae* (Jollyville Plateau Salamander)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/19/2013; Southwest Region (R2) (USFWS, 2015)

Physical Description

The Jollyville Plateau salamander is neotenic (does not transform into a terrestrial form). As neotenic salamanders, they retain external gills and inhabit aquatic habitats (springs, spring-runs, and wet caves) throughout their lives. Adult salamanders are about 2 inches (in) (5 centimeters (cm)) long (Chippindale et al. 2000, pp. 32, 42). Surface-dwelling populations of Jollyville Plateau salamanders have large, well-developed eyes; wide, yellowish heads; blunt, rounded snouts; dark greenish-brown bodies; and bright yellowish-orange tails (Chippindale et al. 2000, pp. 33, 34). Some cave forms of Jollyville Plateau salamanders, which are also entirely aquatic, exhibit cave associated morphologies, such as eye reduction, flattening of the head, and dullness or loss of color (Chippindale et al. 2000, p. 37) (USFWS, 2016).

Taxonomy

A member of the family Plethodontidae. Genetic analysis suggests a taxonomic split within this species that appears to correspond to major geologic and topographic features of the region (Chippindale 2010, p. 2). Chippindale (2010, pp. 5, 8) concluded that the Jollyville Plateau salamander exhibits a strong genetic separation between two lineages within the species: A clade that occurs in the Bull Creek, Walnut Creek, Shoal Creek, Brushy Creek, South Brushy Creek, and southeastern Lake Travis drainages; and a clade that occurs in the Buttercup Creek and northern Lake Travis drainages (Chippindale 2010). The study also suggests this genetic separation may actually represent two species (Chippindale 2010, pp. 5, 8). (USFWS, 2016). Included in Eurycea neotenes by Sweet (1978, 1982) and in previous publications. Certain populations provisionally assigned to this species warrant further study and may prove to be taxonomically distinct (Chippindale et al. 2000) (NatureServe, 2015).

Historical Range

See current range/distribution.

Current Range

Surface populations occur in springs of the Jollyville Plateau region northwest of Austin in Travis and Williamson counties, Texas, and springs of nearby Brushy Creek; known range includes the Brushy Creek, Bull Creek, Cypress Creek, Long Hollow Creek, and Walnut Creek drainages; the Shoal Creek drainage includes a population provisionally assigned to this species (Chippindale et al. 2000). Also provisionally assigned to this species are populations from Kretschmarr Salamander Cave (Travis County), Testudo Tube (Williamson County), and caves of the Buttercup Creek system, elevation approximately 290 m, Williamson County (Chippindale et al. 2000) (NatureServe, 2015).

Critical Habitat Designated

Yes; 8/20/2013.

Legal Description

On August 20, 2013, the U.S. Fish and Wildlife Service designated critical habitat for the Jollyville Plateau salamander (Eurycea tonkawae) under the Endangered Species Act (78 FR 51327 - 51379). Approximately 4,331 acres (1,753 hectares) in Travis and Williamson Counties, Texas, fall within the boundaries of the critical habitat designation.
Critical habitat is designated in specific areas within the geographic area occupied by the species at the time of listing that contain the physical and biological features essential for the conservation of the species and which may require special management.

Critical Habitat Designation

There are 32 units designated as as critical habitat for the Jollyville Plateau salamander, repersenting 4,331 ac (1,753 ha).

Unit 1: Krienke Spring Unit Unit 1 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. The unit is located just south of State Highway 29. The northern part of the unit is under dense residential development, while the southern part of the unit is less densely developed. County Road 175 (Sam Bass Road) crosses the northern half of the unit. This unit contains Krienke Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary of Dry Fork, which is a tributary to Brushy Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, impacts of the impoundment, and depletion of groundwater. Private landowners have shown interest in conserving the area and are providing some management of the area. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 2: Brushy Creek Spring Unit Unit 2 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. The unit is centered just south of Palm Valley Boulevard and west of Grimes Boulevard. The northern part of the unit is covered with commercial and residential development, while the southern part is less densely developed. Some areas along the stream are undeveloped. This unit contains Brushy Creek Spring, which is occupied by the Jollyville Plateau salamander. The spring is near Brushy Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 3: Buttercup Creek Unit In the proposed rule, Unit 3 consisted of 699 ac (283 ha) of City of Austin, City of Cedar Park, State of Texas, and private land in southern Williamson County and northern Travis County, Texas. Under section 4(b)(2) of the Act, certain lands in this unit have been excluded from the final rule for critical habitat (see Application of Section 4(b)(2) of the Act section below). The remaining portions of the unit not within the boundaries of the HCP were retained as critical habitat subunits because these areas still contained subsurface primary constituent elements of the physical or biological features essential to the conservation of the species. We created five subunits following the exclusion. All of the subunits are occupied by the Jollyville Plateau salamander. A description of these subunits follows. Subunit 3A Subunit 3A consists of 260 ac (105 ha) of City of Austin, City of Cedar Park, and private land in southern Williamson County and northern Travis County, Texas. The subunit is located between Anderson Mill Road and Lakeline Boulevard. The subunit is mostly covered with residential property on the eastern half and undeveloped area of parks on the western half. This subunit contains four caves, Hunter’s Lane Cave, Testudo Tube, Bluewater Cave #1, and Bluewater Cave #2, which are all occupied by the Jollyville Plateau salamander. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, potential for vandalism, and depletion of groundwate. These caves are currently gated and locked. The critical habitat designation includes the cave openings. The subunit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP were then excluded from the subunit. Subunit 3B Subunit 3B consists of 28 ac (11 ha) of private land in southern Williamson County, Texas. The unit is located east of Anderson Mill Road and west of Lakeline Boulevard. The unit is mostly under a quarry, except for the eastern portion, which is covered by several buildings and a parking lot. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, depletion of groundwater, and potential impacts from quarry operations. The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then excluded from the subunit. Subunit 3C Subunit 3C consists of 3 ac (1 ha) of private land in southern Williamson County, Texas. The unit is located east of Lakeline Boulevard. The subunit is under residential development. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, and depletion of groundwater. The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then removed from the subunit. Subunit 3D Subunit 3D consists of 16 ac (6 ha) of private land in southern Williamson County, Texas. The subunit is located east of Lakeline Boulevard and north of Buttercup Creek Boulevard. The subunit is under residential development. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, and depletion of groundwater (see Special Management Considerations or Protection section). The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then removed from the subunit. Subunit 3E Subunit 3E consists of 17 ac (7 ha) of private land in southern Williamson County, Texas. The subunit is located east of Lakeline Boulevard. Buttercup Creek Boulevard crosses the subunit from east to west. The subunit is under residential development. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, and depletion of groundwater. The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then removed from the subunit.

Unit 6: Avery Springs Unit Unit 6 consists of 237 ac (96 ha) of private land in southern Williamson County, Texas. The unit is located north of Avery Ranch Boulevard and west of Parmer Lane. The unit has large areas covered by residential development. The developed areas are separated by fairways and greens of a golf course. This unit contains three springs (Avery Springhouse Spring, Hill Marsh Spring, and Avery Deer Spring) that are occupied by the Jollyville Plateau salamander. The springs are located on three unnamed tributaries to South Brushy Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the three springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 7: PC Spring Unit Unit 7 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. State Highway 45, a major toll road, crosses the north central part of the unit from east to west, and Ranch to Market Road 620 goes under the toll road midway between the center and the western edge. Except for roadways, the unit is undeveloped. This unit contains PC Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Davis Spring Branch. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 8: Baker and Audubon Spring Unit Unit 8 consists of 110 ac (45 ha) of private land in northern Travis County, Texas. The unit is located south of Lime Creek Road and southwest of the intersection of Canyon Creek Drive and Lime Springs Road. The unit is wooded, undeveloped, and owned by Travis Audubon Society and Lower Colorado River Authority. The entire unit is managed as part of the Balcones Canyonlands HCP. This unit contains two springs (Baker Spring and Audubon Spring) that are occupied by the Jollyville Plateau salamander. The springs are in the drainage of an unnamed tributary to Cypress Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Special management is being provided by the preserve because the surface watersheds of these two springs are entirely contained within the preserve. Special management may also be needed because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles

Unit 9: Wheless Spring Unit Unit 9 consists of 145 ac (59 ha) of private and Travis County land in northern Travis County, Texas. The unit is located about 0.8 mi (1.3 km) west of Grand Oaks Loop. The unit is wooded and consists of totally undeveloped land. The unit is managed as part of the Balcones Canyonlands Preserve HCP. An unpaved two-track road crosses the unit from north to south. This unit contains three sites (Wheless Spring, Wheless 2 and Spring 25) that are occupied by the Jollyville Plateau salamander. The springs are in the Long Hollow Creek drainage that leads to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands

Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these three sites are entirely contained within the preserve. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 10: Blizzard R-Bar-B Spring Unit Unit 10 consists of 88 ac (36 ha) of private and Travis County land in northern Travis County, Texas. The unit is located west of Grand Oaks Loop. The extreme eastern portion of the unit is on the edge of residential development; a golf course (Twin Creeks) crosses the central portion; and the remainder is wooded and undeveloped. This unit contains three sites (Blizzard R-Bar-B Spring, Blizzard 2, and Blizzard 3) that are occupied by the Jollyville Plateau salamander. The springs are located on Cypress Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these three springs are partially contained within the preserve. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 11: House Spring Unit Unit 11 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located just north of Benevento Way Road. Dies Ranch Road crosses the extreme eastern part of the unit. The entire unit is covered with dense residential development except for a narrow corridor along the stream, which crosses the unit from north to south. Several streets are located in the unit. This unit contains House Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 12: Kelly Hollow Spring Unit Unit 12 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located southeast of the intersection of Anderson Mill Road and Farm to Market Road 2769. With the exception of a portion of Anderson Mill Road along the northern edge of the unit, this unit is primarily undeveloped woodland. This unit contains Kelly Hollow Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 13: MacDonald Well Unit Unit 13 consists of 68 ac (28 ha) of private and Travis County land in northern Travis County, Texas. The unit is centered near the intersection of Grand Oaks Loop and Farm to Market Road 2769. Farm to Market Road 2769 crosses the unit slightly north of its center. The northern portion of the unit contains residential development and part of Twin Creeks Golf Course. This unit contains MacDonald Well, which is a spring occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this spring is partially contained within the preserve. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 14: Kretschmarr Unit Unit 14 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located west of Ranch to Market Road 620. Wilson Parke Avenue crosses the unit along its southern border. Most of the unit is undeveloped, with one commercial development near the west-central portion. This unit contains two sites (Kretschmarr Salamander Cave and Unnamed Tributary Downstream of Grandview) that are occupied by the Jollyville Plateau salamander. Kretschmarr Salamander Cave is a cave, and Unnamed Tributary Downstream of Grandview is a spring site. Under section 4(b)(2) of the Act, certain lands in this unit have been excluded from the final rule for critical habitat (see Application of Section 4(b)(2) of the Act section below). These lands include approximately half of the surface habitat of Unnamed Tributary Downstream of Grandview. This unit also contains approximately half of the surface habitat of SAS Canyon, which is a spring outlet on the Grandview Hills HCP. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Some special management is being provided by the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3), because the surface watersheds of these two springs are partially contained within the preserve. However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The surface designation was delineated by drawing a circle with a radius of 262 ft (80 m) around the spring outlets (including a nearby occupied spring within the boundary of the HCP) and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring outlets (including a nearby occupied spring within the boundary of the HCP) and cave, representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles. Those surface and subsurface areas within the boundary of the Grandview Hills HCP were then removed from the unit.

Unit 15: Pope and Hiers (Canyon Creek) Spring Unit Unit 15 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located between Bramblecrest Drive and Winchelsea Drive. The unit contains dense residential development on its northern, eastern, and western portions. The central portion of the unit is an undeveloped canyon and is preserved in perpetuity as part of a private preserve. This unit contains Pope and Hiers (Canyon Creek) Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 6. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed outside of the preserve into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80

m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat.

Unit 16: Fern Gully Spring Unit Unit 16 consists of 68 ac (28 ha) of private and City of Austin land in northern Travis County, Texas. The unit is centered just south of the intersection of Jenaro Court and Boulder Lane. The unit contains dense residential development on much of its northern half. Most of the southern half of the unit is undeveloped land managed by the City of Austin as part of the Balcones Canyonlands HCP Preserve, and a portion is part of the Canyon Creek preserve, a privately managed conservation area. This unit contains Fern Gully Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 5. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this spring is partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 17: Bull Creek 1 Unit Unit 17 consists of 1,198 ac (485 ha) of private, City of Austin, and Travis County land in northern Travis County, Texas. The unit extends from the southeastern portion of Chestnut Ridge Road to 3M Center, just north of Ranch to Market Road 2222. The unit contains some residential development on the extreme edge of its northern portion and part of Vandegrift High School near its southeastern corner. Most of the remainder of the unit is undeveloped land managed by the City of Austin and Travis County as part of the Balcones Canyonlands HCP Preserve. This unit contains the following sites: Bull Creek Tributary 6 site 2, Bull Creek Tributary 6 site 3, Bull Creek Tributary 5 site 2, Bull Creek Tributary 5 site 3, Tubb Spring, Broken Bridge Spring, Spring 17, Tributary No. 5, Tributary 6 at Sewage Line, Canyon Creek, Tributary No. 6, Gardens of Bull Creek, Canyon Creek Hog Wallow Spring, Spring 5, Three Hole Spring, Franklin, Franklin Tract 2, Franklin Tract 3, Pit Spring, Bull Creek Spring Pool, Spring 1, Spring 4, Spring 2, Lanier Spring, Cistern (Pipe) Spring, Spring 3, Lanier 90-foot Riffle, Bull Creek at Lanier Tract, Ribelin/ Lanier, Spring 18, Horsethief, Ribelin, Spring 15, Spring 16, Spring 14, Lower Ribelin, Spring 13, Spring 12, Upper Ribelin, Ribelin 2, Spring 10, and Spring 9. These springs are occupied by the Jollyville Plateau salamander and are located on Bull Creek and its tributaries. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these springs are partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subsurface critical habitat. We joined the edges of the resulting circles.

Unit 18: Bull Creek 2 Unit Unit 18 consists of 237 ac (96 ha) of private, City of Austin, and Travis County land in northern Travis County, Texas. The center of the unit is near the eastern end of Concordia University Drive. Concordia University is in the central and eastern parts of the unit. Much of the rest of the unit is undeveloped land managed by the City of Austin and Travis County as part of the Balcones Canyonlands HCP Preserve. This unit contains six springs (Schlumberger Spring No. 1, Schlumberger Spring No. 2, Spring 6, Spring 19, Concordia Spring X, and Concordia Spring Y) that are occupied by the Jollyville Plateau salamander. The springs are located on Bull Creek Tributary 7. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these springs are partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat. We joined the edges of the resulting circles.

Unit 19: Bull Creek 3 Unit Unit 19 consists of 97 ac (39 ha) of private and City of Austin land in northern Travis County, Texas. The unit is just southeast of the intersection of Ranch to Market Road 620 and Vista Parke Drive. The unit contains some residential development on its western tip, but the rest of the unit is undeveloped land. Much of the remainder of the unit is managed by the City of Austin as part of the Balcones Canyonlands Preserve HCP. This unit contains two sites (Hamilton Reserve West and Gaas Spring) that are occupied by the Jollyville Plateau salamander.

The springs are located on Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is partially within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these springs are partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). Under section 4(b)(2) of the Act, certain lands in this unit have been excluded from the final rule for critical habitat under the Four Points HCP (see Application of Section 4(b)(2) of the Act section below). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring outlets (including nearby occupied spring outlets within the boundary of the Four Points HCP), representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles. Those areas within the boundary of the Four Points HCP were then excluded from the unit.

Unit 20: Moss Gully Spring Unit Unit 20 consists of 68 ac (28 ha) of City of Austin and Travis County land in northern Travis County, Texas. The unit is just east of the eastern end of Unit 19. The unit is all undeveloped woodland, and it is managed by the City of Austin or Travis County as part of the Balcones Canyonlands HCP Preserve. This unit contains Moss Gully Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this site is entirely contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 21: Ivanhoe Spring Unit Unit 21 consists of 68 ac (28 ha) of City of Austin land in northern Travis County, Texas. The unit is east of the northwest extent of High Hollow Drive. The unit is all undeveloped woodland and is managed by the City of Austin as part of the Balcones Canyonlands

Preserve HCP. This unit contains Ivanhoe Spring 2, which is occupied by the Jollyville Plateau salamander. The spring is located on West Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this site is entirely contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 22: Sylvia Spring Area Unit Unit 22 consists of 439 ac (178 ha) of private, City of Austin, and Williamson County land in northern Travis County and southwestern Williamson County, Texas. The unit is located east of the intersection of Callanish Park Drive and Westerkirk Drive, north of the intersection of Spicewood Springs Road and Yaupon Drive, and west of the intersection of Spicewood Springs Road and Old Lampasas Trail in the Bull Creek Ranch community. Spicewood Springs Road crosses the unit from southwest to east. Residential and commercial development is found in most of the unit. An undeveloped stream corridor crosses the unit from east to west. This unit contains 13 sites (Small Sylvia Spring, Sylvia Spring Area 2, Sylvia Spring Area 3, Sylvia Spring Area 4, Downstream of Small Sylvia Spring 1, Downstream of Small Sylvia Spring 2, Spicewood Valley Park Spring, Tributary 4 upstream, Tributary 4 downstream, Spicewood Park Dam, Tanglewood Spring, Tanglewood 2, and Tanglewood 3) that are occupied by the Jollyville Plateau salamander. Small Sylvia Spring, Sylvia Spring Area 2, Sylvia Spring Area 3, Sylvia Spring Area 4, Downstream of Small Sylvia Spring 1, Downstream of Small Sylvia Spring 2, Spicewood Valley Park Spring, Tributary 4 upstream, Tributary 4 downstream, and Spicewood Park Dam are located on Tributary 4. Tanglewood Spring, Tanglewood 2, and Tanglewood 3 are located on Tanglewood Creek, a tributary to Tributary 4. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat. We joined the edges of the resulting circles.

Unit 24: Long Hog Hollow Unit Unit 24 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered east of the intersection of Cassia Drive and Fireoak Drive. Most of the unit is in residential development. There are wooded corridors in the central and eastern portion of the unit. This unit contains one spring (Long Hog Hollow Tributary below Fireoak Spring) that is occupied by the Jollyville Plateau salamander. The spring is located on Long Hog Hollow Tributary. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 25: Tributary 3 Unit Unit 25 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered between Bluegrass Drive and Spicebush Drive. The eastern and western part of the unit is in residential development. There are wooded corridors in the central part of the unit, and scattered woodland in the eastern and western part. There is a golf course in the north-central part of the unit. This unit contains Tributary No. 3, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 3. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 26: Sierra Spring Unit Unit 26 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located west of the intersection of Tahoma Place and Ladera Vista Drive. The eastern and western part of the unit is in residential development. A wooded corridor crosses the central part of the unit from north to south. A facility that handles automotive fluids is located in the northwest portion of the unit. This unit contains Sierra Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on a tributary to Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 27: Troll Spring Unit Unit 27 consists of 98 ac (40 ha) of City of Austin and private land in northern Travis County, Texas. The unit is located west of the intersection of Jollyville Road and Taylor Draper Lane. The eastern and western part of the unit is in residential development. A wooded corridor crosses the central part of the unit from north to south. This unit contains two springs (Hearth Spring and Troll Spring) that are occupied by the Jollyville Plateau salamander. The springs are located on a tributary to Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles.

Unit 28: Stillhouse Unit Unit 28 consists of 203 ac (82 ha) of City of Austin and private land in northern Travis County, Texas. The unit is centered due north of the intersection of West Rim Drive and Burney Drive. The northern and southern part of the unit is in residential development. A wooded corridor crosses the central part of the unit from east to west. This unit contains eight sites: Stillhouse Hollow, Barrow Hollow Spring, Spring 20, Stillhouse Hollow Tributary, Stillhouse Tributary, Little Stillhouse Hollow Spring, Stillhouse Hollow Spring, and Barrow Preserve Tributary. All are occupied by the Jollyville Plateau salamander. The springs are located on an unnamed tributary to Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflows up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles.

Unit 30: Indian Spring Unit Unit 30 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered just south of Greystone Drive about halfway between its intersection with Edgerock Drive and Chimney Corners Drive. Most of the unit is covered with residential development except for a small wooded corridor that crosses the central part of the unit from east to west. This unit contains Indian Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Shoal Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 31: Spicewood Spring Unit Unit 31 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered just northeast of the intersection of Ceberry Drive and Spicewood Springs Road, just downstream of the bridge on Ceberry Drive. Most of the unit is covered with commercial and residential development except for a small wooded corridor along the stream, which crosses the unit from north to east. This unit contains two sites, Spicewood Spring and Spicewood Tributary, which are occupied by the Jollyville Plateau salamander. The springs are located in an unnamed tributary to Shoal Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subsurface critical habitat.

Unit 32: Balcones District Park Spring Unit Unit 32 consists of 68 ac (28 ha) of private and City of Austin land in northern Travis County, Texas. The unit is centered about 1,411 ft (430 m) northeast of the intersection of Duval Road and Amherst Drive. Most of the unit is in a city park (Balcones District Park) with a swimming pool. A substantial amount of the park is wooded and undeveloped. There is dense commercial development in the southern and southeastern portions of the unit. This unit contains Balcones District Park Spring, which is occupied by the Jollyville Plateau salamander. The spring is located in the streambed of an unnamed tributary to Walnut Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Travis and Williamson Counties, Texas. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of Jollyville Plateau salamander consist of six components:

(i) Surface habitat PCEs. (A) Water from the Trinity Aquifer, Northern Segment of the Edwards Aquifer, and local alluvial aquifers. The groundwater is similar to natural aquifer conditions as it discharges from natural spring outlets. Concentrations of water quality constituents and contaminants should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Jollyville Plateau salamander’s prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with at least some surface flow during the year. The water chemistry is similar to natural aquifer conditions, with temperatures from 64.1 to 73.4 °F (17.9 to 23 °C), dissolved oxygen concentrations from 5.6 to 8 mg L¥1, and specific water conductance from 550 to 721 mS cm¥1. (B) Rocky substrate with interstitial spaces. Rocks in the substrate of the salamander’s surface aquatic habitat are large enough to provide salamanders with cover, shelter, and foraging habitat (larger than 2.5 in (64 mm)). The substrate and interstitial spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The spring environment supports a diverse aquatic invertebrate community that includes crustaceans, insects, and flatworms. (D) Subterranean aquifer. Access to the subsurface water table should exist to provide shelter, protection, and space for reproduction. This access can occur in the form of large conduits that carry water to the spring outlet or porous voids between rocks in the streambed that extend down into the water table.

(ii) Subsurface habitat PCEs. (A) Water from the Trinity Aquifer, Northern Segment of the Edwards Aquifer, and local alluvial aquifers. The groundwater is similar to natural aquifer conditions. Concentrations of water quality constituents and contaminants are below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Jollyville Plateau salamander’s prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with continuous flow. The water chemistry is similar to natural aquifer conditions, including temperature, dissolved oxygen, and specific water conductance. (B) Subsurface spaces. Voids between rocks underground are large enough to provide salamanders with cover, shelter, and foraging habitat. These spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The habitat supports an aquatic invertebrate community that includes crustaceans, insects, or flatworms.

Special Management Considerations or Protections

Surface critical habitat includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat, including the dry stream channel during periods of no surface flow. The surface critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) existing within the legal boundaries on the effective date of this rule; however, the subsurface critical habitat may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.

The features essential to the conservation of these species may require special management considerations or protection to reduce the following threats: water quality degradation from contaminants, alteration to natural flow regimes, and physical habitat modification. For these salamanders, special management considerations or protection are needed to address threats. Management activities that could ameliorate threats include (but are not limited to): (1) Protecting the quality of groundwater by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution throughout the Barton Springs and Northern Segments of the Edwards Aquifer and contributing portions of the Trinity Aquifer, (2) protecting the quality and quantity of surface water by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution within the surface drainage areas of the salamander spring sites, (3) protecting groundwater and spring flow quantity (for example, by implementing water conservation and drought contingency plans throughout the Barton Springs and Northern Segments of the Edwards Aquifer and contributing portions of the Trinity Aquifer), (4) fencing and signage to protect from human vandalism, (5) protecting water quality and quantity from present and future quarrying, and (6) excluding cattle and feral hogs through fencing to protect spring habitats from damage.

Life History

Food/Nutrient Resources

Food Source

Adult: Ostracods, copepods, mayfly larvae, fly larvae, snails, water mites, aquatic beetles, stone fly larvae, flatworms (USFWS, 2013)

Food/Nutrient Narrative

Adult: As in other Eurycea species, the Jollyville Plateau salamander feeds on aquatic invertebrates that commonly occur in spring environments (reviewed in COA 2001, pp. 5–6). A stomach content analysis by the City of Austin demonstrated that this salamander preys on varying proportions of ostracods, copepods, mayfly larvae, fly larvae, snails, water mites, aquatic beetles, and stone fly larvae depending on the location of the site (Bendik 2011b, pers. comm.). In addition, flatworms were found to be the primary food source for the related Barton Springs salamander (Gillespie 2013, p. 5), suggesting that flatworms may also contribute to the diet of the Jollyville Plateau salamander if present in the invertebrate community (USFWS, 2013).

Reproductive Strategy

Adult: Oviparous (USFWS, 2013)

Breeding Season

Adult: Year round (USFWS, 2016)

Reproduction Narrative

Adult: The detection of juveniles in all seasons suggests that reproduction occur year-round (Bendik 2011a, p. 26). However, juvenile abundance of Jollyville Plateau salamanders typically increases in spring and summer, indicating that there may be relatively more reproduction occurring in winter and early spring compared to other seasons (Bowles et al. 2006, p. 116) (USFWS, 2016). Little is known about the reproductive habits of this species in the wild. However, the Jollyville Plateau salamander is fully aquatic and, therefore, spends all of its life cycles in aquifer and spring waters. Eggs of central Texas Eurycea species are rarely seen on the surface, so it is widely assumed that eggs are laid underground (Gluesenkamp 2011, TPWD, pers. comm.; Bendik 2011b, COA, pers. comm.) (USFWS, 2013).

Habitat Type

Adult: Aquatic, subterranean (NatureServe, 2015); fossorial (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Spring (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Water depth < 1 ft., well oxygenated water (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Highways, untraversable habitat (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2016)

Habitat Narrative

Adult: Surface populations occur in springs; certain cave-dwelling populations have been provisionally assigned to this species (Chippindale et al. 2000). The environmental specificity is very narrow (specialist or community with key requirements scarce). Separation barriers include busy highways, especially with high traffic volume at night; other totally inappropriate habitat that the salamanders cannot traverse. (NatureServe, 2015). Spring-fed habitat is typically characterized by a depth of less than 1 ft. (0.3 m) of cool, well oxygenated water (COA 2001, p. 128; Bowles et al. 2006, p. 118). There was a strong positive relationship between salamander abundance and the amount of available rocky substrate (Bowles et al. 2006, p. 114). If springs stop flowing and the surface habitat dries up, Jollyville Plateau salamanders are known to recede with the water table and persist in groundwater refugia until surface flow returns (Bendik 2011a, p. 31). Access to subsurface refugia allows populations some resiliency against drought events (USFWS, 2016).

Dispersal/Migration

Motility/Mobility

Adult: Moderate (inferred from USFWS, 2013)

Dispersal

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: A recent study using mark-recapture methods found marked individuals moved up to 262 ft. (80 m) both upstream and downstream from the Lanier Spring outlet (Bendik 2013, pers. comm.). This study demonstrates that Eurycea salamanders can travel greater distances from a discrete spring opening than previously thought, including upstream areas, if suitable habitat is present (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

4 - 5 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Chippindale et al. (2000) mapped 4 - 5 population clusters consisting of a total of 14 - 17 sites. The population size is unknown. This species has experienced a short term decline of 10 - 30%; it is apparently declining in population size and number/condition of occurrences as water quality declines (Chippindale et al. 2000) (NatureServe, 2015).

Threats and Stressors

Stressor: Aquatic contaminants and pollutants (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: While polycyclic aromatic hydrocarbons (PAHs) and pesticides have been detected at Jollyville Plateau salamander sites, the extent to which aquatic contaminants have affected salamander survival, development, and reproduction, or their prey, is unknown. Due to potential differences in species sensitivity, exposure scenarios that may include dozens of chemical

stressors simultaneously, and multigenerational effects that are not fully understood, the Services continue to view aquatic contaminants, such as PAHs and pesticides, as a potential threat to water quality, salamander health, and the health of aquatic organisms that comprise the diet of salamanders. Excessive nutrient exposure is also a threat. The threat of water quality degradation could cause irreversible declines or extirpation in local populations or significant declines in habitat quality with continuous or repeated exposure. In some instances, exposure to aquatic contaminants and excessive nutrients could negatively impact a salamander population , resulting in significant habitat declines or other significant negative impacts (such as loss of invertebrate prey species). This threat is considered to be low impact for the Jollyville Plateau salamanders, that is likely to increase in the future (USFWS, 2013).

Stressor: Climate change and drought (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The effects of climate change could potentially lead to detrimental impacts on aquifer-dependent species, especially coupled with other threats on water quality and quantity. Recharge, pumping, natural discharge, and saline intrusion of groundwater systems could all be affected by climate change. Climate change could compound the threat of decreased water quantity at salamander spring sites, and affect rainfall and ambient temperatures, which are factors that may limit salamander populations. The threat of water quantity degradation from climate change could negatively impact a population of any of the Jollyville Plateau salamanders in combination with other threats and contribute to significant declines in population sizes or habitat quality. This threat is considered to be of moderate impact now and in the future (USFWS, 2013).

Stressor: Deformities (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Jollyville Plateau salamanders observed at the Stillhouse Hollow monitoring sites have shown high incidences of deformities, such as curved spines, missing eyes, missing limbs or digits, and eye injuries. Environmental toxins are the suspected cause of salamander deformities, but deformities in amphibians can also be the result of genetic mutations, parasitic infections, UV–B radiation, or the lack of an essential nutrient. More research is needed to elucidate the cause of these deformities. Deformities are considered to be a low-level impact to the Jollyville Plateau salamander at this time because this stressor is an issue at only one site, is not affecting the entire population there, and does not appear to be an issue for the other salamander species at that location (USFWS, 2013).

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: Degradation of habitat, in the form of reduced water quality and quantity and disturbance of spring sites (physical modification of surface habitat), is the primary threat to the Jollyville Plateau salamander. Physical modification of surface habitat can occur from sedimentation, impoundments, flooding, feral hogs, livestock, and human activities. Direct mortality to salamanders can also occur as a result of these threats, such as being crushed by feral hogs, livestock, or humans. This threat may affect only the surface habitat, only the subsurface habitat, or both habitat types. These threats can have severe impacts on the species, and are expected to continue into the future. Water chemistry changes (conductivity, salinity, dissolved oxygen) are also considered low impact threats (USFWS, 2013).

Stressor: Overutilization (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Services do not consider overutilization from collecting salamanders in the wild to be a threat by itself, but it may contribute to significant population declines, and could negatively impact the species in combination with other threats (USFWS, 2013).

Stressor: Restricted ranges (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Restricted ranges could negatively affect any of the Jollyville Plateau salamanders' populations in combination with other threats (such as water quality or water quantity degradation) and lead to the species being at a higher risk of extinction. The level of impacts from stochastic events is considered to be moderate for the Jollyville Plateau salamander; the species' continued existence could be compromised by a common event (USFWS, 2013).

Stressor: Small population size and stochastic events (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Services do not consider small population size to be a threat in and of itself to the Jollyville Plateau salamander, but the small population sizes make the species more vulnerable to extinction from other existing or potential threats, such as a major stochastic event. The level of impacts from stochastic events is considered to be moderate for the Jollyville Plateau salamander (USFWS, 2013).

Stressor: Ultraviolet radiation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The effect of increased UV-B radiation has the potential to cause deformities or developmental problems to individual salamanders, but the Services do not consider this stressor

to significantly contribute to the risk of extinction of the Jollyville Plateau salamander at this time. However, UV-B radiation could negatively affect any of the Jollyville Plateau salamanders' surface populations in combination with other threats (such as water quality or water quantity degradation) and contribute to significant declines in population sizes (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Not available.

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SPECIES ACCOUNT: *Cryptobranchus alleganiensis bishopi* (Ozark Hellbender)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/07/2011; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

A large salamander that reaches a maximum length of 57 cm (NatureServe, 2015). Ozark hellbenders have a large, keeled tail and tiny eyes. Numerous fleshy folds along the sides of the body provide surface area for respiration (Nickerson and Mays 1973a, pp. 26-28) and obscure their poorly developed costal grooves (grooves in the inner border of the ribs; Dundee 1971, p. 101.1) (USFWS, 2010).

Taxonomy

The Ozark hellbender was originally described as Cryptobranchus bishopi by Grobman (1943, pp. 6-9) from a specimen collected from the Current River in Carter County, Missouri. Due to the small amount of genetic variation in the genus Cryptobranchus (Merkle et al. 1977, pp. 550-552; Shaffer and Breden 1989, pp. 1017-1022), Dundee and Dundee (1965, p. 370) referred to the Ozark hellbender as a subspecies of the eastern hellbender, C. alleganiensis. This designation persisted until Collins (1991, pp. 42-43) revived C. bishopi, due to the lack of intergradation between the eastern and Ozark hellbenders because of the allopatry (occurring in separate, non-overlapping geographic areas) of the populations (Dundee 1971, p. 101.1) (USFWS, 2010).

Historical Range

Endemic to the Black and White River drainages, in portions of the Spring, White, Eleven Point, and Current rivers and their tributaries (LaClaire 1993) in Southern Missouri and adjacent northern Arkansas (NatureServe, 2015).

Current Range

Currently, hellbenders are considered extirpated in the mainstem White, Black, and Spring Rivers and Jacks Fork, and their range has been considerably reduced in the remaining rivers and tributaries (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: Crayfish, fish, aquatic invertebrates (NatureServe, 2015); salamander eggs (USFWS, 2010)

Food/Nutrient Narrative

Adult: Crayfish are the most important food item, though fishes (often scavenged) and other aquatic invertebrates are also eaten (Peterson et al. 1989). Adults and immatures are invertivores. It is primarily nocturnal but sometimes active in daylight. Evidently active throughout the year in streams heavily influenced by springs (Peterson et al. 1989) (NatureServe, 2015). They are diurnal during the breeding season (Nickerson and Mays 1973a, pp. 40-41; Noeske and Nickerson 1979, p. 92 and p. 94). During or shortly after eggs are laid, males and females may prey upon their own and other individuals' clutches (USFWS, 2010).

Reproductive Strategy

Adult: Oviparous (NatureServe, 2015)

Lifespan

Adult: 25+ years (NatureServe, 2015)

Breeding Season

Adult: Summer - winter (NatureServe, 2015); primarily September - October (USFWS, 2010)

Reproduction Narrative

Adult: Lays eggs in late summer or fall; winter breeding has been observed in the Spring River, Arkansas (Peterson et al. 1989). Clutch size averages about 350-500; increases with female body length. Several females may oviposit in same site. Males guard developing eggs. Larvae hatch in 1.5-3 months, lose gills about 18 months after hatching. Sexually mature in 5th or 6th year. Longevity 25+ years. Density in Missouri was about 400-500 per km of suitable river habitat (Nickerson and Mays 1973, Peterson et al. 1983); 1-6 per 100 sq. m in Ozark streams (Peterson et al. 1988). This species is slow to mature and has a low recruitment rate (NatureServe, 2015). Breeding generally occurs between mid-September and early October (Johnson 2000, p. 42). Ozark hellbenders mate via external fertilization (USFWS, 2010).

Habitat Type

Adult: Aquatic (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riverine, pool, benthic (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Water temperature < 20oC (NatureServe, 2015); water depth < 3 ft., consistent water quality parameters (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Linear (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2010)

Habitat Narrative

Adult: Rocky, clear creeks and rivers, usually where there are large shelter rocks. Usually avoids water warmer than 20oC. Males prepare nests beneath large flat rocks or submerged logs. Inhabits creek, medium rivers, poll, riffle, and benthic environments (NatureServe, 2015). Adult Ozark hellbenders are frequently found beneath large rocks in moderate to deep (less than 3 feet (ft.) to 9.8 ft. (less than 1 meter (m) to 3 m)), rocky, fast-flowing streams in the Ozark plateau (Johnson 2000, p. 42; Fobes and Wilkinson 1995, pp. 5-7). Hellbenders are habitat specialists that depend on consistent levels of dissolved oxygen, temperature, and flow (Williams et al. 1981, p. 97) (USFWS, 2010).

Dispersal/Migration

Motility/Mobility

Adult: Low (NatureServe, 2015)

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: This species is non-migratory and has low vagility. In Missouri, 80% of recaptures were within 30 m of tagging site (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decline of 30-50% (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2010)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Slow to mature (takes several years), low recruitment rate, low vagility. This salamander appears to have declined in most areas. This species has experienced a long-term decline of 30-50%. Total adult population size is unknown but likely is in the low thousands. Few occurrences remain (see trend comments). The range extent is 2,000 - 80,000 square miles. Only one or two populations appear to have good viability (NatureServe, 2015). Evidence indicates Ozark hellbenders are declining throughout their range (Wheeler et al. 2003, pp. 153 and 155), and no populations appear to be stable (USFWS, 2010).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: One of the most likely causes of the decline of the Ozark hellbender in the White River system in Missouri and Arkansas is habitat degradation resulting from impoundments, ore and gravel mining, sedimentation, nutrient runoff, and nest site disturbance from recreational uses of the rivers (Williams et al. 1981, p. 99; LaClaire 1993, pp. 4- 5). The effects of impoundments on Ozark hellbenders are significant because impoundments alter habitat directly, isolate populations, and change water temperatures and flows below reservoirs. Siltation and water quality degradation are caused by industrialization, agricultural runoff, mine waste, and activities related to timber harvesting. Increased siltation affects hellbenders in a variety of ways, such as suffocating eggs, eliminating suitable habitat for all life stages, reducing dissolved oxygen levels, increasing contaminants (that bind to sediments), and reducing prey populations. Increased nitrate levels and fecal coliform, along with a variety of other contaminants from agricultural runoff and increased urbanization, have been detected in hellbender streams, which not only pose a threat directly to hellbenders but also to Ozark aquatic ecosystems in general. Recreational pressure (for example, boat traffic, horseback riding, and ORV use) in streams inhabited by Ozark hellbenders has increased substantially on an annual basis, directly disturbing the habitat (USFWS, 2010).

Stressor: Collection (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The Ozark hellbender is a rare and unique amphibian that has experienced extensive collection from the wild for various reasons. Due to the continued decline of the Ozark hellbender and history of its collection, State agencies in Missouri and Arkansas have implemented measures to reduce the threat of collection. These measures include moratoriums on issuance of scientific collecting permits; prohibiting the collection, possession, and sale of hellbender under appropriate State wildlife statutes; and controlling information on the location of hellbenders. The unauthorized collection of Ozark hellbenders for commercial sale in the pet trade, however, continues to be a significant threat (USFWS, 2010).

Stressor: Chytridiomycosis (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The discovery of the presence of Batrachochytrium dendrobatidis (chytridiomycosis) in 2006 within all remaining populations of the Ozark hellbender has made increased protection even more important to the persistence of this subspecies (Utrup 2007, pers. comm.). This pathogen occurs throughout the entire range of the Ozark hellbender and is determined to be a significant threat to the subspecies. The threat from chytridiomycosis is significant and immediate because: (1) It is proven to be a fatal pathogen to Ozark hellbenders in captivity, and (2) in the wild, all streams with extant Ozark hellbender populations have individuals that tested positive for the pathogen (Briggler 2008b, pers. comm.). In addition, although it is unclear if there is a connection to chytridiomycosis, abnormalities found on Ozark hellbenders are increasingly severe, often to a level that the animal is approaching death (Briggler 2008a, pers. comm.). Researchers view chytridiomycosis as one of the most serious threats to the survival of this subspecies (Briggler et al. 2007, p. 83) (USFWS, 2010).

Stressor: Nonnative trout (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Nonnative trout are stocked in all rivers that historically and currently contain hellbenders in Missouri. Predation of larval hellbenders by nonnative trout possibly contributes to the decline of Ozark hellbender populations in Missouri and may be a growing concern if predatory fish continue to be stocked (or are stocked in larger numbers) in hellbender streams (USFWS, 2010).

Stressor: Small, isolated populations (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The small size and isolation of Ozark hellbender populations and loss of genetic diversity could exacerbate other factors negatively affecting the subspecies and accelerate possible extinction. These factors are particularly detrimental when combined with the factors affecting the hellbender (USFWS, 2010).

Recovery

Reclassification Criteria:
Because each of the three extant Ozark hellbender populations is genetically unique, all three populations are necessary to maximize the evolutionary potential of the species. Given the small range of each population, the persistence of all three populations is also necessary to guard against extinction from catastrophic events such as extreme flooding, drought, and chemical spills. Therefore, to downlist the Ozark hellbender, the following criteria should be achieved for

each of three Ozark hellbender populations (the North Fork White River, Eleven Point River, and Current River): 1. There is a positive population trend for a 20 year period1 . 2. There is evidence of successful recruitment to maintain a sustaining population, with recruitment defined as attainment of sexual maturity by young. 3. Habitat quantity and quality are sufficient to support all life stages. 4. Within each watershed the number and distribution of occupied habitat patches and abundance of individuals within these patches is such that 1) the population is resilient to stochastic and catastrophic events and 2) connectivity and gene flow is sufficient to maintain genetic diversity and provide for natural re-establishment if a patch is extirpated. 5. Causes of population declines have been identified, and it is clear what actions are needed to address these threats. (USFWS, 2021).

Delisting Criteria:
To delist the Ozark hellbender, the following criteria should be achieved for each of three Ozark hellbender populations (the North Fork White River, Eleven Point River, and Current River): 1. Downlisting criteria have been met. 2. Threats and causes of decline have been reduced or eliminated such that delisting criteria will continue to be met into the foreseeable future. (USFWS, 2021).

Recovery Actions:

- The actions below are those that, based on the best available science, the Service believes are necessary to move towards recovery, and ultimately delist the Ozark hellbender. 1. Propagate Ozark hellbenders in captivity to augment declining, wild populations or to restore extirpated populations 2. Monitor populations to assess long-term trends. 3. Protect and improve habitat and water quality, which may include land acquisition 4. Minimize impacts of diseases to Ozark hellbenders via research efforts 5. Investigate causes of abnormalities 6. Identify, prioritize, and conduct other research to enhance the conservation and recovery of Ozark hellbenders 7. Initiate educational and public outreach actions to heighten awareness of the hellbender as an endangered species and solicit help with recovery actions 8. Enhance the level of protection through policy, regulation, and enforcement (USFWS, 2021).
- ESTIMATED TIME AND COST OF RECOVERY ACTIONS It is difficult to estimate the time it will take to accomplish recovery actions such that the delisting criteria have been met because, although several potential threats have been identified (USFWS 2011, USFWS 2020) the primary cause(s) of population declines remains unclear. Assuming that the primary cause(s) could be identified within the next 15 years, it would likely take at least another 15 years to address the cause(s), followed by an additional 15 years to monitor the response of populations (that is, population trends). Thus, we estimate that recovery could be accomplished in 45 years, assuming effective coordination with necessary partners and stakeholders. However, we recognize that it may take longer than this estimate to delist the species. The estimated cost of the first 15 years of recovery actions for the Ozark hellbender is $7,150,000 (Table 1). However, as noted above, we expect that full recovery could take 45 years. If we assume that many research projects and other recovery actions are completed in the first 15 years, we estimate that the following 15 years of recovery actions (years 16-30) will be 50% of the costs of the first 15 years, or $3,575,000. If all of the anticipated recovery actions are completed within 30 years and monitoring populations is the only action to be completed in the next 15 years (years 31-45), we estimate costs of the third 15-

year period to be $638,000. Thus, we estimate that the cost of completing the recovery actions such that the criteria have been met and the Ozark hellbender may be considered for delisting is at least $11,363,000 (Table 2). However, because we cannot currently estimate the costs of protecting and improving habitat and water quality, the actual cost of completing recovery actions is likely higher. (USFWS, 2021).

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SPECIES ACCOUNT: *Eleutherodactylus cooki* (Guajon)

Species Taxonomic and Listing Information

Listing Status: Threatened; June 11, 1997; R4

Physical Description

The guajón has a solid brown coloration in the dorsal area, white-rimmed eyes, and large, truncate disks (i.e., partially cut) on its feet (Rivero 1998, Joglar 1983 and 1981). The species exhibits sexual dimorphism (separate female and male morphs) regarding size, vocalization, and coloration (Burrowes 2000a and 1997). Females are larger than males; the mean size (snout-vent length) for females is 2.01 inches (50.94 millimeters) and 1.71 inches (43.43 millimeters) for males. The ventral coloration of females is uniformly white, while males are yellow extending from the vocal sac to the abdomen and flanks. Juveniles are brown in color with a dorsal pattern of dark brown inverted parentheses (Joglar et al. 1996, Joglar 1998).

Taxonomy

The guajón (Eleutherodactylus cooki) is a petricolous (i.e., inhabiting rocks) frog species endemic to the southeastern part of Puerto Rico. E. cooki is one of sixteen species of the genus Eleutherodactylus, is part of the group commonly known as “coquíes.” Joglar (1989) established the phylogenetic relations of frogs from the West Indies, utilizing morphological characteristics belonging to the genera Eleutherodactylus. Three groups or classes were recognized for the West Indies: Eleutherodactylus inoptatus, Eleutherodactylus ricordii, and Eleutherodactylus unistrigatus. This species is a member of the West Indies subset of the Eleutherodactylus unistrigatus group (Joglar 1989). The guajón is the second largest species of Eleutherodactylus in Puerto Rico.

Historical Range

The first description of the range of this species included only the localities of the Cuchilla de Panduras mountain range (municipalities of Yabucoa and San Lorenzo). In 1998, its distribution was expanded to include southeast Puerto Rico and west to Patillas-San Lorenzo.

Current Range

This species inhabits the Cuchilla de Panduras mountain range in southeastern Puerto Rico. In 2000, new populations were discovered from Humacao and Las Piedras, Puerto Rico.

Critical Habitat Designated

Yes; 10/23/2007.

Legal Description

On October 23, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat (CH) for the guajo´n (Eleutherodactylus cooki) under the Endangered Species Act of 1973, as amended (72 FR 60068 - 60114). In total, approximately 260.6 acres (ac) (105.6 hectares (ha)) fall within the boundaries of the CH designation.

Critical Habitat Designation

17 units are desingated as critical habitat for the guajo´n:

Unit 1: Mariana Unit Unit 1 consists of approximately 23.6 ac (9.6 ha) located south of Road PR–909, west of Road PR–3, and north of Quebrada Catno within Mariana Ward, Humacao. Unit 1 contains 5,412.8 ft (1,649.8 m) of an unnamed, rocky stream with abundant water, a guajo´n foraging area extending laterally 99 ft (30 m) from each bank of the stream, and secondary forest on all sides of the stream. This unit was occupied at the time of listing (J. Sustache, DNER database, 1996). Every PCE is found within this unit, and presence of the species and PCEs at this site was confirmed by the Service in March 2006. Threats that may require special management considerations, due to the proximity of Unit 1 to urbanized areas and infrastructure (e.g., major roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides), and pollution of streams caused by human refuse (PCE 2).

Unit 2: Montones Unit Unit 2 consists of approximately 31.1 ac (12.6 ha) in Montones Ward, Las Piedras. It contains 6,941.7 ft (2,115.8 m) of the headwaters of the Valenciano River in the vicinity of PR 917 Km 9.7, and a guajo´n foraging area of 99 ft (30 m) on each side of the river. This unit was occupied at the time of listing (F. Bird-Pico´, DNER database, 1996). Although some sections of this unit do not contain PCE 1, all other PCEs are found within this unit (a rocky stream with abundant water surrounded by secondary forest, and a rocky creek surrounded by vines, herbaceous vegetation, shrubs, and trees). In some areas of the creek, the water disappears underground and reappears at various intervals. The presence of the species and PCEs at this site was confirmed by the Service in March 2006. Threats that may require special management considerations, due to the proximity of Unit 2 to urbanized areas and infrastructure (e.g., roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCE 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides), and pollution of streams caused by human refuse (PCE 2).

Unit 3: Tejas Unit Unit 3 consists of approximately 5.2 ac (2.1 ha) located between Road PR– 905 to the east, Road PR–908 to the west, Road PR–9921 to the north, and Road PR–9904 to the south within Tejas Ward, Las Piedras. It contains 1,312 ft (400 m) of an unnamed tributary of the Ri´o Humacao, and a guajo´n foraging area of 99 ft (30 m) on each side of the tributary. Every PCE is found within this unit (the area contains a rocky creek surrounded by vines, herbaceous vegetation, shrubs, and trees), and this was confirmed by the Service in March 2006. The Service has not determined whether Unit 3 was occupied at the time of listing, but we have determined that it is essential to the conservation of the guajo´n. The guajo´n was listed under the Act primarily due to its highly restricted geographical distribution and its specialized habitat requirements (Joglar 1998, p. 73). Thus, protection of all existing populations of the guajo´n is important to the conservation of the species. The habitat of this species is naturally fragmented, and the majority of the known populations are found on private land where increased levels of land development in southeastern Puerto Rico are occurring and threaten to further reduce and fragment the species' habitat, distribution, and survival (Joglar 1998, p. 73). Being a habitat specialist, the guajo´n is adapted to particular environmental conditions, and abrupt changes in these conditions could result in population declines. Additionally, fragmenting habitat through human intrusions, such as roads, makes populations less resilient to natural population declines (Pechman et al. 1991, p. 895). In light of the foregoing and because it is currently occupied by the species and contains sufficient PCEs to support the life functions of the species, we have determined that Unit 3 is essential to the conservation of the species.

Unit 4: Emajagua Unit Unit 4 consists of approximately 33.0 ac (13.4 ha) between Quebrada Arenas and Quebrada Emajagua, north of Road PR–901 (on the periphery of an underground tunnel under construction), within Emajagua Ward, Maunabo. It contains three connected, unnamed streams/drainages totaling about 7,400 ft (2,256 m), and a guajo´n foraging area of 99 ft (30 m) on each side of the streams/drainages. This unit was occupied at the time of listing (R. Thomas, DNER database, 1965). Every PCE is found within this unit, and presence of the species and PCEs at this site was confirmed by the Service in April 2006. Threats that may require special management considerations, due to the proximity of Unit 4 to urbanized areas and infrastructure (e.g., major roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3) and pollution of streams caused by human refuse (PCE 2).

Unit 5: Jacaboa Unit Unit 5 consists of approximately 10.3 ac (4.2 ha) northwest of road PR–758 within Rios Ward, Patillas. It contains 2,334.6 ft (711.6 m) of an unnamed rocky drainage to the Jacaboa River, and a guajo´n foraging area of 99 ft (30 m) on each side of the drainage. This unit was occupied at the time of listing (R. Thomas, DNER database, 1965). Every PCE is found within this unit (it contains a rocky creek with small and large sedimentary rocks and boulders, closed forest canopy over the creek, and closed, mature forest along the shores, including some bamboo stands). The presence of the species and PCEs at this site was confirmed by the Service in April 2006. Threats that may require special management considerations, due to the proximity of Unit 5 to urbanized areas and infrastructure (e.g., roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides) and pollution of streams caused by human refuse (PCE 2).

Unit 6: Calabazas Unit Unit 6 consists of approximately 13.8 ac (5.6 ha) located northeast of road PR– 900, between Quebrada Guayabo to the south and Ri´o Guayane´s to the north, within Calabazas Ward, Yabucoa. The unit contains a 3,198 ft (975 m) stretch of a rocky creek surrounded by vines, herbaceous vegetation, shrubs, and trees, and a guajo´n foraging area of 99 ft (30 m) on each side of the drainage. This unit was occupied at the time of listing (J. Montero, DNER database, 1988). Every PCE is found within this unit, and presence of the species and PCEs at this site was confirmed by the Service in March 2006. Threats that may require special management considerations, due to the proximity of Unit 6 to urbanized areas and infrastructure (e.g., roads), include changes in the composition and abundance of vegetation surrounding guajo´ habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides), and pollution of streams caused by human refuse (PCE 2).

Unit 7: Guayane´ s Unit Unit 7 consists of approximately 7.9 ac (3.2 ha) northeast of Road PR–900 between Quebrada Guayabo to the south and Ri´o Guayane´s to the north, and north of Unit 6, within Calabazas Ward, Yabucoa. It contains 4,265 ft (1,300 m) of an unnamed drainage, and a guajo´n foraging area of 99 ft (30 m) on each side of the drainage. This unit was occupied at the time of listing (J. Montero, DNER database, 1988). Every PCE is found within this unit (it contains a rocky creek surrounded by vines, herbaceous vegetation, shrubs, and trees). The presence of the species and PCEs at this site was confirmed by the Service in March 2006. Threats that may require special management considerations, due to the proximity of Unit 7 to urbanized areas and infrastructure (e.g., roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides), and pollution of streams caused by human refuse (PCE 2).

Unit 8: Panduras Unit Unit 8 consists of approximately 28.6 ac (11.6 ha) to the northwest and southeast of Road PR–3 within Calabazas Ward, Yabucoa. It contains 2,314.1 ft (705.6 m) of an unnamed drainage, a guajo´n foraging area of 99 ft (30 m) on each side of the drainage, and 18.2 ac (7.4 ha) of lands owned by the PRCT near the top of Cerro La Pandura. This unit was occupied at the time of listing (J. Rivero 1998, DNER database, 1978). Every PCE is found within this unit (it contains a rocky area with medium and large granite boulders, a drainage with closed-canopy forest over the drainage, and closed, mature forest along the edges). The presence of the species and PCEs at this site was confirmed by the Service in March 2006. Threats that may require special management considerations, due to the proximity of Unit 8 to urbanized areas and infrastructure (e.g., roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3) and pollution of streams caused by human refuse (PCE 2). This area does not currently have a management plan (Fernando Silva, pers. comm., 2006).

Unit 9: Talante Unit Unit 9 consists of approximately 23.5 ac (9.5 ha) east of Road PR–3 within Calabazas Ward and Talante Ward, Yabucoa. It contains the headwaters of the Talante Creek, five unnamed drainages (totaling about 3,500 ft (1,061 m)), and a guajo´n foraging area of 99 ft (30 m) on each side of the creek and drainages. About 2.8 ac (1.1 ha) of Unit 9 are within Calabazas Ward, and the remaining 21.6 ac (8.7 ha) are within Talante Ward. This unit was occupied at the time of listing (J. Rivero 1998, DNER database, 1978). Every PCE is found within this unit (it contains drainages with medium and large granite boulders that are surrounded by vines, herbaceous vegetation, shrubs, and trees, and that connect to a small rocky creek; some patches contain big rocks that are completely exposed to the sun or covered with vines). The presence of the species and PCEs at this site was confirmed by the Service in April 2006. Threats that may require special management considerations, due to the proximity of Unit 9 to urbanized areas and infrastructure (e.g., major roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides) and pollution of streams caused by human refuse (PCE 2).

Unit 10: Guayabota Unit Unit 10 consists of approximately 13.1 ac (5.3 ha) northeast of intersection of roads PR–181 and PR–182, and south of the municipal boundary with San Lorenzo, within Guayabota Ward, Yabucoa. It contains a small unnamed creek (about 700 ft (212 m)), and a guajo´n foraging area of 99 ft (30 m) on each side of the creek. This unit was occupied at the time of listing (J. Rivero, DNER database, 1980; Burrowes 1997). Every PCE is found within this unit. The northwest section of the rocky creek (large and medium granite boulders) is surrounded by closed canopy over the creek, with herbaceous vegetation and some trees along the shore. The southeastern section of the rocky creek has large and medium sedimentary boulders and is surrounded by semiclosed canopy over the creek and shores that are primarily exposed to the sun, with some areas covered with grass. The presence of the species and PCEs at this site was confirmed by the Service in April 2006. Threats that may require special management considerations, due to the proximity of this unit to urbanized areas and infrastructure (e.g., roads), include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides), and pollution of streams caused by human refuse (PCE 2).

Unit 11: Guayabito Unit Unit 11 consists of approximately 17.3 ac (7.0 ha) south of Road PR–900 and north of the Maunabo boundary, within Guayabota Ward, Yabucoa. It contains 1,232.6 ft (4,042 m) of an unnamed drainage and tributary that connects to Quebrada Guayabo, and a guajo´n foraging area of 99 ft (30 m) on each side of both the drainage and tributary. This unit was not known to be occupied at the time of listing. The unit is split into a rocky drainage to the west (large, clumped, granite boulders), and a rocky creek to the east (large granite boulders). Both are surrounded by closed canopy over the drainage and creek, and closed mature forest along the shores. Thus, every PCE is found within this unit, and presence of the species and PCEs at this site was confirmed by the Service in April 2006. The Service has not determined whether Unit 11 was occupied at the time of listing, but we have determined that it is essential to the conservation of the guajo´n for several reasons. The boulders and closed canopy provide the essential habitat for guajo´n reproduction and foraging. The guajo´n was listed primarily due to its highly restricted geographical distribution and habitat requirements (Joglar 1998, p. 73). The habitat of this species is naturally fragmented, and the majority of the known populations are on private land, where the increased levels of land development currently occurring in southeastern Puerto Rico threaten to further reduce and fragment the species' habitat, distribution, and survival (Joglar 1998, p. 73). Being a habitat specialist, the guajo´n is adapted to particular environmental conditions, and abrupt changes in these conditions could result in population declines. Additionally, fragmenting habitat through human intrusions such as roads makes populations less resilient to natural population declines (Pechman et al. 1991, p. 895).

Unit 12: Guayabo Unit Unit 12 consists of approximately 9.8 ac (3.9 ha) along Quebrada Guayabo, along and south of Road PR–900 in Guayabota Ward, Yabucoa. It contains 2,247.5 ft (685 m) of the southwesternmost section of Quebrada Guayabo, and a guajo´n foraging area of 99 ft (30 m) on each side of the stream. Every PCE is found within this unit and presence of the species and PCEs at this site was confirmed by the Service in April 2006. The Service has not determined whether Unit 12 was occupied at the time of listing, but we have determined that it is essential to the conservation of the guajo´n because it contains the PCEs (a rocky stream surrounded by closed canopy over the stream, and closed mature forest along the shores that provide the habitat essential to the guajo´n for food, shelter, breeding, foraging, and population expansion), and because it is occupied. Due to the species’ limited distribution and the specialized habitat it occupies, protection of all existing populations of the guajo´n is extremely important to conservation of the species. The habitat of this species is naturally fragmented, and remaining habitat is threatened by land development which can further reduce and fragment the species’ habitat, distribution, and survival (Joglar 1998, p. 73). Being a habitat specialist, the guajo´n is adapted to particular environmental conditions, and abrupt changes in these conditions could result in population declines. Additionally, fragmenting habitat through human intrusions, such as roads, makes populations less resilient to natural population declines (Pechman et al. 1991, p. 895).

Unit 13: El Cielito Unit Unit 13 consists of approximately 7.84 ac (3.17 ha), between the municipal boundary of Yabucoa to the north, PR– 759 to the south and west, and PR–3 to the east, within Talante Ward, Maunabo. It includes 1,778.15 ft (541.98 m) of a drainage that connects with Quebrada Tumbada, and a guajo´n foraging area extending laterally 99 ft (30 m) from each side of the drainage. This unit was occupied at the time of listing (Joglar, pers. comm., 2007). It consists of a steep, forested drainage with large granite boulders forming large caves, vegetation-covered rocks, and with high humidity. No surface running water is present, but humidity is maintained through percolation from underground water. All PCEs are found within this unit. The presence of the species and PCEs at this site was confirmed by the Service in February 2007. Threats that may require special management considerations, due to Unit 13 being located on a private farm about 1.2 mi (2 km) to the west of PR–3, include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides), and pollution of streams or underground aquifers caused by human and domestic animal refuse (PCE 2).

Unit 14: Verraco Unit Unit 14 consists of approximately 8.9 ac (3.6 ha), between PR–181 to the north and west, Ri´o Grande de Loi´za to the east and south, and the municipal boundary of Yabucoa to the south, within Espino Ward, San Lorenzo. It includes three drainages that connect with Quebrada Verraco, and a guajo´n foraging area extending laterally 99 ft (30 m) from each side of each drainage. This unit was occupied at the time of listing (Burrowes 1997). It is heavily forested and humid, and contains very large granite boulder formations covered with vegetation. No surface running water is present, but humidity is maintained through percolation from underground water. All PCEs are found within this unit. The presence of the species and PCEs at this site was confirmed by the Service in February 2007. Threats that may require special management considerations, due to Unit 14 being located in a private farm about 0.9 mi (1.5 km) from Rd 181, include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides) and pollution of streams/underground aquifers caused by human and domestic animal refuse (PCE 2).

Unit 15: Cueva Marcela Unit Unit 15 is referred to as Cuevas Dona Marcela by Burrowes (1997, 2000) and Burrowes and Joglar (1999), and consists of approximately 7.4 ac (3.02 ha) between PR–181 and Quebrada Verraco to the north, PR–181 to the west, and Ri´o Grande de Loi´za and the municipal boundary of Yabucoa to the south, within Espino Ward, San Lorenzo. It includes two drainages that are not connected and a guajo´n foraging area extending laterally 99 ft (30 m) from each side of both drainages. The north drainage is approximately 4.28 ac (1.73 ha), and the south drainage is approximately 3.2 ac (1.3 ha). This unit was occupied at the time of listing (Joglar 1996). Both drainages have large, vegetation-covered granite boulders that create caves within patchy secondary forest. There is no surface running water, but humidity is maintained through puddles and intermittent streams formed during rainy events. All PCEs are found within this unit. The presence of the species and PCEs at this site was confirmed by the Service in February 2007. Threats that may require special management considerations, due to Unit 15 being located on a private farm about 1.2 mi (2 km) from Road 181, include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to agricultural practices (e.g., use of herbicides, fertilizers, or insecticides) and pollution of streams or underground aquifers caused by human and domestic animal refuse (PCE 2).

Unit 16: Ceiba Sur Unit Unit 16 consists of approximately 13.92 ac (5.63 ha) between Road PR–9934 to the east, and Road PR–919 to the west within Ceiba Sur Ward, Juncos. It includes 3,123 ft (951.91 m) of an intermittent stream that connects with the Ri´o Valenciano, and a guajo´n foraging area extending laterally 99 ft (30 m) on each side of the drainage. Every PCE is found within this unit, and presence of the species and PCEs at this site was confirmed by the Service in January 2007. The Service has not determined whether Unit 16 was occupied at the time of listing, but we have determined that it is essential to the conservation of the guajo´n because it contains the PCEs (the area has high humidity and contains densely forested stream banks, large sedimentary rocks, and vegetation-covered rocks) and because it is occupied. The guajo´n was listed primarily due to its highly restricted geographical distribution and habitat requirements (Joglar 1998, p. 73). The habitat of this species is naturally fragmented and the majority of the known populations are on private land where the increased levels of land development currently occurring in southeastern Puerto Rico where the species occurs, threatens to further reduce and fragment the species habitat, distribution, and survival (Joglar 1998, p. 73). Being a habitat specialist, the guajo´n is adapted to particular environmental conditions, and abrupt changes in these conditions could result in population declines. Additionally, fragmenting habitat through human intrusions such as roads makes populations less resilient to natural population declines (Pechman et al. 1991, p. 895). Protection of existing populations of the guajo´n is extremely important due to its limited distribution and the specialized habitat it occupies.

Unit 17: Playita Unit Unit 17 consists of approximately 5.27 ac (2.13 ha), between PR–900 to the north and east and the municipal boundary of Maunabo to the south, within Calabazas Ward, Yabucoa. It includes 1,208.9 ft (368.47 m) of a forested stream that connect with Ri´o Guayabo, and a guajo´n foraging area extending laterally 99 ft (30 m) on each side of the drainage. This unit was occupied at the time of listing (Joglar, pers. comm., 2007). It is sparsely forested and humid, and it contains very large, vegetation-covered granite boulder formations. All PCEs are found within this unit. The presence of the species and PCEs at this site was confirmed by the Service in February 2007. Threats that may require special management considerations, due to Unit 17 being located adjacent to private homes and close to an ancillary road to PR–900, include changes in the composition and abundance of vegetation surrounding guajo´n habitat (PCEs 1 and 3), degradation of water quality due to use of herbicides, fertilizers, or insecticides, and pollution of the stream caused by human and domestic animal refuse (PCE 2).

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Humacao, Las Piedras, Maunabo, Patillas, and Yabucoa, Puerto Rico, on the maps below. The primary constituent elements of critical habitat for the guajo´n are the habitat components that provide:

(i) Subtropical forest (which may include trees such as Cecropia schreberiana, Dendropanax arboreus, Guarea guidonia, Piper aduncum, Spathodea campanulata, Syzygium jambos, and Thespesia populnea) at elevations from 118 to 1,183 ft (36 to 361 m) above sea level;

(ii) Plutonic, granitic, or sedimentary rocks/boulders that form caves, crevices, and grottoes (interstitial spaces) in a streambed, and that are in proximity, or connected, to a permanent, ephemeral, or subterranean clear-water stream or water source. The interstitial spaces between or underneath rocks provide microenvironments characterized by generally higher humidity and cooler temperatures than outside the rock formations; and

(iii) Vegetation-covered rocks (the vegetation typically includes moss, ferns, and hepatics such as Thuidium urceolatum, Taxilejeunea sulphurea, and Huokeria acutifolia) extending laterally to a maximum of 99 feet (30 meters) on each bank of the stream. These rocks provide cover and foraging sites and help conserve humidity.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one or more of the primary constituent elements, such as buildings, driveways, aqueducts, airports, and roads, and the land on which such structures are located.

The units we designated have features that may require special management considerations or protection due to threats to the primary constituent elements from road construction, agriculture, development, and fishing with chemicals. All the designated units are adjacent to agricultural lands, roads, trails, homes, or other manmade structures. Special management considerations and protection required include protection of the guajo´n and its habitat from threats posed by deforestation and earth movement near streams for road construction, agricultural, urban, and rural development. These threats may result in changes in the composition and abundance of vegetation in and around guajo´n habitat, and degradation of water quality from illegal garbage dumping, disposal of untreated sewage, and agricultural practices (e.g., use of herbicides, fertilizers, or insecticides).

Life History

Food/Nutrient Resources

Food Source

Adult: Terrestrial insects, spiders

Food/Nutrient Narrative

Adult: In a preliminary study of feeding habits Joglar (1998) reported that the bulk of the diet consisted of insects (Coleoptera, Homoptera, Diptera, Hymenoptera and Lepidoptera), and other invertebrates like spiders, Chilopoda, and Diplopoda.At night, males and females left the grottoes to forage and rehydrate. In rocky, stream habitat, animals exit their retreat site at dusk to forage actively over rocks and vegetation.

Reproductive Strategy

Adult: Polygamous

Breeding Season

Adult: April - November

Reproduction Narrative

Egg: Like most of the Eleutherodactylus, the guajón has direct development of eggs, which are laid on humid boulders within grottoes and on flat surfaces (Joglar et al. 1996, Burrowes 1997). The preference for this type of microhabitat probably reduces evaporative water loss, and egg predation (Joglar 1998). The mean clutch size of the guajón is 17.35 eggs, the developmental time of eggs is 20 to 29 days, and parental care contributes to hatching success (Joglar et al. 1996).

Adult: In this species, only the male calls for mates and the vocal activity is more intense during the day than at night (Joglar et al. 1996). Males of the guajón call to attract females, and continue to call while attending the clutch (Joglar et al. 1996). The reproductive activity and the population fluctuations of the guajón are significantly correlated with precipitation and air temperature (Rogowitz et al. 2001, Joglar et al 1996). The reproductive season of this species starts in April and ends in November.Studies on parental care and sexual selection of this species, conducted by Burrowes (2000a and 1997), showed that the amplexus occurs on rocks where the male places his head over the female pelvic region and wraps his arms around the outer part of the female’s hind legs. The amplectic pair remains in this position for 12 hours before oviposition begins. When the oviposition is complete, the male sits over the clutch of eggs to guard and defend it while the female moves away from the eggs (Burrowes 1997). Hatching success of this species is 85 percent, with hatchlings remaining together as a group in the nest for several days before dispersing (Burrowes 1997). Males may guard multiple clutches that are at different stages of development (Burrowes 2000a). Burrowes (2000a) reported that developmental timing between consecutive clutches in the same nest ranged from 4 to 14 days, and one to three developmental stages. Triple and quadruple clutches were less frequent than single and double clutches, and were primarily associated with more secluded crevices or depressions (Vega-Castillo, pers. obs. 2003). Males of the guajón that guard multiple clutches increase their fitness and opportunity for reproduction (Burrowes 2000a). Burrowes (2000a) suggests that different clutches are a result of males mating with different females. Joglar et al. (1996) and Burrowes (1997) described the activity pattern of the guajón in a traditional habitat (caves and grottoes) at San Lorenzo as follows: males remained in the grottoes and crevices of the “guajonales” calling, brooding eggs, tending eggs without brooding, and calling while tending clutches by day. In both types of habitat, the species exhibits site fidelity and homing behavior, and males that have eggs remain in cavities defending and guarding clutches.

Habitat Type

Adult: Terrestrial, freshwater

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest, sunbtropical wet forest, cave, stream

Geographic or Habitat Restraints or Barriers

Adult: The past elevation range was considered to be from about 118 feet (ft) (36 meters (m)) up to 1,312 ft (400 m) above sea level; however, López-Torres (2008) found that populations of the guajón could be found at elevations ranging from about 83 ft (26 m) up to 1,381 ft (421 m) above sea level, and extending further west into the municipality of Patillas (USFWS, 2017).

Environmental Specificity

Adult: Narrow - specialist

Site Fidelity

Adult: High - see reproduction narrative

Habitat Narrative

Adult: The guajón is currently known to inhabit crevices, grottoes, and spaces among boulders in the Cuchilla de Panduras mountain range (Maunabo, San Lorenzo, and Yabucoa), and in the municipalities of Patillas, Humacao, and Las Piedras. López-Torres (2008) found that populations of the guajón could be found at elevations ranging from about 83 ft (26 m) up to 1,381 ft (421 m) above sea level, and extending further west into the municipality of Patillas. The guajón was mainly found in young and mature secondary forests, followed by shrubs, and to a lesser extent in abandoned plantations (López-Torres 2008). The guajón inhabits crevices and grottoes in and among boulders. It also inhabits caves formed by large boulders of granite rock known as “guajonales” or streams with patches of rocks without cave systems. This endemic species was previously believed to occur exclusively inside caves containing or adjacent to streams; however, habitat studies by Vega-Castillo (2000) showed that the guajón also lives in rocky streams. Caves are dark inside, although some light enters through gaps formed from the union of two or more boulders of rock. Structurally the caves are complex, in the form of several chambers of irregular shape and size, and at different depths between the surface of the ground and stream. The ecological conditions of the caves are similar: mean temperature and relative humidity are the same at any given month of the year, and they do not have thermal stratification. In streams, the species has been found only in patches of rock in the streambed. The streams are surrounded by secondary forest and can be a perennial, or an ephemeral stream, which forms with heavy rain. Rocks in the streambed form crevices and grottoes. Streams provide a wide variety of retreat sites for the species, such as vegetation over rocks (e.g., moss, ferns and liverworts) that help in the conservation of humidity. Temperature and relative humidity at streams vary within the year. The habitat of the guajón includes several life zones as described by Ewel and Whitmore (1973). The variables used to delineate any give life zone are mean annual precipitation and mean annual temperature. The two predominant life zones found within guajón habitat are Subtropical Moist and Subtropical Wet Forests. In addition, Subtropical Lower Montane Wet Forest may be found on most mountains above 1000 meters and occasionally extending down to almost 700 meters. Trees up to 20 meters tall, with rounded crowns, characterize the Subtropical Moist Forest life zone. Many of the woody species are deciduous during the dry season and epiphytes are common. The Subtropical Wet Forest occupies much of the higher parts of Puerto Rico's mountains. The abundant moisture of this life zone is evident in the character of vegetation. Epiphytic ferns, bromeliads, and orchids are common, the forests are relatively rich in plant species, and the growth rates of successional trees are rapid. This type of forest contains more than 150 species of trees that form a dark, complete canopy at about 20 meters. The third life zone found in the guajón's habitat is the Subtropical Lower Montane Wet Forest, which may occur at the higher elevations. Open-crowned trees that have coriaceous, dark leaves, giving the canopy a brownish or reddish cast, characterize this forest. The species diversity for this life zone is much less, with 53 tree species found. Vega-Castillo (2000) reported that in streams, the guajón has been found only in patches of rock in the streambed. The streams can be perennial, or ephemeral formed during heavy rain and are surrounded by secondary forest. Rocks in the streambed form crevices and grottoes. Streams provide a wide variety of retreat sites for the species, such as vegetation over rocks (e.g., moss, ferns, and liverworts) that help conserve humidity. Temperature and relative humidity at streams vary with the months of the year. The foraging habitat of the guajón may extend outside the streambed in vegetated areas as far as 66 to 98 feet (20 to 30 meters) from the water source (Vega-Castillo, pers. obs.).Being a habitat specialist, the guajón is adapted to particular environmental conditions, and abrupt changes in these conditions could result in population declines.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Stable

Number of Populations:

19 (USFWS, 2022)

Adaptability:

High

Population Narrative:

The population is stable. There is no information indicating that the species status has either improved or declined. Known guajón populations in the Sierra de Panduras should remain stable, if negotiations during ongoing consultation result in the protection or enhancement of its habitat. Populations in Las Piedras must be closely monitored to prevent impacts from residential developments in private properties. During FY 2010, changes to species distribution, threats and habitat conditions have not been reported.Burrowes (1997) studied the guajón at a cave system in the Cuchilla de Panduras, where a total of 130 individuals were marked at the site, resulting in a mean population size estimate of 96 individuals, and a mean of 20 new individuals entering the population every six months. Another mark-recapture study conducted by Vega-Castillo (2000) showed mean population size of 436 individuals in a rocky stream in Humacao, and 390 individuals for a rocky stream at Las Piedras. Burrowes (2000b and 1997) assessed the genetic variation within and among populations of the guajón, in separate cave systems within the historic geographic range of the species and found a high degree of genetic variation and lack of population differentiation in the species. These studies also documented that genetic flow among populations of “guajones” is necessary to maintain the high genetic variability observed in the species. This genetic variability depends on inter-connection between caves, and the availability of clean subterranean waterways as indirect dispersal routes necessary for out-crossing (Burrowes 2000b and 1997). This study also suggested that the species is perfectly adapted to the existing environmental conditions in the caves, and that clean waterways must be maintained between the guajonales to maintain a high degree of genetic variation among the guajón population USFWS, 2011). López-Torres (2008) found that, out of 169 localities sampled, the guajón was present in 108 (64%). The species was very abundant in only 11 of the sampled sites, abundant in 25, and not abundant in 72. The municipality of Yabucoa contained most of the localities where the species was very abundant (63.3%), and San Lorenzo had the most localities where the species was present (37.9%). López-Torres (2008) further stated that these findings were alarming, considering that isolated populations with low abundance are at high risk of disappearing (USFWS, 2017). The guajón is a threatened frog species limited to seven municipalities in southeastern Puerto Rico and has very specific habitat requirements (i.e., forested areas that contain large boulder granite rock formations and patches of rocks near streams and drainages). The species occurs primarily within private lands and only three protected areas are known to harbor guajón populations. Surveys in 2012 to 2014 suggested that some populations that seem stable and a few may be declining or even extirpated. Previous genetic analysis suggested certain populations are isolated and others well connected through streams and forest corridors. This genetic study grouped the 19 populations sampled into 5 genetic clusters, which may provide a framework for future recovery activities (USFWS, 2022).

Threats and Stressors

Stressor: Deforestation, vegetation removal, and earth movement
Exposure:
Response:
Consequence:

Narrative: Changes in forest structure and vegetation may alter microhabitats and microclimates that affect the quality of habitat and the species. Deforestation and earth movement for agricultural, urban, and rural development has a negative impact on the habitats and interrupts the connection between existing populations, thus dispersal and interaction opportunities between sub-populations can be affected, restricting gene flow and jeopardizing the viability of meta-populations. Isolated populations are vulnerable to extinction through random adverse environmental events and human-caused impacts (Soulé 1987). Any activity that jeopardizes the gene flow among sub-populations also puts in danger the integrity of the species' gene pool. Deforestation near streams can result in erosion and increase flash flooding. Runoff water from slopes during flash flooding drastically disturbs the habitat of the guajón, and high levels of sediment introduced into streams can fill spaces between rocks and decrease the availability of retreat sites among the boulders. Another effect of flash flooding is the flushing and drowning of adults, as well as the destruction of nests. The use of pesticides, herbicides, and fertilizers in agricultural fields could have detrimental effects on survival of the guajón from runoff into waterways adjacent to guajón habitat. Many studies have documented negative impacts of agrochemicals on frogs; impacts include deformities, abnormal immune system functions, diseases, injury and death (Cook 1981; Hine et al 1981; Sanders 1970; Reeder et al. 1998; Davidson et al. 2001; Hayes et al. 2002; Gendron et al. 2003). Also, any stream modification (e.g., embankment, channelization) or development (e.g., tourist, urban) within the watershed where the guajón exists could result in an increase of chemical laden sediments and alteration of the streams quality.

Stressor: Roads and urban development
Exposure:
Response:
Consequence:
Narrative: Road and urban developments result in earth movement, modification of vegetation and streams, and increased noise levels, as well as habitat fragmentation that may interrupt the connection between sub-populations, affecting the genetic variability and population numbers of the guajón. Amphibian populations unable to disperse because of barriers may experience genetic isolation resulting in reduced heterozygosity (i.e., potential reduction in genetic variability and evolutionary fitness). Fragmenting habitat through human intrusions such as roads makes populations less resilient to natural population declines (Pechman et al. 1991).

Stressor: Recreational stream use
Exposure:
Response:
Consequence:
Narrative: Recreational use of streams may degrade the habitat quality for the guajón. People that live adjacent to guajón habitat may collect crabs and shrimp using toxic substances (e.g., chlorine), affecting water and habitat quality. The decrease in water and habitat quality can have a serious impact on this and other amphibians that inhabit streams. Waste generated during recreational use of streams produce waste that people may introduce to the streams, for

example, caves in the Cuchilla de Panduras mountain range are used as garbage dumps, attracting potential predators and diseases for the guajón.

Stressor: Disease and Predation
Exposure:
Response:
Consequence:
Narrative: The magnitude of threat of disease and predation on the guajón is low, and the immediacy of threat to the species is non-imminent, because studies have not shown how disease and predation affect the guajón, and only circumstantial evidence has been found suggesting that the guajón is threatened by disease or predation (USFWS, 2017).

Stressor: Other natural or manmade factors affecting its continued existence.
Exposure:
Response:
Consequence:
Narrative: The guajón was listed primarily due to its highly restricted geographical distribution and habitat requirements. Being a habitat specialist, the guajón is adapted to particular environmental conditions, and abrupt changes in these conditions could result in population declines. Each of the designated critical habitat units for the guajón in southeastern Puerto Rico is adjacent to at least one of the following manmade features: agricultural lands, roads, trails, homes, or other manmade structures. Many studies have documented negative impacts of agrochemicals on frogs; impacts include deformities, abnormal immune system functions, diseases, injury and death (Cook 1981; Reeder et al. 1998; Davidson et al. 2001; Hayes et al. 2002). The Final Rule states "The practice of planting crops right up to the entrance of guajonales may . . . increase the pesticide and fertilizer run-off into the water flowing under the caves." The recovery plan mentions that the use of pesticides, herbicides, and fertilizers in agricultural fields could have detrimental effects on survival of the guajón from runoff into waterways adjacent to guajón habitat. Special management considerations and protection are required to protect the guajón and its habitat from threats posed by human activities, earth movement, and deforestation for road construction, agricultural, urban, and rural development near streams. These threats may result in changes in the composition and abundance of vegetation in and around guajón habitat, and degradation of water quality from illegal garbage dumping, household practices (e.g., car washing, scrubbing of porches and terraces), disposal of untreated sewage, and agricultural practices (e.g., use of herbicides, fertilizers, or insecticides). Presence of garbage generated by people has been documented within drainages of the Cuchilla de Panduras mountain range (Vega-Castillo, pers. comm. 2004; López-Torres, pers. comm. 2008), attracting potential predators and diseases for the guajón. Seven other species of Eleutherodactylus, as well as the white-lipped frog Leptodactylus albilabris, are found within the same habitat as the guajón under rocks, logs, roots, or litter in the Cuchilla de Panduras mountain range (Rivero 1998). However, the extent of competitive interactions (i.e., competition for shelter or food) between these species and the guajón has not been documented. We believe that the magnitude of threat from other natural or manmade factors is high, and the immediacy of threat to the guajón is imminent, because most of the range and habitat of the guajón is within or near

private lands subject to current or previous agricultural use. Streams and drainages inhabited by the guajón are found in slopes where runoff water from agricultural lands and private properties directly drain into them. No protection measures are taken to prevent runoff water from agricultural fields that drain into guajón habitat. Daily human activities; such as household cleaning, and car repairing and washing, result in detergent, oils, and chemicals discharging through gutters into nearby streams and drainages (USFWS, 2017).

Stressor: agricultural practices (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: agricultural practices that degrade the species' habitat (USFWS, 2022)

Stressor: Disease (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: The amphibian pathogenic chytrid fungus and a parasitic tick are now well documented to affect the coqui guajón and are likely to impact the species throughout its range (USFWS, 2022)

Recovery

Reclassification Criteria:
Recovery Priority Number: 11 (USFWS, 2022)

Delisting Criteria:
1. Permanently protect traditional, non-traditional, and unoccupied guajón habitat, and corridors between existing populations, through landowner agreements, conservation easements, habitat conservation plans, and public outreach.

2. Determine the viability of existing populations (e.g., numbers, breeding success, population genetics, and ecology), and how many viable subpopulations are needed to ensure a self-sustaining overall population.

3. Determine the geographic distribution of all subpopulations needed to ensure a self-sustaining overall population.

4. Survey all potential habitats for new occurrences and evaluate suitability for species introduction.

The amended delisting criteria for the coqui guajon are: 1. Within the five (5) known coqui guajon genetic clusters, population are geographically distributed and connected in a manner that allows for the continued existence of populations that exhibit a stable or increasing trends, natural recruitment, and multiple age classes (addresses Factors A,C, and E). 2. Suitable habitat of the five (5) known coqui guajon genetic clusters are protected and managed by a conservation mechanism to ensure ecological integrity of those areas is not affected by adverse anthropogenic habitat modification, including indirect effects of upstream/downstream land uses (addressed Factors (A, C and E) (USFWS, 2019).

Recovery Actions:

- 1. Determine the distribution and population status of the guajón within traditional, non-traditional, and unoccupied habitat.
- 2. Evaluate the need for protection of essential habitat for the species.
- 3. Conduct ecological studies to ensure the reproductive success of the guajón and the species' genetic variability.
- 4. Document the effect of natural and manmade disturbances on the guajón population.
- 5. Facilitate the recovery of the guajón through public awareness and education.
- 6. Refine recovery criteria and determine what additional actions are necessary to achieve recovery criteria.

- 5. Facilitate the recovery of the guajón through public awareness and education.
- 6. Refine recovery criteria and determine what additional actions are necessary to achieve recovery criteria.

- 1. Surveys for the guajón in traditional, non-traditional, and unoccupied habitat should be conducted, using the best available amphibian survey methodology, to determine population numbers, population fluctuations, and number of viable sub-populations (wild naturally reproducing populations large enough to maintain sufficient genetic variation, and evolve and respond to natural habitat changes) necessary to protect and stabilize the overall guajón population (meta-population study).
- 2. Proposed activities that may result in the deterioration of guajón habitat in public and private lands, such as road constructions/improvements, recreational use of streams, agricultural practices, and urban, commercial, and tourist developments, should be carefully evaluated by the appropriate government agencies and parties interested in the recovery of the guajón. Long-term leases, conservation easements, designation of guajón conservation areas, enforcement of regulations protecting the guajón, habitat restoration, and land acquisition must be explored as strategies to minimize loss of guajón habitat. This will assure that the resources necessary to support a successful breeding population of the guajón are not compromised.
- 3. The impact of predators, competitors, and parasites on the population dynamics of the guajón should be evaluated to determine if competitor and predator/parasite management techniques are necessary. In view of the studies concerning the potential for chytrid fungus infection in the guajón, guajón populations at higher elevations must be monitored for the presence of this fungus.
- 4. The effect of natural disturbances, such as flooding during storms and hurricanes, on the population dynamics (e.g., change in distribution, dispersal) and survival of the guajón should be assessed through monitoring of guajón populations before and after natural disturbances (e.g., monitor changes in: habitat characteristics, location of individuals, mortality, dispersal). To determine which hydrological areas are important, hydrological/hydraulic (H/H) studies must be done, not only in forest areas where the species is present, but also in urban areas, and localities where the species is not present to assess all threats.

- 5. Conserve hydrological units as corridors for the species.
- 6. Distribution models developed by Gould et al. (2007) and López-Torres (2008) can be employed to find other populations, and for evaluating land management practices that may threaten guajón habitat. Information on the percent of available habitat should be monitored by the Service, taking into account these recent studies.
- 7. Effective public education and outreach programs are key to the recovery of the guajón. Such programs need to develop interest among stakeholders (e.g., landowners, government agencies, legislators, consultants for development projects, academic community, and general public) about their contributions to the recovery activities of the guajón. Understanding the species needs would involve different groups into working towards common goals. This outreach and education program should balance the needs of the target audiences and the guajón, and include the development and distribution of information (e.g., species reports, audiovisual presentations, meetings, media sources) on the recovery needs of the species.
- 8. GIS and genetic analysis should be done to evaluate possible connectivity between populations thru hydrological systems, and the opportunity to establish these biological corridors should also be considered as a priority for conservation.
- 9. The recovery plan should be revised to better define and possibly modify recovery criteria and incorporate recovery actions based on new information on distribution and spatial data obtained from recent studies.

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. Develop plans for each municipality to protect the watersheds that contain guajón frog populations in a manner that promotes population growth, dispersion, and resilience. 2. Protect guajón suitable habitat and designated critical habitat through long-term mechanisms such as conservation easements. 3. Continue to support guajón research that contributes to our understanding of threats and population fluctuations. 4. Promote habitat conservation strategies with public, private and government entities to ensure that the ecological integrity of the species' habitat is not affected by adverse anthropogenic habitat modification, including effects of upstream/downstream land uses. 5. Increase public awareness of the species through public education and outreach programs that develop interest among stakeholders (e.g., landowners, government agencies, legislators, consultants for development projects, academic community, and general public) (USFWS, 2022).

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SPECIES ACCOUNT: *Eleutherodactylus jasperi* (Golden coqui)

Species Taxonomic and Listing Information

Listing Status: Threatened; November 11, 1977; R4

Physical Description

E. jasperi measures 19 -22 mm snout-vent length and is olive-gold to yellow-gold in color (Rivero 1978). The eyes are small, protruding slightly from the sockets. The snout lacks a pointed tip, a characteristic that differentiates it from the closely related E. gryllus.

Taxonomy

The species was first described as E. jasperi by Drewry and Jones (1976). Joglar (1998) mentions that in 1986 A. Dubois placed the golden coquí in another genera altogether because of its different reproductive strategy. He proposed that Ladailadne jasperi be considered the new taxonomic name. This name has not been well accepted by other authors believing that a new reproductive strategy is not enough to justify a new genera. Joglar (1998) used the genera Eleutherodactylus for the 16 species in Puerto Rico.

Current Range

E. jasperi is endemic to Puerto Rico and is restricted to a small area south of Cayey.

Critical Habitat Designated

Yes; 11/11/1977.

Legal Description

On November 11, 1977, the U.S. Fish and Wildlife Service designated critical habitat for Eleutherodactylus jasperi (Golden coqui) under the Endangered Species Act of 1973, as amended (42 FR 58756 - 58758; USFWS, 2012).

Critical Habitat Designation

Puerto Rico. Areas of land, water and airspace with the following components:

(1) Cerro Avispa - elevation above 700 meters on the south and southeastern slope of the mountain: from the northern junction of Highway 715 and an unnumbered dirt road southeast and southwest along Highway 715 to the southern junction with the same unnumbered dirt road and Highway 715, north and northeast along the unnumbered dirt road just below the southeast facing crest of Cerro Avispa to its junction with Highway 715.

(2) Monte el Gato - entire summit above 700 meters: from the junction of Highway 715 to the junction of Highway 715 and the 700 meter contour interval west along Highway 715 to the junction of Highway 715 and an unnumbered road, north and northeast along this road to where it crosses the 700 meter contour interval, and east along the 700 meter contour interval to where it crosses Highway 715.

(3) Sierra de Cayey - elevations above 700 meters: southeast from the junction of Highways 738 and 15 along Highway 15 to point .5 kilometer south of Benchmark 684.5. northeast from this point in a line to a point on Highway 7741 two kilometers south of the junction of Highway 738 and 7741, north and northwest along Highway 7741 to its junction with Highway 738, and northwest from the junction of Highways 1741 and 738 along Highway 738 to its junction with Highway 15.

Primary Constituent Elements/Physical or Biological Features

Not available

Special Management Considerations or Protections

Not available

Life History

Food/Nutrient Resources

Food Source

Adult: Terrestrial insects

Food/Nutrient Narrative

Adult: Little is known regarding feeding habits. Drewry and Jones (1976) observed that in daylight E. jasperi captures insects that enter the axils of the bromeliad leaves. At night they venture out on the leaves but retreat when disturbed.

Reproductive Strategy

Adult: Ovoviparous

Reproduction Narrative

Larvae: Three to five froglets metamorphosed within 33 days (Drewry and Jones 1976, and Rivero 1978).

Adult: Drewry and Jones (1976) reported gravid females from April to August. They observed that about a month elapsed between fertilization and birth in captive golden coquis. Rivero (1978) reported a 26-day gestation period for a captive female. Based on the observation of two classes of sub-adults on a single plant, Drewry and Jones (1976) suggested that females may produce two clutches per year. However, females and males could be receptive during long periods of time or throughout the year (Wake 1978), suggesting that reproduction could be acyclical (T. Nakamura, pers. comm.).Wake (1978) reported that eggs are retained in a modified oviduct and that fertilization is internal. Female E. jasperi retain five to six developing embryos in the oviducts. This species gives birth to live young (Drewry and Jones 1976, Rivero 1978, Wake 1978).Data on growth rates and longevity are not available. This species is presumed to have a low reproductive rate.

Habitat Type

Adult: Terrestrial

Habitat Vegetation or Surface Water Classification

Adult: Montane wet forest, subtropical moist forest, lowland mosit evergreen forest, montane wet noncalcareous evergreen forest, montane wet evergreen abandoned and active coffee plantations

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 700 - 850 m elevation

Dependency on Other Individuals or Species for Habitat

Adult: Bromeliads (Vriesia, Hohenbergia, and Guzmania spp.)

Habitat Narrative

Adult: The critical habitat for the golden coquí lies within the subtropical moist forest life zone of Puerto Rico. This life zone covers approximately 58% of the land mass of Puerto Rico and the US Virgin Islands (Ewel and Whitmore 1973). This life zone receives a mean annual rainfall ranging 39 to 87 inches (100 to 220 centimeters). Most of subtropical moist forest life zone has been deforested at one time or another with the exception of scattered remnants of zonal association vegetation (such as El Yunque National Forest) that may have trees up to 66 ft. (20 m) in height. The rest of the vegetation in this life zone consists mainly of grasses in both natural and improved pastures. Of the woody species still present in these areas, many are deciduous during the dry season and epiphytes are common, but seldom completely cover branches and trunks (Ewel and Whitmore 1973). Currently, the dominant vegetation types found in the Sierra de Cayey portion of the golden coquí's designated critical habitat mainly consists of mature secondary lowland moist noncalcareous evergreen forest, mature secondary montane wet noncalcareous evergreen forest, and montane wet evergreen abandoned and active coffee plantations. In the Monte El Gato and Cerro Avispa portion of the golden coquí's habitat, the dominant vegetation types consist of mature secondary lowland moist noncalcareous evergreen forest and young secondary lowland moist noncalcareous evergreen forest.It occurs on mountain tops, from 700 to 850 meters in elevation, at Cerro Avispa, Monte el Gato, and Sierra de Cayey, and occupies a total habitat area of approximately 24 hectares (G.E. Drewry pers. comm.). The area receives heavy dew from orographic uplift of air striking the mountain range. It has been found on dense clusters of bromeliads such as Vriesia, Hohenbergia, and Guzmania growing on trees, rock edges, and on the ground. The golden coquí inhabits the water-filled leaf axils of the bromeliads.

Dispersal/Migration

Dispersal

Adult: Low

Dispersal/Migration Narrative

Adult: Extremely low dispersal capability is presumed to be afactor in the decline of this species.

Population Information and Trends

Population Trends:

Sharp decline since discovery, unknown if still extant.

Number of Populations:

3

Population Size:

1

Population Narrative:

Although there is no causal evidence of the threatened status of the species, it is presumed that loss of habitat (deforestation and fires), its obligate bromeliad dwelling mode of existence, its presumed low reproductive rate, the potential for over-collection, and an extremely low dispersal capability, may have contributed to the species status as a threatened species (USFWS 1984, Joglar 1998).Population trends, demographic features and trends are not possible to define due to the limited information available at the time of listing and development of the Plan. The original populations may have been overestimated considering that in just 7 years the estimated population had gone from an estimated 1500-3000 individuals down to only 1 individual. There have been no confirmed sightings since 1981. The only available population estimates are those developed by Drewry while conducting field investigations of E. jasperi between May 1973 and August 1974. He estimated a population of less than 10 individuals for Cerro Avispa, 500-1000 for Monte El Gato, and 1000-2000 for all Sierra De Cayey (pers. comm.).

Threats and Stressors

Stressor: Habitat modification
Exposure:
Response:
Consequence:
Narrative: At the time of listing and when the Plan (USFWS 1984) was approved, deforestation for development projects was considered an imminent threat to the survival of the species. Additionally, three years prior to the approval of the Plan, the type locality burned (USFWS 1984). Burrowes and Joglar (1991) stated that deforestation was the largest factor for the decline of the species, followed by urban development, and over collection. Hedges and Thomas (1991) stated that factors such as deforestation and development as being the largest factors in the decline of amphibian and reptile species in Puerto Rico. Unprotected forests remain vulnerable to development especially those forests which are in close proximity to urbanized areas (Kennaway and Helmer 2007). Critical habitat for the species is located on private lands in the southeastern portion of the island, which is currently under pressure for development projects. Habitat modification related to these projects can possibly affect the habitat characteristics necessary for the species survival, if any individuals remain extant.

Stressor: Collection
Exposure:

Response:
Consequence:
Narrative: In the final rule, over collection for scientific purposes was considered a factor in the decline of the species. Burrowes and Joglar (1991) stated that this was a significant cause for the decline of the species, secondary only to deforestation and urban development. Joglar (1998) does mention that over 90 individuals of golden coquí are present in collections. When evaluating this threat it is important to consider that for such a specialized frog, quite a few specimens were collected from the historical collections. Thus, overutilization for commercial, scientific, or educational purposes may have constituted a limiting factor for the species, although the magnitude is unknown. If the species is found, collecting efforts would probably be needed for captive breeding and would need to be assessed. Therefore, we believe that the overutilization for commercial, recreational, scientific, or educational purposes should remain as a threat to this species, given it still exists.

Stressor: Disease
Exposure:
Response:
Consequence:
Narrative: Burrowes and Joglar (2004) postulated that climate change and disease may have been a contributing factor for the decline of various Eleutherodactylus species including the golden coquí. They specifically referred to the discovery of chytrid fungus, Batrachochytrium dendrobatidis (Bd), in samples of other species (not the golden coquí) collected as early as 1976. This is the first report of chytrid fungus in the Caribbean. In addition, the authors described significant warming trends and extended periods of drought during the 1970’s and 1990’s and correlated these factors with the decline of amphibians in Puerto Rico. The authors suggest a possible synergistic interaction between drought and the pathological effect of Bd on amphibian populations (Burrowes and Joglar 2004). Although Burrowes and Joglar (2004) addressed possible causes of amphibian mortality in Puerto Rico, the authors mentioned the lack of accurate updated population data for the golden coquí.

Recovery

Reclassification Criteria:
Recovery Priority Number: 5C

Delisting Criteria:
1. The three known populations be stable or expanding, each having a minimum of 1,000 individuals

2. Long-term habitat protection has been insured for essential habitat of the three known populations through appropriate means as determined by an evaluation of all available options

3. Habitat management plans for essential habitat in 2 above are completed and provide a basis for long-term management of golden coquí habitat to insure sustained availability of required habitat conditions and reduce the likelihood of catastrophic losses from fires or hurricanes.

Recovery Actions:

- 1. Protect the population: protect essential habitat on privately owned lands through conservation agreements, easements, or other appropriate means; develop interim management plans and revise as new data become available; protect essential habitat verified to occur on Commonwealth lands.
- 2. Determine the current status of the species: survey the known population for distribution and abundance; characterize its present habitat and its requirements; survey similar habitats throughout Puerto Rico in search of other populations and complete the population survey; determine possible threats and limiting factors.
- 3. Study life history: reproductive biology; feeding habits and food availability.
- 4. Monitor recovery of the populations.
- Not available

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SPECIES ACCOUNT: *Eurycea chisholmensis* (Salado Salamander)

Species Taxonomic and Listing Information

Listing Status: Threatened; 3/26/2014; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Salado salamander is a small salamander, with an elongate body, large rectangular head, uniform brown to gray-brown coloration, and very reduced eyes (Chippindale et al. 1994). (NatureServe, 2015)

Taxonomy

Based on morphological distinctiveness and distribution, Chippindale et al. (1994) regarded salamanders from Salado Springs as a distinct species and indicated their plans to describe it as such. Chippindale et al. (2000) formally described this species as Eurycea chisholmensis. Sweet (1982) included this salamander in E. neotenes. (NatureServe, 2015)

Historical Range

Historically, the Salado salamander was known from only four spring sites near the village of Salado, Bell County, Texas; it is still extant in these sites. (USFWS, 2014)

Current Range

The Salado salamander is known historically from four spring sites near the village of Salado, Bell County, Texas: Big Boiling Springs (also known as Main, Salado, or Siren Springs), Lil' Bubbly Springs, Lazy Days Fish Farm Springs (also known as Critchfield Springs), and Robertson Springs (Chippindale et al., 2000; TPWD, 2011). These springs bubble up through faults in the Northern Segment of the Edwards Aquifer and associated limestone along Salado Creek (Brune, 1975). The four spring sites all contribute to Salado Creek. In 2009 and 2010, additional populations of Salado salamanders were found at three other springs along Salado Creek. In total, the Salado salamander is currently known from seven springs. (USFWS, 2014)

Critical Habitat Designated

Yes; 9/17/2021.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), designate critical habitat for the Georgetown salamander (Eurycea naufragia) and Salado salamander (Eurycea chisholmensis) under the Endangered Species Act of 1973, as amended (Act). We designate a total of approximately 1,315 acres (538 hectares) of critical habitat for these species in Bell and Williamson Counties, Texas. This rule extends the Act's protections to the Georgetown salamander's and Salado salamander's designated critical habitat (USFWS, 2021)

Critical Habitat Designation

We are designating as critical habitat nine units for the Georgetown salamander and seven units for the Salado salamander. In Tables 1 and 2 below, we present the critical habitat units for the Georgetown and Salado salamanders. All units are considered occupied by the relevant species at the time of listing. We also provide unit descriptions for all Georgetown and Salado salamander critical habitat units. The critical habitat areas we describe below constitute our current best assessment of subsurface and surface areas that meet the definition of critical habitat for the Georgetown and Salado salamanders. During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must be provided for shelter and protection. Surface critical habitat includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of downstream habitat, but does not include terrestrial habitats or human-made structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule (see DATES, above) or land adjacent to streams; however, the subterranean aquifer may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.(USFWS, 2021)

Primary Constituent Elements/Physical or Biological Features

(1) Critical habitat units are depicted for Bell and Williamson Counties, Texas, on the maps in this entry. (2) Within these areas, the physical or biological features essential to the conservation of Salado salamander consist of the following components: (i) For surface habitat: (A) Water from the Northern Segment of the Edwards Aquifer. Groundwater quality issuing to the surface from the underlying aquifer is similar to natural aquifer conditions as it discharges from natural spring outlets. Concentrations of water quality constituents and contaminants are below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Salado salamander’s prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with at least some surface flow during the year. The water chemistry of aquatic surface habitats is similar to natural aquifer conditions, with temperatures from 61 to 84 °F (16 to 29 °C), dissolved oxygen concentrations from 5 to 13 milligrams per liter (mg/L), and specific water conductance from 317 to 814 micro-Siemens per centimeter (mS/cm). (B) Rocky substrate with interstitial spaces. Rocks in the substrate of the salamander’s surface aquatic habitat are large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The spring environment is capable of supporting a diverse aquatic invertebrate community that includes crustaceans, insects, and aquatic snails. (D) Subterranean aquifer. Access to the subsurface water table exists to provide shelter, protection, and space for reproduction. This access can occur in the form of large conduits that carry water to the spring outlet or porous voids between rocks in the streambed that extend down into the water table. (ii) For subsurface habitat: (A) Water from the Northern Segment of the Edwards Aquifer. Groundwater quality is similar to natural aquifer conditions. Concentrations of water quality constituents and contaminants are below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Salado salamander’s prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with continuous flow. The water chemistry is similar to natural aquifer conditions,

with temperatures from 61 to 84 °F (16 to 29 °C), dissolved oxygen concentrations from 5 to 13 mg/ L, and specific water conductance from 317 to 814 mS/cm. (B) Subsurface spaces. Voids between rocks underground are large enough to provide salamanders with cover, shelter, and foraging habitat. These spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The habitat is capable of supporting an aquatic invertebrate community that includes crustaceans, insects, and aquatic snails. (3) Surface critical habitat includes the spring outlets and outflow up to the high-water line and 262 ft (80 m) of upstream and downstream habitat, including the dry stream channel during periods of no surface flow. The surface critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) existing within the legal boundaries on September 17, 2021; however, the subsurface critical habitat may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs. (4) Data layers defining map units were created using a geographic information system (GIS), which included species locations, roads, property boundaries, 2011 aerial photography, and U.S. Geological Survey 7.5′ quadrangles. Points were placed on the GIS. We delineated critical habitat unit boundaries by starting with the cave or spring point locations that are occupied by the salamanders. From these cave or springs points, we delineated a 984-ft (300-m) buffer to create the polygons that capture the extent to which we estimate the salamander populations exist through underground conduits. The polygons were then simplified to reduce the number of vertices, but still retain the overall shape and extent. Subsequently, polygons that were within 98 ft (30 m) of each other were merged together. Each new merged polygon was then revised to remove extraneous divots or protrusions that resulted from the merge process. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the Service's internet site at http:// www.fws.gov/southwest/es/ AustinTexas/, at http:// www.regulations.gov at Docket No. FWS–R2–ES–2020–0048, and at the field office responsible for this designation. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2. (USFWS, 2021)

Special Management Considerations or Protections

For these salamanders, special management considerations or protections may be needed to address identified threats. Management activities that could ameliorate threats to surface habitat include (but are not limited to): (1) Protecting the quality of cave and spring water by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution throughout the Northern Segment of the Edwards Aquifer; (2) minimizing the likelihood of pollution events or surface runoff from existing and future development that would affect groundwater quality; (3) protecting groundwater and spring flow quantity (for example, by implementing water conservation and drought contingency plans throughout the Northern Segment of the Edwards Aquifer); (4) protecting water quality and quantity from present and future quarrying; (5) excluding cattle and feral hogs from spring openings and outflow through fencing to protect spring habitats from damage; and (6) fencing and signage to protect spring habitats from human vandalism. Some of the management activities listed above, such as those that protect spring flow and groundwater quality, protect both surface and subsurface habitats, as these are interconnected. Additional management activities that could ameliorate threats that are specific to subsurface habitat include (but are not limited to): (1) The development and implementation of void mitigation plans for construction projects to prevent impacts to salamanders in the event of severed aquifer conduits or interrupted groundwater flow paths; (2) site-specific plans developed by geotechnical engineers to prevent changes to subsurface water flow from construction activities; (3) the presence of environmental monitors during construction, excavation, and drilling activities to monitor spring flow; and (4) post-construction monitoring of spring flow. Because subsurface habitat differs with regard to groundwater flow paths, depth, and amount of water-bearing rocks with voids that can support salamanders, management, and mitigation plans to ameliorate threats will need to be developed on a site-specific basis. (USFWS, 2021)

Life History

Food/Nutrient Resources

Food Source

Adult: Macroinvertebrates (USFWS, 2014)

Food/Nutrient Narrative

Adult: Although detailed dietary studies are lacking for the Salado salamander, the diet is presumed to be similar to other Eurycea species, consisting of small aquatic invertebrates such as amphipods, copepods, isopods, and insect larvae (reviewed in COA, 2001}. They more frequently feed in surface water areas where prey availability is higher. Prey availability for carnivores is low underground due to the lack of sunlight. These prey items also require high water quality. (USFWS, 2014)

Reproductive Strategy

Adult: Sexual (USFWS, 2014)

Breeding Season

Adult: Year round (USFWS, 2014)

Other Reproductive Information

Adult: This salamander is neotenic, i.e., retaining the gilled larval form into adulthood capable of reproduction. (USFWS, 2014)

Reproduction Narrative

Adult: The detection of juveniles in all seasons suggests that reproduction occurs year-round (Bendik 2011a; Hillis et al. 2001). Because eggs are very rarely found on the surface, these salamanders likely deposit their eggs underground for protection (O’Donnell et al. 2005). (USFWS, 2014)

Habitat Type

Adult: Springs and brooks (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Edwards aquifer springs (USFWS, 2014)

Dependencies on Specific Environmental Elements

Adult: High water quality (USFWS, 2014)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 2014)

Habitat Narrative

Adult: This completely aquatic salamander is restricted to the immediate vicinity of spring outflows, under rocks and in gravel substrate (Chippindale 2005). (NatureServe, 2015)

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USWFWS, 2014)

Dispersal

Adult: Low (USFWS, 2014)

Dispersal/Migration Narrative

Adult: More study is needed to determine the nature and extent of the dispersal capabilities of the Salado salamander. Some data indicate that some populations could be connected through subterranean water-filled spaces. However, we are unaware of any information available on the frequency of movements and the actual nature of connectivity among populations. (USFWS, 2014)

Population Information and Trends

Population Trends:

Declining (inferred from USFWS, 2014)

Species Trends:

Declining (inferred from USFWS, 2014)

Number of Populations:

7 (USFWS, 2014)

Population Size:

Unknown (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 2014)

Population Narrative:

There are no population estimates available for any Salado salamander sites, but recent surveys have indicated that Salado salamanders are exceedingly rare at the four most impacted sites and much more abundant at the three least impacted sites (Gluesenkamp 2011a, b, TPWD, pers. comm.). (USFWS, 2014) The long-term trend is unknown, but available data suggest a decline in abundance. Prior to 1991, several specimens could sometimes be found at Big Boiling Springs, the type locality (Chippindale 2005). In contrast, only one specimen was found between 1991 and 1998, despite over 20 additional visits that occurred (Chippindale et al. 2000, Chippindale 2005). Robertson Springs are on private land and access to the site has not been granted, so the population there is unknown. (NatureServe, 2015)

Threats and Stressors

Stressor: Urbanization (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Urban development leads to various stressors on spring systems, including increased frequency and magnitude of high flows in streams, increased sedimentation, increased contamination and toxicity, and changes in stream morphology and water chemistry (Coles et al., 2012). Urbanization can also impact aquatic species by negatively affecting their invertebrate prey base (Coles et al., 2012). Urbanization also increases the sources and risks of an acute or catastrophic contamination event, such as a leak from an underground storage tank or a hazardous materials spill on a highway. The population of Bell County, now at 310,235, is expected to increase 128 percent over the next 40 years. It is notable, however, that three of the Salado salamander springs are on ranchland and are being protected from development, as well as livestock impacts. (USFWS, 2014)

Stressor: Degraded water quality and quantity (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Habitat modification, in the form of degraded water quality and quantity and disturbance of spring sites, is the primary threat to the Salado salamander. The Salado salamander spends its entire life cycle in water. It has evolved under natural aquifer conditions both underground and as the water discharges from natural spring outlets. Deviations from high water quality and quantity have detrimental effects on salamander ecology because the aquatic habitat can be rendered unsuitable for salamanders by changes in water chemistry and flow

patterns. Polycyclic aromatic hydrocarbons, pesticides, and nutrients (fertilizers) are all potentially hazardous to the salamander. (USFWS, 2014)

Stressor: Substrate modification (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Substrate modification is also a major concern for aquatic salamander species (City of Austin (COA), 2001; Geismar, 2005; O'Donnell et al., 2006). Unobstructed interstitial space is a critical component to the surface habitat for the Salado salamander because it provides cover from predators and habitat for their macroinvertebrate prey items within surface sites. When the interstitial spaces become compacted or filled with fine sediment, the amount of available foraging habitat and protective cover for salamanders with these behaviors is reduced, resulting in population declines (Welsh and Ollivier, 1998; Geismar, 2005; O'Donnell et al., 2006). (USFWS, 2014)

Stressor: Impervious cover (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Impervious cover is detrimental because water will run off instead of filtering though the soil. This alters flow patterns and also allows contaminants to enter the water directly rather than through the soil. Impervious cover also alters habitats in and near streams that provide living spaces for aquatic species (Coles et al., 2012). (USFWS, 2014)

Stressor: Hazardous material spills (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The Edwards Aquifer is at risk from a variety of sources of contaminants and pollutants (Ross, 2011), including hazardous materials that have the potential to be spilled or leaked, resulting in contamination of both surface and groundwater resources (Service, 2005). Utility structures such as storage tanks or pipelines (particularly gas and sewer lines) can accidentally discharge. Some Salado salamander sites are located downstream of Interstate 35, a major transportation corridor for trucks, including those with hazardous materials that could spill. Any activity that involves the extraction, storage, manufacture, or transport of potentially hazardous substances, such as fuels or chemicals, can contaminate water resources and cause harm to aquatic life. (USFWS, 2014)

Stressor: Construction Activities
Exposure:
Response:
Consequence:

Narrative: Short-term increases in pollutants, particularly sediments, can occur during construction in areas of new development. When vegetation is removed and rain falls on unprotected soils, large discharges of suspended sediments can erode from newly exposed areas, resulting in increased sedimentation in downstream drainage channels (Schueler, 1987; Turner, 2003; O'Donnell et al., 2005). Cave sites are also impacted by construction. Construction activities within rock quarries can permanently alter the geology and groundwater hydrology of the immediate area, and adversely affect springs that are hydrologically connected (Ekmekci, 1990; van Beynan and Townsend, 2005; Humphreys, 2011). At least three of the seven known sites for the Salado salamander have been physically modified by construction activities. (USFWS, 2014)

Recovery

Recovery Actions:

- No Recovery Plan
- None specified

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed July 2016.

USFWS. 2014. Endangered and Threatened Wildlife and Plants

Determination of Threatened Species Status for the Georgetown Salamander and Salado Salamander Throughout Their Ranges

Final Rule. 79 Federal Register 36, February 24, 2014. Pages 10236-10293.

USFWS. 2021. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for the Georgetown and Salado Salamanders. Final Rule. FR Vol. 86, No. 157. Pages 46536-46578.

U. S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Eurycea nana* (San Marcos salamander)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southwest Region (R2) (USFWS, 2016)

Physical Description

A small, brown, gilled salamander. The length is 5 cm. (NatureServe, 2015)

Taxonomy

Chippindale et al. (1998, 2000) reviewed the systematic status of this salamander. (NatureServe, 2015)

Current Range

Pool at source of San Marcos River (San Marcos Springs, Spring Lake), Hays County, Texas, and a short distance downstream (Chippindale et al. 2000). A second, smaller population of this species was thought to occur in the Comal River (Springs), slightly to the west in Comal County; however, this population recently was determined not to be E. NANA (USFWS 1990; Chippindale et al. 1994, 1998). (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/14/1980.

Legal Description

On July 14, 1980, the Service determined the San Marcos salamander (Eurycea nana) to be a Threatened species and determined the Critical Habitat of the San Marcos salamander. The San Marcos salamander has been listed with special rules (§ 17.43) which allow taking in accordance with Texas State law.

Critical Habitat Designation

The entire known range of the species is designated as Critical Habitat.

Texas, Hays County. Spring Lake and its outflow, the San Marcos River, downstream approximately 50 meters from the Spring Lake Dam.

Primary Constituent Elements/Physical or Biological Features

The major threats to this species are: (1) Lowering of water tables in the area such that Spring Lake could become either dry or intermittent, thus exposing algal mats, and leading to the destruction of this species' sole habitat; (2) the owners of Spring Lake expressed concern that skin divers could disrupt algal mats and the bottom of the lake. This could expose salamanders to predation by fish and other predatory species.

PCEs not described. Based on the text above it can be inferred that (1) water present in Spring Lake year round and (2) benthic algal mats are major constituent elements required by this species.

Special Management Considerations or Protections

The Act provides no legal means of prohibiting the activities of private landowners, such as excluding people from the Critical Habitat who are not involved in direct taking of the species ("taking" prohibitions do not apply to plants). In this regard, the designation of Critical Habitat will not impose restrictions on private recreational use of the San Marcos River.

Life History

Food/Nutrient Resources

Food Source

Adult: Diet includes amphipods, midge larvae, and aquatic snails.; Food Habits: Invertivore (Adult, Immature) (NatureServe, 2015)

Food/Nutrient Narrative

Adult: Diet includes amphipods, midge larvae, and aquatic snails.; Food Habits: Invertivore (Adult, Immature) (NatureServe, 2015)

Reproductive Strategy

Adult: Paedomorphic. Eggs hatch in about 24 days.; (NatureServe, 2015)

Lifespan

Adult: Paedomorphic. Eggs hatch in about 24 days.; (NatureServe, 2015)

Breeding Season

Adult: Paedomorphic. Eggs hatch in about 24 days.; (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Paedomorphic. Eggs hatch in about 24 days.; (NatureServe, 2015)

Other Reproductive Information

Adult: Paedomorphic. Eggs hatch in about 24 days.; (NatureServe, 2015)

Reproduction Narrative

Adult: Paedomorphic. Eggs hatch in about 24 days.; (NatureServe, 2015)

Habitat Type

Adult: Shallow alkaline springs carved out of limestone, with sand and gravel substrate. Associated with water plants and algal mat covering spring pool.SPRING/SPRING BROOKBenthic (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shallow alkaline springs carved out of limestone, with sand and gravel substrate. Associated with water plants and algal mat covering spring pool.SPRING/SPRING BROOKBenthic (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Shallow alkaline springs carved out of limestone, with sand and gravel substrate. Associated with water plants and algal mat covering spring pool.SPRING/SPRING BROOKBenthic (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: Shallow alkaline springs carved out of limestone, with sand and gravel substrate. Associated with water plants and algal mat covering spring pool.SPRING/SPRING BROOKBenthic (NatureServe, 2015)

Dispersal/Migration

Motility/Mobility

Adult: Nonmigrant: Y; Local migrant: N; Distant migrant: N; (NatureServe, 2015)

Dispersal

Adult: Nonmigrant: Y; Local migrant: N; Distant migrant: N; (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Nonmigrant: Y; Local migrant: N; Distant migrant: N; (NatureServe, 2015)

Additional Life History Information

Adult: Nonmigrant: Y; Local migrant: N; Distant migrant: N; (NatureServe, 2015)

Population Information and Trends

Population Trends:

Decline of <30% to increase of 25% (NatureServe, 2015)

Population Growth Rate:

Decline of <30% to increase of 25% (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Decline of <30% to increase of 25% Only one occurrence. (NatureServe, 2015)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: Vulnerable to alterations in water level and water quality that may result from agricultural and residential development. (NatureServe, 2015)

Recovery

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia.

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed July 2016.

U.S. Fish and Wildlife Service. 1980. Endangered and Threatened Wildlife and Plants

Listing of the San Marcos Salamander as Threatened, the San Marcos Gambusia as Endangered, and the Listing of Critical Habitat for Texas Wild Rice, San Marcos Salamander

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.”

SPECIES ACCOUNT: *Eurycea naufragia* (Georgetown Salamander)

Species Taxonomic and Listing Information

Listing Status: Threatened; 3/26/2014; Southwest Region (Region 2) (USFWS, 2014)

Physical Description

The Georgetown salamander is a small neotenic salamander characterized by a broad, relatively short head with three pairs of bright-red gills on each side behind the jaws, a rounded and short snout, and large eyes with a gold iris. The upper body is generally grayish while the underside is pale and translucent. The tail tends to be long with poorly developed dorsal and ventral fins that are golden-yellow at the base, cream-colored to translucent toward the outer margin, mottled with melanophores and iridophores, and with a distinct dark border along the lateral margins (Chippindale et al., 2000). There are cave-adapted forms with reduced eyes and pale coloration (TPWD, 2011). (USFWS, 2014)

Taxonomy

The Georgetown salamander was formerly considered conspecific with the Salado and Jollyville Plateau salamanders. However, molecular evidence strongly supports that there is a high level of divergence between the three taxa (Chippindale et al., 2000; Chippindale, 2010). It was regarded as a distinct species by Chippindale et al. (1994) and formally described as E. naufragia by Chippindale et al. (2000). (USFWS, 2014) It had been included in Eurycea neotenes by Sweet (1978, 1982). (NatureServe, 2015)

Historical Range

The species has not been observed in more than 20 years at San Gabriel Spring and more than 10 years at Buford Hollow Spring, despite several survey efforts to find it (Chippindale et al., 2000; Pierce, 2011b, c, Southwestern University, pers. comm.). (USFWS, 2014)

Current Range

The Georgetown salamander is known from springs along five tributaries (South, Middle, and North Forks; Cowan Creek; and Berry Creek) to the San Gabriel River (Pierce 2011a, p. 2) and from two caves (aquatic, subterranean locations) in Williamson County, Texas. (USFWS, 2014)

Critical Habitat Designated

Yes; 9/17/2021.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), designate critical habitat for the Georgetown salamander (Eurycea naufragia) and Salado salamander (Eurycea chisholmensis) under the Endangered Species Act of 1973, as amended (Act). We designate a total of approximately 1,315 acres (538 hectares) of critical habitat for these species in Bell and Williamson Counties, Texas. This rule extends the Act’s protections to the Georgetown salamander’s and Salado salamander’s designated critical habitat (USFWS, 2021)

Critical Habitat Designation

We are designating as critical habitat nine units for the Georgetown salamander and seven units for the Salado salamander. In Tables 1 and 2 below, we present the critical habitat units for the Georgetown and Salado salamanders. All units are considered occupied by the relevant species at the time of listing. We also provide unit descriptions for all Georgetown and Salado salamander critical habitat units. The critical habitat areas we describe below constitute our current best assessment of subsurface and surface areas that meet the definition of critical habitat for the Georgetown and Salado salamanders. During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must be provided for shelter and protection. Surface critical habitat includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of downstream habitat, but does not include terrestrial habitats or human-made structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule (see DATES, above) or land adjacent to streams; however, the subterranean aquifer may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.(USFWS, 2021)

Primary Constituent Elements/Physical or Biological Features

(1) Critical habitat units are depicted for Williamson County, Texas, on the maps in this entry. (2) Within these areas, the physical or biological features essential to the conservation of Georgetown salamander consist of the following components: (i) For surface habitat: (A) Water from the Northern Segment of the Edwards Aquifer. Groundwater issuing to the surface from the underlying aquifer is similar to natural aquifer conditions as it discharges from natural spring outlets. Concentrations of water quality constituents and contaminants should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Georgetown salamander’s prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with at least some surface flow during the year. The water chemistry of aquatic surface habitats is similar to natural aquifer conditions, with temperatures from 61 to 84 °F (16 to 29 °C), dissolved oxygen concentrations from 5 to 13 milligrams per liter (mg/L), and specific water conductance from 317 to 814 microSiemens per centimeter (mS/cm). (B) Rocky substrate with interstitial spaces. Rocks in the substrate of the salamander’s surface aquatic habitat are large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The spring environment supports a diverse aquatic invertebrate community that includes crustaceans, insects, and aquatic snails. (D) Subterranean aquifer. Access to the subsurface water table exists to provide shelter, protection, and space for reproduction. This access can occur in the form of large conduits that carry water to the spring outlet or porous voids between rocks in the streambed that extend down into the water table. (ii) For subsurface habitat: (A) Water from the Northern Segment of the Edwards Aquifer. Groundwater quality is similar to natural aquifer conditions. Concentrations of water quality constituents and contaminants should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Georgetown salamander’s prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with continuous flow. The water chemistry is similar to natural aquifer conditions, with temperatures from 61 to 84 °F (16 to 29 °C), dissolved oxygen concentrations from 5 to 13 mg/ L, and specific water conductance from 317 to 814 mS/cm. (B) Subsurface spaces. Voids between rocks underground are large enough to provide salamanders with cover, shelter, and foraging habitat. These spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The habitat supports an aquatic invertebrate community that includes crustaceans, insects, and aquatic snails. (3) Surface critical habitat includes the spring outlets and outflow up to the high-water line and 262 feet (ft) (80 meters (m)) of upstream and downstream habitat, including the dry stream channel during periods of no surface flow. The surface critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) existing within the legal boundaries on September 17, 2021; however, the subsurface critical habitat may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs. (4) Data layers defining map units were created using a geographic information system (GIS), which included species locations, roads, property boundaries, 2011 aerial photography, and U.S. Geological Survey 7.5’ quadrangles. Points were placed on the GIS. We delineated critical habitat unit boundaries by

starting with the cave or spring point locations that are occupied by the salamander. From these cave or springs points, we delineated a 984-ft (300-m) buffer to create the polygons that capture the extent to which we estimate the salamander populations exist through underground conduits. The polygons were then simplified to reduce the number of vertices, but still retain the overall shape and extent. Subsequently, polygons that were within 98 ft (30 m) of each other were merged together. Each new merged polygon was then revised to remove extraneous divots or protrusions that resulted from the merge process. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the Service's internet site at http:// www.fws.gov/southwest/es/ AustinTexas/, at http:// www.regulations.gov at Docket No. FWS–R2–ES–2020–0048, and at the field office responsible for this designation. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2. (USFWS, 2021)

Special Management Considerations or Protections

For these salamanders, special management considerations or protections may be needed to address identified threats. Management activities that could ameliorate threats to surface habitat include (but are not limited to): (1) Protecting the quality of cave and spring water by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution throughout the Northern Segment of the Edwards Aquifer; (2) minimizing the likelihood of pollution events or surface runoff from existing and future development that would affect groundwater quality; (3) protecting groundwater and spring flow quantity (for example, by implementing water conservation and drought contingency plans throughout the Northern Segment of the Edwards Aquifer); (4) protecting water quality and quantity from present and future quarrying; (5) excluding cattle and feral hogs from spring openings and outflow through fencing to protect spring habitats from damage; and (6) fencing and signage to protect spring habitats from human vandalism. Some of the management activities listed above, such as those that protect spring flow and groundwater quality, protect both surface and subsurface habitats, as these are interconnected. Additional management activities that could ameliorate threats that are specific to subsurface habitat include (but are not limited to): (1) The development and implementation of void mitigation plans for construction projects to prevent impacts to salamanders in the event of severed aquifer conduits or interrupted groundwater flow paths; (2) site-specific plans developed by geotechnical engineers to prevent changes to subsurface water flow from construction activities; (3) the presence of environmental monitors during construction, excavation, and drilling activities to monitor spring flow; and (4) post-construction monitoring of spring flow. Because subsurface habitat differs with regard to groundwater flow paths, depth, and amount of water-bearing rocks with voids that can support salamanders, management, and mitigation plans to ameliorate threats will need to be developed on a site-specific basis. (USFWS, 2021)

Life History

Food/Nutrient Resources

Food Source

Adult: Macroinvertebrates (USFWS, 2014)

Food/Nutrient Narrative

Adult: Although detailed dietary studies are lacking for the Georgetown salamander, the diet is presumed to be similar to other Eurycea species, consisting of small aquatic invertebrates such as amphipods, copepods, isopods, and insect larvae (reviewed in COA, 2001}. They more frequently feed in surface water areas where prey availability is higher. Prey availability for carnivores is low underground due to the lack of sunlight. These prey items also require high water quality. (USFWS, 2014)

Reproductive Strategy

Adult: Sexual (USFWS, 2014)

Breeding Season

Adult: Mostly winter and spring (USFWS, 2014)

Other Reproductive Information

Adult: This salamander is neotenic, i.e., retaining the gilled larval form into adulthood capable of reproduction. (USFWS, 2014)

Reproduction Narrative

Adult: Little is known about the reproductive habits of this species. The detection of juveniles in all seasons suggests that reproduction occurs year-round (Bendik, 2011a; Hillis et al., 2001). However, juvenile abundance of Georgetown salamanders typically increases in spring and summer, indicating that there may be relatively more reproduction occurring in winter and early spring compared to other seasons (Pierce, 2012). In addition, most gravid (egg-bearing) females of the Georgetown salamander are found from October through April (Pierce, 2012; Pierce and McEntire, 2013). Because eggs are very rarely found on the surface, these salamanders likely deposit their eggs underground for protection (O'Donnell et al., 2005). (USFWS, 2014)

Habitat Type

Adult: Springs and brooks (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Edwards aquifer springs (USFWS, 2014)

Dependencies on Specific Environmental Elements

Adult: High water quality (USFWS, 2014)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 2014)

Habitat Narrative

Adult: Surface-dwelling Georgetown salamanders inhabit spring runs, riffles, and pools with gravel and cobble rock substrates (Pierce et al., 2010). This species prefers larger cobble and boulders to use as cover (Pierce et al., 2010). Georgetown salamanders are found within 164 ft (50 m) of a spring opening (Pierce et al., 2011a), but they are most abundant within the first 16.4 ft (5 m) (Pierce et al., 2010). It also occurs in subsurface (within caves or other underground areas within the Edwards Aquifer) habitats. It may travel an unknown depth into interstitial spaces within the spring or streambed substrate that provide foraging habitat and protection from predators and drought conditions (Cole, 1995; Pierce and Wall, 2011). It may also use deeper passages of the aquifer that connect to the spring opening (Dries 2011, City of Austin (COA), pers. comm.). (USFWS, 2014)

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USWFWS, 2014)

Dispersal

Adult: Low (USFWS, 2014)

Dispersal/Migration Narrative

Adult: More study is needed to determine the nature and extent of the dispersal capabilities of the Georgetown salamander. Some data indicate that some populations could be connected through subterranean water-filled spaces. However, we are unaware of any information available on the frequency of movements and the actual nature of connectivity among populations. (USFWS, 2014)

Population Information and Trends

Population Trends:

Variable (inferred from USFWS, 2014)

Species Trends:

Declining (inferred from USFWS, 2014)

Number of Populations:

12-20 (USFWS, 2014)

Population Size:

Unknown (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 2014)

Population Narrative:

The only mark-recapture studies on the Georgetown salamander estimated surface population sizes of 100 to 200 adult salamanders at 2 sites thought to be of the highest quality for this species (Twin Springs and Swinbank Springs, Pierce 2011a, p. 18). Georgetown salamander populations are likely smaller at other, lower quality sites. In fact, this species has not been observed in more than 10 years at two locations (San Gabriel Spring and Buford Hollow Spring), despite several survey efforts to find it (Pierce 2011b, c, Southwestern University, pers. comm.). (UFWS, 2014)

Threats and Stressors

Stressor: Urbanization (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Urban development leads to various stressors on spring systems, including increased frequency and magnitude of high flows in streams, increased sedimentation, increased contamination and toxicity, and changes in stream morphology and water chemistry (Coles et al., 2012). Urbanization can also impact aquatic species by negatively affecting their invertebrate prey base (Coles et al., 2012). Urbanization also increases the sources and risks of an acute or catastrophic contamination event, such as a leak from an underground storage tank or a hazardous materials spill on a highway. The city of Georgetown population, now at 68.821, is expected to increase 227 percent over a 23-year period. (USFWS, 2014)

Stressor: Degraded water quality and quantity (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Habitat modification, in the form of degraded water quality and quantity and disturbance of spring sites, is the primary threat to the Georgetown salamander. The Georgetown salamander spends its entire life cycle in water. It has evolved under natural aquifer conditions both underground and as the water discharges from natural spring outlets. Deviations from high water quality and quantity have detrimental effects on salamander ecology because the aquatic habitat can be rendered unsuitable for salamanders by changes in water chemistry and flow patterns. Polycyclic aromatic hydrocarbons, pesticides, and nutrients (fertilizers) are all potentially hazardous to the salamander. (USFWS, 2014)

Stressor: Substrate modification (USFWS, 2014)
Exposure:
Response:
Consequence:

Narrative: Substrate modification is also a major concern for aquatic salamander species (City of Austin (COA), 2001; Geismar, 2005; O'Donnell et al., 2006). Unobstructed interstitial space is a critical component to the surface habitat for the Georgetown salamander because it provides cover from predators and habitat for their macroinvertebrate prey items within surface sites. When the interstitial spaces become compacted or filled with fine sediment, the amount of available foraging habitat and protective cover for salamanders with these behaviors is reduced, resulting in population declines (Welsh and Ollivier, 1998; Geismar, 2005; O'Donnell et al., 2006). (USFWS, 2014)

Stressor: Impervious cover (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Impervious cover is detrimental because water will run off instead of filtering though the soil. This alters flow patterns and also allows contaminants to enter the water directly rather than through the soil. Impervious cover also alters habitats in and near streams that provide living spaces for aquatic species (Coles et al., 2012). (USFWS, 2014)

Stressor: Hazardous material spills (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The Edwards Aquifer is at risk from a variety of sources of contaminants and pollutants (Ross, 2011), including hazardous materials that have the potential to be spilled or leaked, resulting in contamination of both surface and groundwater resources (Service, 2005). Utility structures such as storage tanks or pipelines (particularly gas and sewer lines) can accidentally discharge. Any activity that involves the extraction, storage, manufacture, or transport of potentially hazardous substances, such as fuels or chemicals, can contaminate water resources and cause harm to aquatic life. (USFWS, 2014)

Stressor: Construction Activities (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Short-term increases in pollutants, particularly sediments, can occur during construction in areas of new development. When vegetation is removed and rain falls on unprotected soils, large discharges of suspended sediments can erode from newly exposed areas, resulting in increased sedimentation in downstream drainage channels (Schueler, 1987; Turner, 2003; O'Donnell et al., 2005). Cave sites are also impacted by construction. Construction activities within rock quarries can permanently alter the geology and groundwater hydrology of the immediate area, and adversely affect springs that are hydrologically connected (Ekmekci, 1990; van Beynan and Townsend, 2005; Humphreys, 2011). (USFWS, 2014)

Recovery

Recovery Actions:

- No Recovery Plan
- None specified

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Determination of Threatened Species Status for the Georgetown Salamander and Salado Salamander Throughout Their Ranges

Final Rule. 79 Federal Register 36, February 24, 2014. Pages 10236-10293.

USFWS. 2021. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for the Georgetown and Salado Salamanders. Final Rule. FR Vol. 86, No. 157. Pages 46536-46578.

U. S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Eurycea sosorum* (Barton Springs salamander)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southwest Region (R2) (USFWS, 2015)

Physical Description

Adults reach about 2.5 to 3 inches (63-76 mm) in total length. Adult body morphology includes reduced eyes and elongate, spindly limbs that are indicative of a semi-subterranean lifestyle. The head is relatively broad and deep in lateral view, and the snout appears somewhat truncate when viewed from above. On either side of the base of the head is a set of three feathery gills that are bright red. The coloration on the salamander's upper body varies from light to dark brown, purple, reddish brown, yellowish cream, or orange. The tail is relatively short with a well-developed dorsal (upper) fin and poorly developed ventral (lower) fin. The upper and lower mid-lines of the tail usually exhibit some degree of orange-yellow pigmentation. A small, brown, gilled slamander.A small, olive-brown salamander with a coarse-grained, blotchy "salt-and-pepper" pattern; retains external gills throughout life. Standard length (tip of snout to posterior margin of vent) averages about 29 mm, maximum about 37 mm; tail length averages 21 mm, maximum about 31 mm. LENGTH:6 (NatureServe, 2015)

Taxonomy

Sweet (1984) found this salamander to be structurally intermediate between E. neotenes and E. tridentifera. Chippindale et al. (1993, 2000) determined that this species is morphologically and biochemically distinct from all known species of plethodontids. Included in E. neotenes by Brown (1950, 1967). (NatureServe, 2015)

Current Range

The Barton Springs salamander has one of the smallest geographic ranges of any vertebrate species in North America (Chippindale et al. 1993, Conant and Collins 1998). The species was first collected from Barton Springs in 1946 (Brown 1950, Texas Natural History Collection specimens 6317-6321), was formally described in 1993 (Chippindale et al. 1993), and has been found at the four spring outlets that make up Barton Springs. Barton Springs, located in Zilker Park near downtown Austin, Texas, is an aquifer-fed system consisting of four hydrologically connected springs: (1) Main Springs (also known as Parthenia Springs or Barton Springs Pool); (2) Eliza Springs (also known as the Elks Pit); (3) Sunken Garden Springs (also known as Old Mill or Walsh Springs); and (4) Upper Barton Springs (Pipkin and Frech 1993). The salamander was first observed in Barton Springs Pool and Eliza Springs in the 1940s, Sunken Garden Springs in 1993 (Chippindale et al. 1993), and the intermittent Upper Barton Springs in 1997 (City of Austin 1998). Recent searches have documented salamanders at other springs in the Barton Springs Segment of the Edwards Aquifer including Cold Springs and Blowing Sink Cave. Mitochondrial DNA analysis suggests that these salamanders are closely related to one of two haplotypes found in the Barton Springs salamander (Chippindale 2012). The extent of the Barton Springs salamander's range within the Barton Springs Segment of the Edwards Aquifer, and thus the degree of subsurface connection among these spring populations, is unknown. Sweet (1978) suggested the species was troglobitic (cave-adapted) and that the salamanders observed from the surface were discharged from the springs. However, CoA biologists have observed Barton Springs salamanders swimming directly into various spring outlets, including Main Springs in Barton Springs Pool (Dee Ann Chamberlain and Lisa O'Donnell, City of Austin, pers. comm. 2004). Chippindale et al. (1993) characterized the species as a predominately surface-dwelling salamander capable of living underground. Reproduction of the Barton Springs salamander is believed to occur inside the Edwards Aquifer since salamander larvae are found in surface water year-round, but very few eggs (which are white and very visible) have been observed in the wild (Chamberlain and O'Donnell 2003). The CoA initiated salamander surveys in (1) Barton Springs Pool in 1993, (2) Sunken Garden Springs and Eliza Springs in 1995, and (3) Upper Barton Springs in 1997. Monthly surveys conducted since 1993 have resulted in a number of salamander observations within each spring ranging from 1 to over 1,200. Numbers have remained fairly constant within each survey location, with a noticeable spike in Barton Springs salamander numbers in Eliza Spring and Barton Springs Pool in late 2005 and early 2006 (City of Austin 2007). Severe drought in 2006 caused flow within all the springs to drop and remain at less than 40 cfs through December 2006 with a corresponding drop in salamander numbers. This cycle was repeated in 2008 and 2009 with Barton Springs salamander numbers peaking in early 2008 and dropping down again during the drought of 2009 (please see Appendix A in the HCP).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: ostracods, copepods, chironomids, snails, amphipods, mayfly larvae, leeches, and adult riffle beetles.

Food/Nutrient Narrative

Adult: Barton Springs salamanders appear to be opportunistic predators of small, live invertebrates. Chippindale et al. (1993) found amphipod remains in the stomachs of wild-caught salamanders. The gastro-intestinal tracts of 18 adult and juvenile Barton Springs salamanders and fecal pellets from 11 adult salamanders collected from Eliza Springs, Barton Springs Pool, and Sunken Garden Springs contained ostracods, copepods, chironomids, snails, amphipods, mayfly larvae, leeches, and adult riffle beetles. The most common organisms found in these samples were ostracods, amphipods, and chironomids (City of Austin, unpublished data). A recent study found that planarians (flatworms) are the primary food source for Barton Springs salamanders, and amphipods only become part of the diet when planarians and chironomids are rare (Gillespie 2013, p. 5).

Reproductive Strategy

Adult: Oviparity

Reproduction Narrative

Adult: They live in water throughout their life cycle where they become sexually mature and eventually reproduce. Gravid females, eggs, and larvae are typically found throughout the year in Barton Springs, which suggests that the salamander can reproduce year-round. Juveniles closely resemble adults (Chippindale et al. 1993). Newly hatched larvae are about 0.5 inch (12 mm) in total length and may lack fully developed limbs or pigment (Chamberlain and O'Donnell 2003). Information obtained from captive-raised Barton Springs salamanders indicates that females can develop eggs within 11 to 17 months after hatching. Recently hatched young have been found in November, March, and April, and females with well-developed eggs have been found from September through January; in captivity, one female retained well-developed eggs for over a year (Chippindale et al. 1993). Apparently breeds year-round.; (NatureServe, 2015)

Habitat Type

Adult: Springs

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: The Barton Springs salamander inhabits springs, spring-runs, and water-bearing karst formations of the Edwards Aquifer (Chippindale 1993). They are aquatic and neotenic, meaning they retain larval, gill-breathing morphology throughout their lives. Neotenic salamanders, including the Barton Springs salamander, do not metamorphose and leave water. Instead, they live in water throughout their life cycle where they become sexually mature and eventually reproduce. Gravid females, eggs, and larvae are typically found throughout the year in Barton Springs, which suggests that the salamander can reproduce year-round. Juveniles closely resemble adults (Chippindale et al. 1993). Newly hatched larvae are about 0.5 inch (12 mm) in total length and may lack fully developed limbs or pigment (Chamberlain and O'Donnell 2003). Information obtained from captive-raised Barton Springs salamanders indicates that females can develop eggs within 11 to 17 months after hatching.

Dispersal/Migration

Population Information and Trends

Population Trends:

Stable

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

Monthly surveys conducted since 1993 have resulted in a number of salamander observations within each spring ranging from 1 to over 1,200. Numbers have remained fairly constant within each survey location, with a noticeable spike in Barton Springs salamander numbers in Eliza Spring and Barton Springs Pool in late 2005 and early 2006 (City of Austin 2007). Severe drought in 2006 caused flow within all the springs to drop and remain at less than 40 cfs through December 2006 with a corresponding drop in salamander numbers. This cycle was repeated in 2008 and 2009 with Barton Springs salamander numbers peaking in early 2008 and dropping down again during the drought of 2009 (please see Appendix A in the HCP).

Threats and Stressors

Stressor: Water quality
Exposure:
Response:
Consequence:
Narrative: The primary threat to the Barton Springs salamander is the degradation of the quality and quantity of water that feeds Barton Springs as a result of urban expansion over the watershed. The species' restricted range makes it vulnerable to both acute and chronic groundwater contamination. The salamander is also vulnerable to catastrophic hazardous

materials spills, increased water withdrawals from the Edwards Aquifer, and impacts to the surface habitat. An analysis of spring discharge data by the CoA (2000) indicated that degradation of water quality parameters has occurred at Barton Springs over the years. Dissolved oxygen has decreased while conductivity, sulfates, turbidity, nitrate-nitrogen, and total organic carbon have increased. The magnitude of these changes in water quality at Barton Springs has been variable and is dependent on flow conditions (City of Austin 2000, 2005). Changes in water quality at Barton Springs may be related to cumulative impacts of urbanization, including increased groundwater use. Variations in the quality of discharge at Barton Springs may also be related to seasonal changes in the amount of precipitation (City of Austin 1997). The extent to which these water quality changes have affected the Barton Springs salamander or its habitat is unknown. Salamander habitat may also be affected by excessive deposition of sediment within Barton Springs. Deposition of sediment can physically reduce the amount of available habitat and protective cover for salamanders. Once deposited in large volumes, sediment can become devoid of oxygen and clog the interstitial spaces of the substrates surrounding the spring outlets that offer protective cover, rendering the habitat unsuitable for salamanders.

Recovery

Reclassification Criteria:

1. Protect water quality. 2. Prevent or contain catastrophic spills. 3. Protect water quality. 4. Maintain healthy, self-sustaining salamander population levels throughout the Barton Springs ecosystem. 5. Manage surface habitat to adequately reduce local threats to the Barton Springs ecosystem. 6. Establish and maintain captive population(s) to ensure protection from extinction. (USFWS, 2019)

Delisting Criteria:

1. Protect water quality. 2. Prevent or contain catastrophic spills. 3. Protect water quality. 4. Maintain healthy, self-sustaining salamander population levels throughout the Barton Springs ecosystem. 5. Manage surface habitat to adequately reduce local threats to the Barton Springs ecosystem. 6. Establish and maintain captive population(s) to ensure protection from extinction. (USFWS, 2019)

Recovery Actions:

- Based on the Barton Springs Salamander Recovery Plan (USFWS 2005) protection and improvement in water quality within the Barton Springs watershed are necessary to provide for the survival of the species. Comprehensive regional plans are needed to address water quality and quantity threats. A number of interested parties are working on comprehensive regional approaches to aid in the conservation of this species; however, these approaches have yet to be fully implemented. The potential for a catastrophic spill to occur at or near Barton Springs, or within the recharge zone of the Barton Springs Segment of the Edwards Aquifer, is of particular concern due to the limited range of this species. There continues to be a need for a comprehensive regional spill response and remediation plan to address the potential impacts of on-site and off-site spills. The extremely limited range of this species makes captive breeding an important tool to help guard against extinction while other conservation measures are being put in place. Captive breeding, habitat improvement, and other efforts to increase numbers of existing viable populations is critical to the survival and recovery of this species, particularly as expanding urbanization continues to threaten habitat quality. Efforts to protect, manage, and restore surface salamander habitat at the four spring sites, followed by consistent and effective monitoring of Barton Springs salamander populations, continues to yield valuable information regarding the recovery needs of this species.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Revise the Barton Springs Salamander Recovery Plan to include recovery criteria with measurable objectives and recovery actions that take into account newly discovered Barton Springs salamander locations. • Investigate population status and habitat conditions of the newly discovered Barton Springs salamander locations. • Continue to survey for previously undocumented Barton Springs salamander locations. • Continue to investigate the effects of different levels and concentrations of water quality constituents on the Barton Springs salamander. • Investigate the prevalence of chytrid fungus and other diseases in wild Barton Springs salamander populations. • Develop a Captive Propagation and Contingency Plan for the Barton Springs salamander that addresses the incorporation of individuals from the newly discovered Barton Springs salamander locations into the existing captive assurance colony for this species. (USFWS, 2019)

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SPECIES ACCOUNT: *Eurycea tonkawae* (Jollyville Plateau Salamander)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/19/2013; Southwest Region (R2) (USFWS, 2015)

Physical Description

The Jollyville Plateau salamander is neotenic (does not transform into a terrestrial form). As neotenic salamanders, they retain external gills and inhabit aquatic habitats (springs, spring-runs, and wet caves) throughout their lives. Adult salamanders are about 2 inches (in) (5 centimeters (cm)) long (Chippindale et al. 2000, pp. 32, 42). Surface-dwelling populations of Jollyville Plateau salamanders have large, well-developed eyes; wide, yellowish heads; blunt, rounded snouts; dark greenish-brown bodies; and bright yellowish-orange tails (Chippindale et al. 2000, pp. 33, 34). Some cave forms of Jollyville Plateau salamanders, which are also entirely aquatic, exhibit cave associated morphologies, such as eye reduction, flattening of the head, and dullness or loss of color (Chippindale et al. 2000, p. 37) (USFWS, 2016).

Taxonomy

A member of the family Plethodontidae. Genetic analysis suggests a taxonomic split within this species that appears to correspond to major geologic and topographic features of the region (Chippindale 2010, p. 2). Chippindale (2010, pp. 5, 8) concluded that the Jollyville Plateau salamander exhibits a strong genetic separation between two lineages within the species: A clade that occurs in the Bull Creek, Walnut Creek, Shoal Creek, Brushy Creek, South Brushy Creek, and southeastern Lake Travis drainages; and a clade that occurs in the Buttercup Creek and northern Lake Travis drainages (Chippindale 2010). The study also suggests this genetic separation may actually represent two species (Chippindale 2010, pp. 5, 8). (USFWS, 2016). Included in Eurycea neotenes by Sweet (1978, 1982) and in previous publications. Certain populations provisionally assigned to this species warrant further study and may prove to be taxonomically distinct (Chippindale et al. 2000) (NatureServe, 2015).

Historical Range

See current range/distribution.

Current Range

Surface populations occur in springs of the Jollyville Plateau region northwest of Austin in Travis and Williamson counties, Texas, and springs of nearby Brushy Creek; known range includes the Brushy Creek, Bull Creek, Cypress Creek, Long Hollow Creek, and Walnut Creek drainages; the Shoal Creek drainage includes a population provisionally assigned to this species (Chippindale et al. 2000). Also provisionally assigned to this species are populations from Kretschmarr Salamander Cave (Travis County), Testudo Tube (Williamson County), and caves of the Buttercup Creek system, elevation approximately 290 m, Williamson County (Chippindale et al. 2000) (NatureServe, 2015).

Critical Habitat Designated

Yes; 8/20/2013.

Legal Description

On August 20, 2013, the U.S. Fish and Wildlife Service designated critical habitat for the Jollyville Plateau salamander (Eurycea tonkawae) under the Endangered Species Act (78 FR 51327 - 51379). Approximately 4,331 acres (1,753 hectares) in Travis and Williamson Counties, Texas, fall within the boundaries of the critical habitat designation.
Critical habitat is designated in specific areas within the geographic area occupied by the species at the time of listing that contain the physical and biological features essential for the conservation of the species and which may require special management.

Critical Habitat Designation

There are 32 units designated as as critical habitat for the Jollyville Plateau salamander, repersenting 4,331 ac (1,753 ha).

Unit 1: Krienke Spring Unit Unit 1 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. The unit is located just south of State Highway 29. The northern part of the unit is under dense residential development, while the southern part of the unit is less densely developed. County Road 175 (Sam Bass Road) crosses the northern half of the unit. This unit contains Krienke Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary of Dry Fork, which is a tributary to Brushy Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, impacts of the impoundment, and depletion of groundwater. Private landowners have shown interest in conserving the area and are providing some management of the area. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 2: Brushy Creek Spring Unit Unit 2 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. The unit is centered just south of Palm Valley Boulevard and west of Grimes Boulevard. The northern part of the unit is covered with commercial and residential development, while the southern part is less densely developed. Some areas along the stream are undeveloped. This unit contains Brushy Creek Spring, which is occupied by the Jollyville Plateau salamander. The spring is near Brushy Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 3: Buttercup Creek Unit In the proposed rule, Unit 3 consisted of 699 ac (283 ha) of City of Austin, City of Cedar Park, State of Texas, and private land in southern Williamson County and northern Travis County, Texas. Under section 4(b)(2) of the Act, certain lands in this unit have been excluded from the final rule for critical habitat (see Application of Section 4(b)(2) of the Act section below). The remaining portions of the unit not within the boundaries of the HCP were retained as critical habitat subunits because these areas still contained subsurface primary constituent elements of the physical or biological features essential to the conservation of the species. We created five subunits following the exclusion. All of the subunits are occupied by the Jollyville Plateau salamander. A description of these subunits follows. Subunit 3A Subunit 3A consists of 260 ac (105 ha) of City of Austin, City of Cedar Park, and private land in southern Williamson County and northern Travis County, Texas. The subunit is located between Anderson Mill Road and Lakeline Boulevard. The subunit is mostly covered with residential property on the eastern half and undeveloped area of parks on the western half. This subunit contains four caves, Hunter's Lane Cave, Testudo Tube, Bluewater Cave #1, and Bluewater Cave #2, which are all occupied by the Jollyville Plateau salamander. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, potential for vandalism, and depletion of groundwate. These caves are currently gated and locked. The critical habitat designation includes the cave openings. The subunit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP were then excluded from the subunit. Subunit 3B Subunit 3B consists of 28 ac (11 ha) of private land in southern Williamson County, Texas. The unit is located east of Anderson Mill Road and west of Lakeline Boulevard. The unit is mostly under a quarry, except for the eastern portion, which is covered by several buildings and a parking lot. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, depletion of groundwater, and potential impacts from quarry operations. The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then excluded from the subunit. Subunit 3C Subunit 3C consists of 3 ac (1 ha) of private land in southern Williamson County, Texas. The unit is located east of Lakeline Boulevard. The subunit is under residential development. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, and depletion of groundwater. The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then removed from the subunit. Subunit 3D Subunit 3D consists of 16 ac (6 ha) of private land in southern Williamson County, Texas. The subunit is located east of Lakeline Boulevard and north of Buttercup Creek Boulevard. The subunit is under residential development. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, and depletion of groundwater (see Special Management Considerations or Protection section). The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then removed from the subunit. Subunit 3E Subunit 3E consists of 17 ac (7 ha) of private land in southern Williamson County, Texas. The subunit is located east of Lakeline Boulevard. Buttercup Creek Boulevard crosses the subunit from east to west. The subunit is under residential development. This subunit does not contain a cave opening. The subunit contains subsurface primary constituent elements of the physical or biological features essential to the conservation of the Jollyville Plateau salamander. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, and depletion of groundwater. The subunit was delineated by drawing a circle with a radius of 984 ft (300 m) around nearby cave openings, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Those areas within the boundary of the Buttercup Creek HCP (including the cave openings) were then removed from the subunit.

Unit 6: Avery Springs Unit Unit 6 consists of 237 ac (96 ha) of private land in southern Williamson County, Texas. The unit is located north of Avery Ranch Boulevard and west of Parmer Lane. The unit has large areas covered by residential development. The developed areas are separated by fairways and greens of a golf course. This unit contains three springs (Avery Springhouse Spring, Hill Marsh Spring, and Avery Deer Spring) that are occupied by the Jollyville Plateau salamander. The springs are located on three unnamed tributaries to South Brushy Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the three springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 7: PC Spring Unit Unit 7 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. State Highway 45, a major toll road, crosses the north central part of the unit from east to west, and Ranch to Market Road 620 goes under the toll road midway between the center and the western edge. Except for roadways, the unit is undeveloped. This unit contains PC Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Davis Spring Branch. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 8: Baker and Audubon Spring Unit Unit 8 consists of 110 ac (45 ha) of private land in northern Travis County, Texas. The unit is located south of Lime Creek Road and southwest of the intersection of Canyon Creek Drive and Lime Springs Road. The unit is wooded, undeveloped, and owned by Travis Audubon Society and Lower Colorado River Authority. The entire unit is managed as part of the Balcones Canyonlands HCP. This unit contains two springs (Baker Spring and Audubon Spring) that are occupied by the Jollyville Plateau salamander. The springs are in the drainage of an unnamed tributary to Cypress Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Special management is being provided by the preserve because the surface watersheds of these two springs are entirely contained within the preserve. Special management may also be needed because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles

Unit 9: Wheless Spring Unit Unit 9 consists of 145 ac (59 ha) of private and Travis County land in northern Travis County, Texas. The unit is located about 0.8 mi (1.3 km) west of Grand Oaks Loop. The unit is wooded and consists of totally undeveloped land. The unit is managed as part of the Balcones Canyonlands Preserve HCP. An unpaved two-track road crosses the unit from north to south. This unit contains three sites (Wheless Spring, Wheless 2 and Spring 25) that are occupied by the Jollyville Plateau salamander. The springs are in the Long Hollow Creek drainage that leads to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these three sites are entirely contained within the preserve. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 10: Blizzard R-Bar-B Spring Unit Unit 10 consists of 88 ac (36 ha) of private and Travis County land in northern Travis County, Texas. The unit is located west of Grand Oaks Loop. The extreme eastern portion of the unit is on the edge of residential development; a golf course (Twin Creeks) crosses the central portion; and the remainder is wooded and undeveloped. This unit contains three sites (Blizzard R-Bar-B Spring, Blizzard 2, and Blizzard 3) that are occupied by the Jollyville Plateau salamander. The springs are located on Cypress Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these three springs are partially contained within the preserve. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat. The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 11: House Spring Unit Unit 11 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located just north of Benevento Way Road. Dies Ranch Road crosses the extreme eastern part of the unit. The entire unit is covered with dense residential development except for a narrow corridor along the stream, which crosses the unit from north to south. Several streets are located in the unit. This unit contains House Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 12: Kelly Hollow Spring Unit Unit 12 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located southeast of the intersection of Anderson Mill Road and Farm to Market Road 2769. With the exception of a portion of Anderson Mill Road along the northern edge of the unit, this unit is primarily undeveloped woodland. This unit contains Kelly Hollow Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 13: MacDonald Well Unit Unit 13 consists of 68 ac (28 ha) of private and Travis County land in northern Travis County, Texas. The unit is centered near the intersection of Grand Oaks Loop and Farm to Market Road 2769. Farm to Market Road 2769 crosses the unit slightly north of its center. The northern portion of the unit contains residential development and part of Twin Creeks Golf Course. This unit contains MacDonald Well, which is a spring occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Travis. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this spring is partially contained within the preserve. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat. The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 14: Kretschmarr Unit Unit 14 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located west of Ranch to Market Road 620. Wilson Parke Avenue crosses the unit along its southern border. Most of the unit is undeveloped, with one commercial development near the west-central portion. This unit contains two sites (Kretschmarr Salamander Cave and Unnamed Tributary Downstream of Grandview) that are occupied by the Jollyville Plateau salamander. Kretschmarr Salamander Cave is a cave, and Unnamed Tributary Downstream of Grandview is a spring site. Under section 4(b)(2) of the Act, certain lands in this unit have been excluded from the final rule for critical habitat (see Application of Section 4(b)(2) of the Act section below). These lands include approximately half of the surface habitat of Unnamed Tributary Downstream of Grandview. This unit also contains approximately half of the surface habitat of SAS Canyon, which is a spring outlet on the Grandview Hills HCP. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Some special management is being provided by the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3), because the surface watersheds of these two springs are partially contained within the preserve. However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The surface designation was delineated by drawing a circle with a radius of 262 ft (80 m) around the spring outlets (including a nearby occupied spring within the boundary of the HCP) and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring outlets (including a nearby occupied spring within the boundary of the HCP) and cave, representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles. Those surface and subsurface areas within the boundary of the Grandview Hills HCP were then removed from the unit.

Unit 15: Pope and Hiers (Canyon Creek) Spring Unit Unit 15 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located between Bramblecrest Drive and Winchelsea Drive. The unit contains dense residential development on its northern, eastern, and western portions. The central portion of the unit is an undeveloped canyon and is preserved in perpetuity as part of a private preserve. This unit contains Pope and Hiers (Canyon Creek) Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 6. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed outside of the preserve into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat.

Unit 16: Fern Gully Spring Unit Unit 16 consists of 68 ac (28 ha) of private and City of Austin land in northern Travis County, Texas. The unit is centered just south of the intersection of Jenaro Court and Boulder Lane. The unit contains dense residential development on much of its northern half. Most of the southern half of the unit is undeveloped land managed by the City of Austin as part of the Balcones Canyonlands HCP Preserve, and a portion is part of the Canyon Creek preserve, a privately managed conservation area. This unit contains Fern Gully Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 5. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this spring is partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 17: Bull Creek 1 Unit Unit 17 consists of 1,198 ac (485 ha) of private, City of Austin, and Travis County land in northern Travis County, Texas. The unit extends from the southeastern portion of Chestnut Ridge Road to 3M Center, just north of Ranch to Market Road 2222. The unit contains some residential development on the extreme edge of its northern portion and part of Vandegrift High School near its southeastern corner. Most of the remainder of the unit is undeveloped land managed by the City of Austin and Travis County as part of the Balcones Canyonlands HCP Preserve. This unit contains the following sites: Bull Creek Tributary 6 site 2, Bull Creek Tributary 6 site 3, Bull Creek Tributary 5 site 2, Bull Creek Tributary 5 site 3, Tubb Spring, Broken Bridge Spring, Spring 17, Tributary No. 5, Tributary 6 at Sewage Line, Canyon Creek, Tributary No. 6, Gardens of Bull Creek, Canyon Creek Hog Wallow Spring, Spring 5, Three Hole Spring, Franklin, Franklin Tract 2, Franklin Tract 3, Pit Spring, Bull Creek Spring Pool, Spring 1, Spring 4, Spring 2, Lanier Spring, Cistern (Pipe) Spring, Spring 3, Lanier 90-foot Riffle, Bull Creek at Lanier Tract, Ribelin/ Lanier, Spring 18, Horsethief, Ribelin, Spring 15, Spring 16, Spring 14, Lower Ribelin, Spring 13, Spring 12, Upper Ribelin, Ribelin 2, Spring 10, and Spring 9. These springs are occupied by the Jollyville Plateau salamander and are located on Bull Creek and its tributaries. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these springs are partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subsurface critical habitat. We joined the edges of the resulting circles.

Unit 18: Bull Creek 2 Unit Unit 18 consists of 237 ac (96 ha) of private, City of Austin, and Travis County land in northern Travis County, Texas. The center of the unit is near the eastern end of Concordia University Drive. Concordia University is in the central and eastern parts of the unit. Much of the rest of the unit is undeveloped land managed by the City of Austin and Travis County as part of the Balcones Canyonlands HCP Preserve. This unit contains six springs (Schlumberger Spring No. 1, Schlumberger Spring No. 2, Spring 6, Spring 19, Concordia Spring X, and Concordia

Spring Y) that are occupied by the Jollyville Plateau salamander. The springs are located on Bull Creek Tributary 7. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these springs are partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat. We joined the edges of the resulting circles.

Unit 19: Bull Creek 3 Unit Unit 19 consists of 97 ac (39 ha) of private and City of Austin land in northern Travis County, Texas. The unit is just southeast of the intersection of Ranch to Market Road 620 and Vista Parke Drive. The unit contains some residential development on its western tip, but the rest of the unit is undeveloped land. Much of the remainder of the unit is managed by the City of Austin as part of the Balcones Canyonlands Preserve HCP. This unit contains two sites (Hamilton Reserve West and Gaas Spring) that are occupied by the Jollyville Plateau salamander. The springs are located on Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is partially within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watersheds of these springs are partially contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the springs, which may extend outside of the preserve. The surface habitat also needs special management to protect it from surface runoff from impervious cover outside of the preserve and potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). Under section 4(b)(2) of the Act, certain lands in this unit have been excluded from the final rule for critical habitat under the Four Points HCP (see Application of Section 4(b)(2) of the Act section below). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring outlets (including nearby occupied spring outlets within the boundary of the Four Points HCP), representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles. Those areas within the boundary of the Four Points HCP were then excluded from the unit.

Unit 20: Moss Gully Spring Unit Unit 20 consists of 68 ac (28 ha) of City of Austin and Travis County land in northern Travis County, Texas. The unit is just east of the eastern end of Unit 19. The unit is all undeveloped woodland, and it is managed by the City of Austin or Travis County as part of the Balcones Canyonlands HCP Preserve. This unit contains Moss Gully Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this site is entirely contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 21: Ivanhoe Spring Unit Unit 21 consists of 68 ac (28 ha) of City of Austin land in northern Travis County, Texas. The unit is east of the northwest extent of High Hollow Drive. The unit is all undeveloped woodland and is managed by the City of Austin as part of the Balcones Canyonlands Preserve HCP. This unit contains Ivanhoe Spring 2, which is occupied by the Jollyville Plateau salamander. The spring is located on West Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. The unit is within the Balcones Canyonlands Preserve, which serves as mitigation for impacts to 35 species covered in the Balcones Canyonlands HCP (Service 1996, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP. Some special management is being provided by the preserve because the surface watershed of this site is entirely contained within the preserve. However, special management considerations or protection may be required because of the potential for groundwater pollution and depletion from current and future development in the groundwater recharge area of the spring, which may extend outside of the preserve. The surface habitat also needs special management to protect it from potential physical disturbance of the surface habitat (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 22: Sylvia Spring Area Unit Unit 22 consists of 439 ac (178 ha) of private, City of Austin, and Williamson County land in northern Travis County and southwestern Williamson County, Texas. The unit is located east of the intersection of Callanish Park Drive and Westerkirk Drive, north of the intersection of Spicewood Springs Road and Yaupon Drive, and west of the intersection of Spicewood Springs Road and Old Lampasas Trail in the Bull Creek Ranch community. Spicewood Springs Road crosses the unit from southwest to east. Residential and commercial development is found in most of the unit. An undeveloped stream corridor crosses the unit from east to west. This unit contains 13 sites (Small Sylvia Spring, Sylvia Spring Area 2, Sylvia Spring Area 3, Sylvia Spring Area 4, Downstream of Small Sylvia Spring 1, Downstream of Small Sylvia Spring 2, Spicewood Valley Park Spring, Tributary 4 upstream, Tributary 4 downstream, Spicewood Park Dam, Tanglewood Spring, Tanglewood 2, and Tanglewood 3) that are occupied by the Jollyville Plateau salamander. Small Sylvia Spring, Sylvia Spring Area 2, Sylvia Spring Area 3, Sylvia Spring Area 4, Downstream of Small Sylvia Spring 1, Downstream of Small Sylvia Spring 2, Spicewood Valley Park Spring, Tributary 4 upstream, Tributary 4 downstream, and Spicewood Park Dam are located on Tributary 4. Tanglewood Spring, Tanglewood 2, and Tanglewood 3 are located on Tanglewood Creek, a tributary to Tributary 4. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat. We joined the edges of the resulting circles.

Unit 24: Long Hog Hollow Unit Unit 24 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered east of the intersection of Cassia Drive and Fireoak Drive. Most of the unit is in residential development. There are wooded corridors in the central and eastern portion of the unit. This unit contains one spring (Long Hog Hollow Tributary below Fireoak Spring) that is occupied by the Jollyville Plateau salamander. The spring is located on Long Hog Hollow Tributary. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 25: Tributary 3 Unit Unit 25 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered between Bluegrass Drive and Spicebush Drive. The eastern and western part of the unit is in residential development. There are wooded corridors in the central part of the unit, and scattered woodland in the eastern and western part. There is a golf course in the north-central part of the unit. This unit contains Tributary No. 3, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 3. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 26: Sierra Spring Unit Unit 26 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located west of the intersection of Tahoma Place and Ladera Vista Drive. The eastern and western part of the unit is in residential development. A wooded corridor crosses the central part of the unit from north to south. A facility that handles automotive fluids is located in the northwest portion of the unit. This unit contains Sierra Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on a tributary to Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 27: Troll Spring Unit Unit 27 consists of 98 ac (40 ha) of City of Austin and private land in northern Travis County, Texas. The unit is located west of the intersection of Jollyville Road and Taylor Draper Lane. The eastern and western part of the unit is in residential development. A wooded corridor crosses the central part of the unit from north to south. This unit contains two springs (Hearth Spring and Troll Spring) that are occupied by the Jollyville Plateau salamander. The springs are located on a tributary to Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles.

Unit 28: Stillhouse Unit Unit 28 consists of 203 ac (82 ha) of City of Austin and private land in northern Travis County, Texas. The unit is centered due north of the intersection of West Rim Drive and Burney Drive. The northern and southern part of the unit is in residential development. A wooded corridor crosses the central part of the unit from east to west. This unit contains eight sites: Stillhouse Hollow, Barrow Hollow Spring, Spring 20, Stillhouse Hollow Tributary, Stillhouse Tributary, Little Stillhouse Hollow Spring, Stillhouse Hollow Spring, and Barrow Preserve Tributary. All are occupied by the Jollyville Plateau salamander. The springs are located on an unnamed tributary to Bull Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlets and outflows up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subsurface critical habitat. We connected the edges of the resulting circles.

Unit 30: Indian Spring Unit Unit 30 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered just south of Greystone Drive about halfway between its intersection with Edgerock Drive and Chimney Corners Drive. Most of the unit is covered with residential development except for a small wooded corridor that crosses the central part of the unit from east to west. This unit contains Indian Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Shoal Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Unit 31: Spicewood Spring Unit Unit 31 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered just northeast of the intersection of Ceberry Drive and Spicewood Springs Road, just downstream of the bridge on Ceberry Drive. Most of the unit is covered with commercial and residential development except for a small wooded corridor along the stream, which crosses the unit from north to east. This unit contains two sites, Spicewood Spring and Spicewood Tributary, which are occupied by the Jollyville Plateau salamander. The springs are located in an unnamed tributary to Shoal Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the sites, representing the extent of the subsurface critical habitat.

Unit 32: Balcones District Park Spring Unit Unit 32 consists of 68 ac (28 ha) of private and City of Austin land in northern Travis County, Texas. The unit is centered about 1,411 ft (430 m) northeast of the intersection of Duval Road and Amherst Drive. Most of the unit is in a city park (Balcones District Park) with a swimming pool. A substantial amount of the park is wooded and undeveloped. There is dense commercial development in the southern and southeastern portions of the unit. This unit contains Balcones District Park Spring, which is occupied by the Jollyville Plateau salamander. The spring is located in the streambed of an unnamed tributary to Walnut Creek. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the recharge area, runoff from impervious cover within the surface watershed into surface habitat, potential physical disturbance of the surface habitat, and depletion of groundwater (see Special Management Considerations or Protection section). The designation includes the spring outlet and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subsurface critical habitat.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Travis and Williamson Counties, Texas. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of Jollyville Plateau salamander consist of six components:

(i) Surface habitat PCEs. (A) Water from the Trinity Aquifer, Northern Segment of the Edwards Aquifer, and local alluvial aquifers. The groundwater is similar to natural aquifer conditions as it discharges from natural spring outlets. Concentrations of water quality constituents and contaminants should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Jollyville Plateau salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with at least some surface flow during the year. The water chemistry is similar to natural aquifer conditions, with temperatures from 64.1 to 73.4 °F (17.9 to 23 °C), dissolved oxygen concentrations from 5.6 to 8 mg L¥1, and specific water conductance from 550 to 721 mS cm¥1. (B) Rocky substrate with interstitial spaces. Rocks in the substrate of the salamander's surface aquatic habitat are large enough to provide salamanders with cover, shelter, and foraging habitat (larger than 2.5 in (64 mm)). The substrate and interstitial spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The spring environment supports a diverse aquatic invertebrate community that includes crustaceans, insects, and flatworms. (D) Subterranean aquifer. Access to the subsurface water table should exist to provide shelter, protection, and space for reproduction. This access can occur in the form of large conduits that carry water to the spring outlet or porous voids between rocks in the streambed that extend down into the water table.

(ii) Subsurface habitat PCEs. (A) Water from the Trinity Aquifer, Northern Segment of the Edwards Aquifer, and local alluvial aquifers. The groundwater is similar to natural aquifer conditions. Concentrations of water quality constituents and contaminants are below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Jollyville Plateau salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with continuous flow. The water chemistry is similar to natural aquifer conditions, including temperature, dissolved oxygen, and specific water conductance. (B) Subsurface spaces. Voids between rocks underground are large enough to provide salamanders with cover, shelter, and foraging habitat. These spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The habitat supports an aquatic invertebrate community that includes crustaceans, insects, or flatworms.

Special Management Considerations or Protections

Surface critical habitat includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat, including the dry stream channel during periods of no surface flow. The surface critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) existing within the legal boundaries on the effective date of this rule; however, the subsurface critical habitat may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.

The features essential to the conservation of these species may require special management considerations or protection to reduce the following threats: water quality degradation from contaminants, alteration to natural flow regimes, and physical habitat modification. For these salamanders, special management considerations or protection are needed to address threats. Management activities that could ameliorate threats include (but are not limited to): (1) Protecting the quality of groundwater by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution throughout the Barton Springs and Northern Segments of the Edwards Aquifer and contributing portions of the Trinity Aquifer, (2) protecting the quality and quantity of surface water by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution within the surface drainage areas of the salamander spring sites, (3) protecting groundwater and spring flow quantity (for example, by implementing water conservation and drought contingency plans throughout the Barton Springs and Northern Segments of the Edwards Aquifer and contributing portions of the Trinity Aquifer), (4) fencing and signage to protect from human vandalism, (5) protecting water quality and quantity from present and future quarrying, and (6) excluding cattle and feral hogs through fencing to protect spring habitats from damage.

Life History

Food/Nutrient Resources

Food Source

Adult: Ostracods, copepods, mayfly larvae, fly larvae, snails, water mites, aquatic beetles, stone fly larvae, flatworms (USFWS, 2013)

Food/Nutrient Narrative

Adult: As in other Eurycea species, the Jollyville Plateau salamander feeds on aquatic invertebrates that commonly occur in spring environments (reviewed in COA 2001, pp. 5–6). A stomach content analysis by the City of Austin demonstrated that this salamander preys on varying proportions of ostracods, copepods, mayfly larvae, fly larvae, snails, water mites, aquatic beetles, and stone fly larvae depending on the location of the site (Bendik 2011b, pers. comm.). In addition, flatworms were found to be the primary food source for the related Barton Springs salamander (Gillespie 2013, p. 5), suggesting that flatworms may also contribute to the diet of the Jollyville Plateau salamander if present in the invertebrate community (USFWS, 2013).

Reproductive Strategy

Adult: Oviparous (USFWS, 2013)

Breeding Season

Adult: Year round (USFWS, 2016)

Reproduction Narrative

Adult: The detection of juveniles in all seasons suggests that reproduction occur year-round (Bendik 2011a, p. 26). However, juvenile abundance of Jollyville Plateau salamanders typically increases in spring and summer, indicating that there may be relatively more reproduction occurring in winter and early spring compared to other seasons (Bowles et al. 2006, p. 116) (USFWS, 2016). Little is known about the reproductive habits of this species in the wild. However, the Jollyville Plateau salamander is fully aquatic and, therefore, spends all of its life cycles in aquifer and spring waters. Eggs of central Texas Eurycea species are rarely seen on the surface, so it is widely assumed that eggs are laid underground (Gluesenkamp 2011, TPWD, pers. comm.; Bendik 2011b, COA, pers. comm.) (USFWS, 2013).

Habitat Type

Adult: Aquatic, subterranean (NatureServe, 2015); fossorial (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Spring (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Water depth < 1 ft., well oxygenated water (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Highways, untraversable habitat (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2016)

Habitat Narrative

Adult: Surface populations occur in springs; certain cave-dwelling populations have been provisionally assigned to this species (Chippindale et al. 2000). The environmental specificity is very narrow (specialist or community with key requirements scarce). Separation barriers include busy highways, especially with high traffic volume at night; other totally inappropriate habitat that the salamanders cannot traverse. (NatureServe, 2015). Spring-fed habitat is typically characterized by a depth of less than 1 ft. (0.3 m) of cool, well oxygenated water (COA 2001, p. 128; Bowles et al. 2006, p. 118). There was a strong positive relationship between salamander abundance and the amount of available rocky substrate (Bowles et al. 2006, p. 114). If springs stop flowing and the surface habitat dries up, Jollyville Plateau salamanders are known to recede with the water table and persist in groundwater refugia until surface flow returns (Bendik 2011a, p. 31). Access to subsurface refugia allows populations some resiliency against drought events (USFWS, 2016).

Dispersal/Migration

Motility/Mobility

Adult: Moderate (inferred from USFWS, 2013)

Dispersal

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: A recent study using mark-recapture methods found marked individuals moved up to 262 ft. (80 m) both upstream and downstream from the Lanier Spring outlet (Bendik 2013, pers. comm.). This study demonstrates that Eurycea salamanders can travel greater distances from a discrete spring opening than previously thought, including upstream areas, if suitable habitat is present (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

4 - 5 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Chippindale et al. (2000) mapped 4 - 5 population clusters consisting of a total of 14 - 17 sites. The population size is unknown. This species has experienced a short term decline of 10 - 30%; it is apparently declining in population size and number/condition of occurrences as water quality declines (Chippindale et al. 2000) (NatureServe, 2015).

Threats and Stressors

Stressor: Aquatic contaminants and pollutants (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: While polycyclic aromatic hydrocarbons (PAHs) and pesticides have been detected at Jollyville Plateau salamander sites, the extent to which aquatic contaminants have affected salamander survival, development, and reproduction, or their prey, is unknown. Due to potential differences in species sensitivity, exposure scenarios that may include dozens of chemical stressors simultaneously, and multigenerational effects that are not fully understood, the Services continue to view aquatic contaminants, such as PAHs and pesticides, as a potential threat to water quality, salamander health, and the health of aquatic organisms that comprise the diet of salamanders. Excessive nutrient exposure is also a threat. The threat of water quality degradation could cause irreversible declines or extirpation in local populations or significant declines in habitat quality with continuous or repeated exposure. In some instances, exposure to aquatic contaminants and excessive nutrients could negatively impact a salamander population , resulting in significant habitat declines or other significant negative impacts (such as loss of invertebrate prey species). This threat is considered to be low impact for the Jollyville Plateau salamanders, that is likely to increase in the future (USFWS, 2013).

Stressor: Climate change and drought (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The effects of climate change could potentially lead to detrimental impacts on aquifer-dependent species, especially coupled with other threats on water quality and quantity. Recharge, pumping, natural discharge, and saline intrusion of groundwater systems could all be affected by climate change. Climate change could compound the threat of decreased water quantity at salamander spring sites, and affect rainfall and ambient temperatures, which are factors that may limit salamander populations. The threat of water quantity degradation from

climate change could negatively impact a population of any of the Jollyville Plateau salamanders in combination with other threats and contribute to significant declines in population sizes or habitat quality. This threat is considered to be of moderate impact now and in the future (USFWS, 2013).

Stressor: Deformities (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Jollyville Plateau salamanders observed at the Stillhouse Hollow monitoring sites have shown high incidences of deformities, such as curved spines, missing eyes, missing limbs or digits, and eye injuries. Environmental toxins are the suspected cause of salamander deformities, but deformities in amphibians can also be the result of genetic mutations, parasitic infections, UV–B radiation, or the lack of an essential nutrient. More research is needed to elucidate the cause of these deformities. Deformities are considered to be a low-level impact to the Jollyville Plateau salamander at this time because this stressor is an issue at only one site, is not affecting the entire population there, and does not appear to be an issue for the other salamander species at that location (USFWS, 2013).

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Degradation of habitat, in the form of reduced water quality and quantity and disturbance of spring sites (physical modification of surface habitat), is the primary threat to the Jollyville Plateau salamander. Physical modification of surface habitat can occur from sedimentation, impoundments, flooding, feral hogs, livestock, and human activities. Direct mortality to salamanders can also occur as a result of these threats, such as being crushed by feral hogs, livestock, or humans. This threat may affect only the surface habitat, only the subsurface habitat, or both habitat types. These threats can have severe impacts on the species, and are expected to continue into the future. Water chemistry changes (conductivity, salinity, dissolved oxygen) are also considered low impact threats (USFWS, 2013).

Stressor: Overutilization (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Services do not consider overutilization from collecting salamanders in the wild to be a threat by itself, but it may contribute to significant population declines, and could negatively impact the species in combination with other threats (USFWS, 2013).

Stressor: Restricted ranges (USFWS, 2013)
Exposure:
Response:

Consequence:
Narrative: Restricted ranges could negatively affect any of the Jollyville Plateau salamanders' populations in combination with other threats (such as water quality or water quantity degradation) and lead to the species being at a higher risk of extinction. The level of impacts from stochastic events is considered to be moderate for the Jollyville Plateau salamander; the species' continued existence could be compromised by a common event (USFWS, 2013).

Stressor: Small population size and stochastic events (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Services do not consider small population size to be a threat in and of itself to the Jollyville Plateau salamander, but the small population sizes make the species more vulnerable to extinction from other existing or potential threats, such as a major stochastic event. The level of impacts from stochastic events is considered to be moderate for the Jollyville Plateau salamander (USFWS, 2013).

Stressor: Ultraviolet radiation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The effect of increased UV-B radiation has the potential to cause deformities or developmental problems to individual salamanders, but the Services do not consider this stressor to significantly contribute to the risk of extinction of the Jollyville Plateau salamander at this time. However, UV-B radiation could negatively affect any of the Jollyville Plateau salamanders' surface populations in combination with other threats (such as water quality or water quantity degradation) and contribute to significant declines in population sizes (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Not available.

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Determination of Endangered Species Status for the Austin Blind and Jollyville Plateau Salamanders

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USFWS. 2013. Determination of Endangered Species Status for the Austin Blind Salamander and Threatened Species Status for the Jollyville Plateau Salamander Throughout Their Ranges

SPECIES ACCOUNT: *Eurycea waterlooensis* (Austin blind Salamander)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southwest Region (R2) (USFWS, 2015)

Physical Description

The Austin blind salamander is a member of the family Plethodontidae (lungless salamanders) within the genus Eurycea. The Austin blind salamander has a pronounced extension of the snout, no external eyes, 12 costal grooves, and weakly developed tail fins. In general appearance and coloration, the Austin blind salamander is more similar to the Texas blind salamander (Eurycea rathbuni) that occurs in the Southern Segment of the Edwards Aquifer than its sympatric species (occurring within the same range), the Barton Springs salamander. The Austin blind salamander has a reflective, lightly pigmented skin with a pearly white or lavender appearance (Hillis et al. 2001). Before the Austin blind salamander was formally described, juvenile salamanders were sighted occasionally in Barton Springs and thought to be a variation of the Barton Springs salamander. It was not until 2001 that enough specimens were available to formally describe these juveniles as a separate species using morphological and genetic characteristics (Hillis et al. 2001). Given the reduced eye structure of the Austin blind salamander and the fact that it is rarely seen at the water's surface (Hillis et al. 2001), this salamander is thought to be more subterranean than the surface-dwelling Barton Springs salamander.

Taxonomy

The Austin blind and Jollyville Plateau salamanders are neotenic (do not transform into a terrestrial form) members of the family Plethodontidae. Plethodontid salamanders comprise the largest family of salamanders within the Order Caudata, and are characterized by an absence of lungs (Petranka 1998, pp. 157–158). The Jollyville Plateau salamander has very similar external morphology. Because of this, the Jollyville Plateau salamander was previously believed to be the same species as the Georgetown and Salado salamanders; however, molecular evidence strongly supports that there is a high level of divergence between the three groups (Chippindale et al. 2000, pp. 15–16). Based on our review of these differences, and taking into account the view expressed in peer reviews by taxonomists, we believe that the currently available evidence is sufficient for recognizing these salamanders as separate species (USFWS, 2013).

Current Range

The Austin blind salamander occurs in Barton Springs in Austin, Texas. These springs are fed by the Barton Springs Segment of the Edwards Aquifer. This segment covers roughly 155 square miles (mi) [401 square kilometers (km)] from southern Travis County to northern Hays County, Texas (Barton Springs/Edwards Aquifer Conservation District, 2004). It has a storage capacity of over 300,000 acre-feet. The contributing zone for the Barton Springs Segment of the Edwards Aquifer that supplies water to the salamander's spring habitat extends into both Travis and Hays counties, Texas. The Austin blind salamander is found in three of the four Barton Springs outlets in the City of Austin's Zilker Park, Travis County, Texas: Main (Parthenia) Springs, Eliza Springs, and Sunken Garden (Old Mill or Zenobia) Springs. The proposed critical habitat for the Austin blind salamander is divided into surface and subterranean components for each of the three springs. Proposed critical habitat at the surface includes each of the three spring outlets, including outflow up to the high water line, and 164 ft (50 meters) of downstream habitat. The proposed subterranean critical habitat includes underground features in a circle with a radius of 984 ft (300 meters) around the spring outlets. The Main Springs form the Barton Springs Pool, which is operated by CoA as a public swimming pool. These spring sites have been significantly modified for human use. The area around Main Springs was impounded in the late 1920s to create Barton Springs Pool. Flows from Eliza and Sunken Garden Springs are also retained by concrete structures, forming small pools on either side of Barton Springs Pool (City of Austin 1998, USFWS 2005). The Austin blind salamander has not been observed at the fourth Barton Springs outlet, known as Upper Barton Springs (Hillis et al. 2001).

Critical Habitat Designated

Yes; 8/20/2013.

Legal Description

On August 20, 2013, the U.S. Fish and Wildlife Service designated critical habitat for the Austin blind salamander (Eurycea waterlooensis) under the Endangered Species Act (78 FR 51327 - 51379). In total, approximately 4,451 acres (ac) (1,801 hectares (ha)) in Travis and Williamson Counties, Texas, fall within the boundaries of the critical habitat designation.

Critical Habitat Designation

1 unit is designated as critical habitat for the Austin blind salamander:

Unit 1: Barton Springs Unit The Barton Springs Unit consists of 120 ac (49 ha) of City and private land in the City of Austin, Travis County, Texas. Most of the unit consists of landscaped areas managed as Zilker Park, which is owned by the City of Austin. The southwestern portion of the unit is dense commercial development, and part of the southern portion contains residential development. Barton Springs Road, a major roadway, crosses the northeastern portion of the unit. This unit contains Parthenia Spring, Sunken Gardens (Old Mill) Spring, and Eliza Spring, which are occupied by Austin blind salamander. The springs are located in the Barton Creek watershed. Parthenia Spring is located in the backwater of Barton Springs Pool, which is formed by a dam on Barton Creek; Eliza Spring is on an unnamed tributary to the bypass channel of the pool; and Sunken Gardens Spring is located on a tributary that enters Barton Creek downstream of the dam for Barton Springs Pool. The unit contains primary constituent elements of the physical or biological features essential to the conservation of the species. Special management considerations or protection may be required because of the potential for groundwater pollution from current and future development in the contributing and recharge zone for the Barton Springs segment of the Edwards Aquifer, depletion of groundwater, runoff from impervious cover within the surface watershed into surface habitat, and impacts of the impoundment (see Special Management Considerations or Protection section). Special management may also be needed to protect the surface from disturbance as part of the operation of Barton Springs Pool, and this management is being provided as part of the Barton Springs Pool HCP. Twenty-two ac (9 ha) of this unit are covered by the Barton Springs Pool HCP, which covers adverse impacts to the Barton Springs salamander and the Austin blind salamander. The designation includes the underground aquifer in this area and the springs and fissure outlets, and their outflows 262 ft (80 m) upstream and downstream. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Because we did not have specific points for species locations, we used the center of Eliza and Sunken Gardens springs and the southwestern point of a fissure in Parthenia Springs as the center point for the circles.

Primary Constituent Elements/Physical or Biological Features

The critical habitat unit is designated for Travis County, Texas. Within this area, the primary constituent elements (PCEs) of the physical or biological features essential to the conservation of Austin blind salamander consist of six components:

(i) Surface habitat PCEs. (A) Water from the Barton Springs Segment of the Edwards Aquifer. The groundwater is similar to natural aquifer conditions as it discharges from natural spring outlets. Concentrations of water quality constituents and contaminants are below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Austin blind salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with constant surface flow. The water chemistry is similar to natural aquifer conditions, with temperatures from 67.8 to 72.3 °F (19.9 and 22.4 °C), dissolved oxygen concentrations from 5 to 7 mg L¥1, and specific water conductance from 605 to 740 mS cm¥1. (B) Rocky substrate with interstitial spaces. Rocks in the substrate of the salamander's surface aquatic habitat are large enough to provide salamanders with cover, shelter, and foraging habitat (larger than 2.5 in (64 mm)). The substrate and interstitial spaces have minimal sedimentation. (C) Aquatic invertebrates for food. The spring environment supports a diverse aquatic invertebrate community that includes crustaceans, insects, and flatworms. (D) Subterranean aquifer. Access to the subsurface water table exists to provide shelter, protection, and space for reproduction. This access can occur in the form of large conduits that carry water to the spring outlet or fissures in the bedrock.

(ii) Subsurface habitat PCEs. (A) Water from the Barton Springs Segment of the Edwards Aquifer. The groundwater is similar to natural aquifer conditions. Concentrations of water quality constituents and contaminants are below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Austin blind salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with continuous flow in the subterranean habitat. The water chemistry is similar to natural aquifer conditions, including temperature, dissolved oxygen, and specific water conductance. (B) Subsurface spaces. Conduits underground are large enough to provide salamanders with cover, shelter, and foraging habitat. (C) Aquatic invertebrates for food. The habitat supports an aquatic invertebrate community that includes crustaceans, insects, or flatworms.

Special Management Considerations or Protections

Surface critical habitat includes the spring outlets and outflow up to the high water line and 262 ft (80 m) of upstream and downstream habitat, including the dry stream channel during periods of no surface flow. The surface critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) existing within the legal boundaries on the effective date of this rule; however, the subsurface critical habitat may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.

The features essential to the conservation of these species may require special management considerations or protection to reduce the following threats: water quality degradation from contaminants, alteration to natural flow regimes, and physical habitat modification. For these salamanders, special management considerations or protection are needed to address threats. Management activities that could ameliorate threats include (but are not limited to): (1) Protecting the quality of groundwater by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution throughout the Barton Springs and Northern Segments of the Edwards Aquifer and contributing portions of the Trinity Aquifer, (2) protecting the quality and quantity of surface water by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution within the surface drainage areas of the salamander spring sites, (3) protecting groundwater and spring flow quantity (for example, by implementing water conservation and drought contingency plans throughout the Barton Springs and Northern Segments of the Edwards Aquifer and contributing portions of the Trinity Aquifer), (4) fencing and signage to protect from human vandalism, (5) protecting water quality and quantity from present and future quarrying, and (6) excluding cattle and feral hogs through fencing to protect spring habitats from damage.

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Wild-caught adult defecated the remains of amphipods, ostracods, copepods, and plant material (Hillis et al. 2001).; Food Habits: Invertivore (Adult, Immature) (NatureServe, 2015)

Reproduction Narrative

Adult: Neotenic salamanders, including the Austin blind salamander, do not metamorphose and leave water. Instead, they live in water throughout their life cycle where they become sexually mature and eventually reproduce.

Habitat Type

Adult: Springs/Spring runs

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: The Austin blind salamander inhabits springs, spring-runs, and water-bearing karst formations of the Edwards Aquifer (Chippindale et al. 2000). They are aquatic and neotenic, meaning they retain larval, gill-breathing morphology throughout their lives. Neotenic salamanders, including the Austin blind salamander, do not metamorphose and leave water. Instead, they live in water throughout their life cycle where they become sexually mature and eventually reproduce.

Dispersal/Migration

Motility/Mobility

Adult: Nonmigrant

Population Information and Trends

Population Trends:

Unknown

Population Growth Rate:

Trend is difficult to assess because most of the population may be subterranean and not easily sampled. Unknown (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Population Status: From January 1998 to December 2000, there were only 17 documented observations of the Austin blind salamander. During this same time frame, 1,518 Barton Springs salamander observations were made (Hillis et al. 2001). Although the technology to safely and reliably mark salamanders for individual recognition has recently been developed (O'Donnell et al. 2008), population estimates for this species have not been undertaken because surveying within the Edwards Aquifer is not possible at the current time. However, population estimates are possible for aquifer-dwelling species using genetic techniques, and one such study is planned for Austin blind salamander in the near future. When they are found, Austin blind salamanders appear to occur in relatively low numbers (City of Austin 2011, unpublished data). Most of the Austin blind salamanders that were observed during these surveys were juveniles [less than 1 in (2.5 cm) in total length]. Barton Springs Pool: Since the Austin blind salamander resides in subterranean habitat of the perennial springs, Eliza, Parthenia, and Old Mill, it is difficult to infer the status of the populations and the species. Lack of information on life history characteristics in wild populations further hampers assessment of reproduction and recruitment. Within the Pool, Austin blind salamander mean density from 2003-2010 was 0.0001/sqft. The maximum number of Austin blind salamanders found in the pool during a single survey in 2010 was five. Proposed surface critical habitat for the Austin blind salamander in Barton Springs Pool includes the spring outlets including outflow up to the high water line, and 164 ft (50 meters) of downstream habitat. The proposed subterranean critical habitat in Barton Springs Pool includes underground features in a circle with a radius of 984 ft (300 meters) around the spring outlets. Eliza Spring: The Austin blind salamander was not found regularly in Eliza Spring until after 2002. From 2003 to 2010 the mean density of Austin blind salamanders in Eliza Spring was 0.001/sqft. The maximum number of Austin blind salamanders found in Eliza Spring during a single survey was twelve in 2006. No Austin blind salamanders were recorded in Eliza Spring in 2010. Proposed surface critical habitat for the Austin blind salamander in Eliza Spring includes the spring outlet including outflow up to the high water line, and 164 ft (50 meters) of downstream habitat. The proposed subterranean critical habitat in Eliza Spring includes underground features in a circle with a radius of 984 ft (300 meters) around the spring outlet. Old Mill Spring: The Austin blind salamander has been found consistently in Old Mill Spring since 1998 with the highest numbers recorded in 2001-2004. The maximum number of Austin blind salamanders found in Old Mill Spring during a single survey was 43 in 2003, however only one Austin blind salamander was recorded in 2010. The mean density of Austin blind salamanders within Old Mill Spring is 0.003/sqft, which is the highest density for this species within any of the three spring sites that it inhabits. Proposed surface critical habitat for the Austin blind salamander in Old Mill Spring includes the spring outlet including outflow up to the high water line, and 164 ft (50 meters) of downstream habitat. The proposed subterranean critical habitat in Old Mill Spring includes underground features in a circle with a radius of 984 ft (300 meters) around the spring outlet.

Threats and Stressors

Stressor: Water contamination/degradation
Exposure:
Response:
Consequence:
Narrative: The primary threat to the Austin blind salamander is the degradation of the quality and quantity of water that feeds Barton Springs as a result of urban expansion over the watershed. The species' restricted range makes it vulnerable to both acute and chronic groundwater contamination. The salamander is also vulnerable to catastrophic hazardous materials spills, increased water withdrawals from the Edwards Aquifer, and impacts to the surface habitat. An analysis of spring discharge data by the CoA (2000) indicated that degradation of water quality parameters has occurred at Barton Springs over the years. Dissolved oxygen has decreased while conductivity, sulfates, turbidity, nitrate-nitrogen, and total organic carbon have increased. The magnitude of these changes in water quality at Barton Springs has been variable and is dependent on flow conditions (City of Austin 2000, 2005). Changes in water quality at Barton Springs may be related to cumulative impacts of urbanization, including increased groundwater use. Variations in the quality of discharge at Barton Springs may also be related to seasonal changes in the amount of precipitation (City of Austin 1997). The extent to which these water quality changes have affected the Austin blind salamander or its habitat is unknown. Austin blind salamander habitat may also be affected by excessive deposition of sediment within Barton Springs. Deposition of sediment can physically reduce the amount of available habitat and protective cover for salamanders. Once deposited in large volumes, sediment can become devoid of oxygen and clog the interstitial spaces of the substrates surrounding the spring outlets that offer protective cover, rendering the habitat unsuitable for salamanders.

Recovery

Recovery Actions:

- As this species occurs in and around three of the spring sites that are also known to support the endangered Barton Springs salamander, recommended conservation measures follow those outlined for the Barton Springs salamander in the Barton Springs Salamander Recovery Plan (USFWS 2005). Such conservation efforts should include implementing comprehensive regional plans to address water quality and quantity threats. A plan to protect or enhance water quality should include measures for projects constructed over contributing and recharge zones of the Barton Springs Segment of the Edwards Aquifer. Such measures should include impervious cover limits, buffer zones for streams and other sensitive environmental features, low-impact developments, structural water quality controls and other strategies to reduce pollutant loads. Land preservation through acquisition, conservation easements, or deed restrictions also can provide permanent protection for water quality and quantity. Programs should be developed to reduce pollutant loading from already existing development and other potential sources of pollutants such as golf courses and transportation infrastructure. The City of Austin should continue their efforts to protect the salamander's habitat. The Austin blind salamander is also a high priority species in the Texas Parks and Wildlife Department's Wildlife Action Plan of Texas. This may help in securing State funds for both research and recovery efforts for this species. The potential for a catastrophic spill to occur at or near Barton Springs, or within the recharge zone of the Barton Springs Segment of the Edwards Aquifer, is of particular concern due to the limited range of this species. There continues to be a need for a comprehensive regional spill response and remediation plan to address the potential impacts of on-site and off-site spills. The extremely limited range of this species means that captive breeding is an important tool to help guard against extinction while other conservation measures are being put in place. Captive breeding, habitat improvement, and other efforts to increase numbers of existing viable populations is critical to the survival and recovery of this species, particularly as expanding urbanization continues to threaten habitat quality. Efforts to protect, manage, and restore surface salamander habitat at the three spring sites, followed by consistent and effective monitoring of Austin blind salamander populations, continues to yield valuable information regarding the recovery needs of this species.

- Training lifeguard and maintenance staff to protect salamander habitat
- Controlling erosion and preventing surface runoff from entering the springs.
- Ecological enhancement and restoration.
- Monthly monitoring of salamander numbers.
- Public outreach and education.
- Establishment and maintenance of a captive breeding program which includes the Austin blind salamander.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Develop water quality protection levels for aquatic contaminants adequate to promote the viability of the Austin blind salamander [Recovery Objective 1]. 2. Implement a comprehensive hazardous material spills plan for the Barton Springs watershed (not only the City of Austin jurisdiction area) [Downlisting Criterion 2]. 3. Develop and implement a survey methodology that would allow for a better understanding of subsurface distribution of the Austin blind salamander and improved estimates of the population [Recovery Objective 4]. 4. Continue coordination with biologists from the City of Austin to monitor Austin blind salamander populations and water quality indicators at the spring outlets in Zilker Park. 5. Continue captive breeding efforts at the San Marcos Aquatic Resource Center (USFWS, 2019)

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SPECIES ACCOUNT: *Lithobates (=Rana) chiricahuensis* (Chiricahua leopard frog (=Lithobates))

Species Taxonomic and Listing Information

Listing Status: Threatened; June 13, 2002; Southwest Region (R2)

Physical Description

The Chiricahua leopard frog (Lithobates chiricahuensis) is distinguished from other members of the Lithobates pipiens complex by a combination of characters, including a distinctive pattern on the rear of the thigh consisting of small, raised, cream-colored spots or tubercles on a dark background; dorsolateral folds that are interrupted and deflected medially; stocky body proportions; relatively rough skin on the back and sides; and often green coloration on the head and back (Platz and Mecham 1979). The species also has a distinctive call consisting of a relatively long snore of 1 to 2 seconds (Platz and Mecham 1979, Davidson 1996). Snout-vent lengths of adults range from about 2.1 to 5.4 in (Platz and Mecham 1979, Stebbins 2003).

Taxonomy

Leopard frogs (Rana pipiens complex), long considered to consist of a few highly variable taxa, are now recognized as a diverse assemblage of about 29 species (Hillis et al. 1983, Frost 2004, Hillis and Wilcox 2005), many of which have been described in the last 30 years, and several more await description. Mecham (1968) recognized two distinct variations of "Rana pipiens", or the northern leopard frog, in the White Mountains of Arizona. One of these was referred to as the "southern form". The other form matched previous descriptions of Rana pipiens. Based on morphology, mating calls, and genetic analyses (electrophoretic comparisons of blood proteins), Platz and Platz (1973) demonstrated that at least three distinct forms of leopard frogs occurred in Arizona, including the southern form. This southern form was subsequently described as the Chiricahua leopard frog (Platz and Mecham 1979).

Historical Range

Historical records exist for Pima, Santa Cruz, Cochise, Graham, Apache, Greenlee, Gila, Coconino, Navajo, and Yavapai counties, Arizona; and Catron, Grant, Hidalgo, Luna, Soccoro, and Sierra counties, New Mexico (Degenhardt et al. 1996, Sredl et al. 1997).

Current Range

The range of the Chiricahua leopard frog includes central and southeastern Arizona; west-central and southwestern New Mexico; and, in Mexico, northeastern Sonora, the Sierra Madre Occidental of northwestern and west-central Chihuahua, and possibly as far south as northern Durango (Platz and Mecham 1984, Degenhardt et al. 1996, Lemos-Espinal and Smith 2007, Rorabaugh 2008). The distribution of the species in Mexico is unclear due to limited survey work and the presence of closely related taxa (especially L. lemosespinali) in the southern part of the range of the Chiricahua leopard frog. The species has been extirpated from about 80 percent of its historical localities in Arizona and New Mexico. The species is still extant in the major drainage basins in Arizona and New Mexico where it occurred historically; with the exception of the Little Colorado River drainage in Arizona and possibly the Yaqui drainage in New Mexico. However, it has not been found recently in many rivers within those major drainage basins, valleys, and mountains ranges, including the following in Arizona: White River, West Clear Creek, Tonto Creek, Verde River mainstem, San Francisco River, San Carlos River, upper San Pedro River mainstem, Santa Cruz River mainstem, Aravaipa Creek, Babocomari River mainstem, and Sonoita Creek mainstem. In many of these regions Chiricahua leopard frog were not found for a decade or more despite repeated surveys. As of 2009, there were 84 sites in Arizona at which Chiricahua leopard frog occur or are likely to occur in the wild, with an additional four captive or partially captive refuge sites. At least 33 of the wild sites support breeding. In New Mexico, 15 to 23 breeding sites were known in 2008; the frogs occur at additional dispersal sites. Nineteen and eight localities are known from Sonora and Chihuahua, respectively. The species' current status in Mexico is poorly understood; however, it has been found in recent years in western Chihuahua. Some threats, such as introduced nonnative predators and the threat of catastrophic wildfire, appear to be less important south of the border, particularly in the mountains where Chiricahua leopard frog have been found (Gingrich 2003, Rosen and Melendez 2006, Rorabaugh 2008).

Critical Habitat Designated

Yes; 3/20/2012.

Legal Description

On March 20, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for the Chiricahua leopard frog (Lithobates chiricahuensis) under the Endangered Species Act of 1973, as amended (77 FR 16324 - 16424). In total, approximately 10,346 acres (4,187 hectares) were designated as critical habitat for the Chiricahua leopard frog in Apache, Cochise, Gila, Graham, Greenlee, Pima, Santa Cruz, and Yavapai Counties, Arizona; and Catron, Grant, Hidalgo, Sierra, and Socorro Counties, New Mexico.

Critical Habitat Designation

39 units are designated as critical habitat for the Chiricahua leopard frog. All 39 units are within the species' geographical range, including areas occupied at the time of listing and areas not known to be occupied at the time of listing but identified as essential for the conservation of the species (Platz and Mecham 1984, p. 347.1). The 39 areas designated as critical habitat are grouped by Recovery Unit.

Recovery Unit 1 (Tumacacori-Atascosa-Pajarito Mountains, Arizona and Mexico) Twin Tanks and Ox Frame Tank Unit This unit consists of 1.3 ac (0.5 ha) of lands owned by the Arizona State Land Department and 0.4 ac (0.2 ha) of private lands in the Sierrita Mountains, Pima County, Arizona. Twin Tanks is on lands owned and managed by the Arizona State Land Department and consists of two tanks in proximity to each other as well as a drainage running between them. Ox Frame Tank is on private lands. Occupancy of these livestock tanks at the time of listing is unknown, as they were not surveyed for frogs until 2007. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because these sites are important breeding sites for recovery. Twin Tanks held more than 1,000 frogs in 2008, and is a robust breeding population. Ox Frame and Twin tanks are too far apart (4.3 mi (7.0 km) overland) across rugged terrain to expect frogs to move between these sites. Hence, these tanks serve as isolated populations. The Twin Tanks area is less than 0.5 mi (0.8 km) upslope of active mining at Freeport McMoRan's Sierrita Copper Mine and could be affected from expansion of mining activities, creation of aerial pollutants that could affect water chemistry or quality, and possible effects to the frog's prey base. Addtionally, this unit contains both PCEs 1 and 2. Both sites are also at risk of introduction of nonnative predators, such as bullfrogs and nonnative crayfish. Presence of chytridiomycosis at these tanks has not been investigated. Garcia Tank Unit This unit consists of 0.7 ac (0.3 ha) of Federal land located on the Buenos Aires National Wildlife Refuge (NWR), Pima County, Arizona. It is a double tank; the southwest or downstream impoundment is more dependable at holding water than the upstream tank. However, both parts of the tank are designated as critical habitat. Garcia Tank is designated as critical habitat, because it was occupied at the time of listing and currently contains PCE 1 to support life-history functions essential for the conservation of the species. A breeding site, Garcia Tank was known to have been occupied in 2002 and 2006. Leopard frogs were noted in 2010, but they were not identified to species (the lowland leopard frog is also known to occur in the area). It is about 3.6 mi (5.8 km) over land across dissected and hilly terrain to the next nearest population at Lower Carpenter Tank. The nearest known populations to the east are on the Coronado National Forest and are more than 9.0 mi (14 km) away. Hence, this site is isolated and is managed as an isolated, robust population. The features essential to the conservation of the species in this unit may require special management considerations or protection to ensure these characteristics persist over time. The greatest threats needing special management are introductions of or colonization by nonnative species, such as bullfrogs and crayfish, and drought that could greatly reduce or eliminate the aquatic habitat. If necessary, in the wake of sustained drought, alternative water supplies or interim measures may be necessary in the form of water hauling or a supply well. Buenos Aires National Wildlife Refuge (NWR) Central Tanks Unit This unit, consisting of 1,720 ac (696 ha) of Federal land within the Buenos Aires NWR, Pima County, Arizona, includes former cattle tanks and other waters used as breeding and dispersal sites, plus intervening and connecting drainages and uplands. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains the features essential to the conservation of the species (PCEs 1 and 2 are present). Breeding sites at permanent or nearly permanent tanks (Carpenter, Rock, State, Triangle, and New Round Hill) support the most stable metapopulation known within the range of the species. Chongo Tank, where a population was established in 2009, may become a sixth breeding site. Seven other tanks support frogs periodically to regularly, and breeding and recruitment likely take place at these tanks in wet cycles (periods marked by successional precipitation events). Frogs occupied Carpenter, Rock, and Triangle Tanks in 2002, at or about the time of listing. Tanks designated for designation include Carpenter, Rock, State, Triangle, New Round Hill, Banado, Choffo, Barrel Cactus, Sufrido, Hito, Morley, McKay, and Chongo Tanks. McKay Tank is a cluster of three tanks, all of which are designated as critical habitat. Also designated as critical habitat are the intervening drainages, including: (1) Puertocito Wash from Triangle Tank north through and including Aguire Lake to New Round Hill Tank, then upstream to the confluence with Las Moras Wash, and upstream in Las Moras Wash to Chongo Tank; (2) an unnamed drainage from Puertocito Wash upstream to McKay Tank; (3) an unnamed drainage from Puertocito Wash upstream to Rock Tank, including Morley Tank, then upstream in an unnamed drainage to the top of that drainage, directly overland to an unnamed drainage, and then upstream to Hito Tank and downstream to McKay Tank; (4) from Sufrido Tank downstream in an unnamed drainage to its confluence with an unnamed drainage running between Rock and Morley tanks; (5) Lopez Wash from Carpenter Tank downstream to Aguire Lake; (6) an unnamed drainage from its confluence with Lopez Wash upstream to Choffo Tank; (7) an unnamed drainage from its confluence with Lopez Wash upstream to State Tank; (8) an unnamed drainage from Banado Tank downstream to its confluence with an unnamed drainage, then upstream in that drainage to Barrel Cactus Tank; and (9) an unnamed drainage from Banado Tank upstream to a saddle, then directly downslope to Lopez Wash. The features essential to the conservation of the species in this unit may require special management considerations or protection to alleviate the threats from bullfrogs and disease. In this unit, bullfrogs remain a threat, but efforts are underway to eliminate the last known populations of bullfrogs in the Altar Valley (on the Santa Margarita Ranch to the south of Buenos Aires NWR). Frogs in this area have tested positive for chytridiomycosis, but the disease appears to have little effect on population persistence. Bonita, Upper Turner, and Mojonera Tanks Unit This unit includes 201 ac (81 ha) of Federal lands in the Coronado National Forest in the Pajarito and Atascosa Mountains, Santa Cruz County, Arizona. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains the features essential to the conservation of the species (both PCEs 1 and 2). Two breeding sites (Bonita Tank and Mojonera Tank), combined with a dispersal site or site where breeding and recruitment may occur in wet years (Upper Turner Tank), form the center of a future metapopulation. Three additional waters—Sierra Tank East, Sierra Tank West, and Sierra Well— require special management to increase breeding potential in these areas. Frogs currently occupy Bonita and Mojonera Tanks, and Bonita Tank was occupied at the time of listing. Frogs were last found at Upper Turner Tank in 2004. The occupancy status of Mojonera and Upper Turner Tanks at the time of listing is unknown. The designated critical habitat in this unit also includes intervening drainages, uplands, and ephemeral or intermittent waters as follows: (1) From Upper Turner Tank upstream in an unnamed drainage to its confluence with a minor drainage coming in from the east, then directly upslope in that drainage and east to a saddle, and directly downslope to Bonita Canyon, and upstream in Bonita Canyon to Bonita Tank; and (2) from Mojonera Tank downstream in Mojonera Canyon to a sharp bend where the drainage turns west-northwest, then southeast and upstream in an unnamed drainage to a saddle, downslope through an unnamed drainage to its confluence with another unnamed drainage, upstream in that unnamed drainage to a saddle, and then downstream in an unnamed drainage to Sierra Well, to include Sierra Tank West and Sierra Tank East, then directly overland to Upper Turner Tank. In this unit, special management is needed because bullfrogs are a continuing threat, and illegal border activity and associated law enforcement have resulted in watershed damage. A road on the berm of Upper Turner Tank is scheduled for improvement to access a surveillance tower operated by U.S. Customs and Border Protection. Special management is also needed because frogs in this region have tested positive for chytridiomycosis, but the disease appears to have little effect on population persistence. Sycamore Canyon Unit This unit includes 262 ac (106 ha) of Federal lands in the Coronado National Forest and 7 ac (3 ha) of private lands along Atascosa Canyon through Bear Valley Ranch in the Pajarito and Atascosa Mountains, Santa Cruz County, Arizona. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains the features essential to the conservation of the species (PCEs 1 and 2). Sycamore Canyon is the only lotic (flowing water) site in Recovery Unit 1 capable of supporting breeding subpopulations of Chiricahua leopard frogs. Most other sites are livestock tanks or impounded springs. Sycamore Canyon, Bear Valley Ranch Tank, Rattlesnake Tank, and Atascosa Canyon downstream of Bear Valley Ranch were all occupied by Chiricahua leopard frogs at the time of listing. The occupancy status of the other sites at the time of listing is unknown. Sycamore Canyon, Yank Tank, North Mesa tank, South Mesa Tank, and Bear Valley Ranch Tank are currently occupied. The current occupancy status of Rattlesnake Tank and Atascosa Canyon downstream of Bear Valley Ranch Tank is unknown. Designated critical habitat includes approximately 6.35 mi (10.23 km) of Sycamore Canyon from Ruby Road to the international border, which supports frogs and breeding, although in the driest months (May and June) the stream dries to pools and tinajas (a term used in the American Southwest for water pockets formed in bedrock depressions that occur below waterfalls or are carved out by spring flow or seepage). A number of livestock tanks in the unit form a viable metapopulation with Sycamore Canyon. Designated critical habitat includes the following tanks and their connecting drainages: (1) From Yank Tank downstream in an unnamed drainage to Sycamore Canyon; (2) from North Mesa Tank downstream in Atascosa Canyon to its confluence with Pen˜ asco Canyon, then from that confluence downstream in Pen˜ asco Canyon to Sycamore Canyon; (3) from Horse Pasture Spring downstream to Pen˜ asco Canyon; (4) from Bear Valley Ranch Tank downstream in an unnamed drainage to Atascosa Canyon; (5) from South Mesa Tank downstream in an unnamed drainage to Pen˜ asco Canyon; and (6) from Rattlesnake Tank downstream in an unnamed canyon to its confluence with another unnamed drainage, then upstream in that drainage to South Mesa Tank. Special management is required in this unit because bullfrogs have been a continuing problem, although recent control efforts seem to have eliminated them from Sycamore Canyon. Nonnative green sunfish (Lepomis cyanellus) have occasionally been found in Sycamore Canyon as well, and they could prey on larval Chiricahua leopard frogs. Pools critical to survival of frogs and tadpoles through the dry season are sensitive to sedimentation and erosion upstream in the watershed of Sycamore Canyon. The earliest records of chytridiomycosis in Arizona are from Sycamore Canyon (1972). A robust population of Chiricahua leopard frogs persists at this site despite the disease and periodic die-offs. Illegal border activity and associated law enforcement have resulted in many trails and new vehicle routes in the area, as well as trampling in the canyon. Sycamore Canyon is designated a Research Natural Area by the Coronado National Forest and is closed to livestock grazing. Critical habitat is designated for the Sonora chub (Gila ditaenia) in Sycamore Canyon from Hank and Yank Spring (about 0.25 mi (0.40 km) downstream of the Ruby Road crossing) downstream to the international border, and in a 25-ft (7.6-m) strip on both sides of the creek (51 FR 16042; April 30, 1986). Much of this unit also lies within the Pajarita Wilderness area. These designations provide some level of protection to Chiricahua leopard frog habitats in Sycamore Canyon because management for Sonora chub conservation is consistent with that for Chiricahua leopard frogs. However, the Chiricahua leopard frog may require additional measures. Pen˜ a Blanca Lake and Spring and Associated Tanks Unit This unit includes 202 ac (82 ha) of Federal lands in the Coronado National Forest, Santa Cruz County, Arizona. This area is designated as critical habitat because it was occupied at the time of listing and contains PCEs 1 and 2, which support the life-history functions essential for the conservation of the species. This unit is a metapopulation that includes Pen˜ a Blanca Lake, Pen˜ a Blanca Spring, Summit Reservoir, Tinker Tank, Thumb Butte Tank, and Coyote Tank. These sites were all occupied in 2009. Chiricahua leopard frogs and tadpoles were found in Pen˜ a Blanca Lake in 2009 and 2010, after the lake had been drained and then refilled, which eliminated the nonnative predators. However, early in 2010, rainbow trout (Oncorhynchus mykiss) were stocked back into the lake, and plans are underway to reestablish a variety of warm water, predatory fish (such as largemouth bass (Micropterus salmoides)) in the spring of 2012. Despite the stocking of rainbow trout, Pen˜ a Blanca Lake now contains a robust breeding population of Chiricahua leopard frogs, one of the largest single populations throughout its range. In April 2011, surveys of the lake confirmed that Chiricahua leopard frogs remained extant. In September 2011, surveys of the lake estimated the Chiricahua leopard frog population to number between 300 to 500 individuals, which is likely a low estimate, because only a single night survey was performed, and the shoreline habitat was complex, making observations difficult. During that survey, Chiricahua leopard frogs were calling, indicating that fall breeding may have been occurring. In 2002, Chiricahua leopard frogs were only known to occur at Pen˜ a Blanca Spring. Occupancy status at the time of listing for the other sites is unknown. Designated critical habitat also includes: (1) From Summit Reservoir directly southeast to a saddle on Summit Motorway, then downslope to an unnamed drainage and downstream in that drainage to its confluence with Alamo Canyon, then downstream in Alamo Canyon to its confluence with Pen˜ a Blanca Canyon, then downstream in Pen˜ a Blanca Canyon to Pen˜ a Blanca Lake, to include Pen˜ a Blanca Spring; (2) from Thumb Butte Tank downstream in an unnamed drainage to its confluence with Alamo Canyon; (3) from Tinker Tank downstream in an unnamed drainage to its confluence with Alamo Canyon, then downstream in Alamo Canyon to the confluence with the drainage from Summit Reservoir; and (4) from Coyote Tank downstream in an unnamed drainage to its confluence with Alamo Canyon, and then downstream in Alamo Canyon to the confluence with the drainage from Tinker Tank, to include Alamo Spring. Special management is required in this unit because nonnative predators, particularly bullfrogs and sportfish, remain a serious threat. A concerted effort began in 2008 to clear the area of bullfrogs. The effort appears to be successful, and Chiricahua leopard frogs have clearly benefited because their population has grown exponentially in Pen˜ a Blanca Lake. However, there is a continuing threat of recolonization or purposeful introduction of bullfrogs, and management of this area will continue to concentrate on preventing bullfrogs from recolonizing the area and eliminating those that do. As discussed, warmwater sportfish at Pen˜ a Blanca Lake are scheduled to be stocked in the spring of 2012, which will affect the suitability of the lake as Chiricahua leopard frog habitat. However, in a May 2011, section 7 consultation for sportfish stocking of the lake, conservation measures were established that require shoreline habitat to be managed in a manner to retain its complexity, which will provide some level of protection to resident Chiricahua leopard frogs from potential predation from sportfish. In that consultation, we determined that, given the number of conservation measures (which included managing against bullfrogs and ensuring the persistence of dense shoreline vegetation), the proposed stocking of warmwater fish would not result in adverse modification of this critical habitat unit. Given the robust population of Chiricahua leopard frogs that currently occurs in the lake and protection offered by attributes of existing shoreline habitat, we recognize the value of Pen˜ a Blanca Lake as essential for the conservation of Chiricahua leopard frogs, even with the presence of warmwater sportfish. Chiricahua leopard frogs in this region have tested positive for chytridiomycosis; however, the disease appears to have little effect on population persistence.

Recovery Unit 2 (Santa Rita-HuachucaAjos Bavispe, Arizona and Mexico) Florida Canyon Unit Florida Canyon includes 4 ac (2 ha) of Federal lands in the Coronado National Forest in the Santa Rita Mountains, Pima County, Arizona. Chiricahua leopard frogs currently occupy this site; however, its occupancy status at the time of listing is unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because it can be managed as a breeding population to provide overall stability to the species' status. A single frog was found in 2008, which was augmented with frogs from elsewhere in the Santa Rita Mountains in 2009. The site is too far from other known breeding populations to be part of a metapopulation (the next nearest population is about a 5-mi (8-km) straight-line distance away in Unit 8; hence, it will be managed as an isolated population). PCE 1 is present and was enhanced in 2010, with the addition of a steel tank for breeding. Included in the designation is approximately 1,521 ft (463 m) of Florida Canyon from a siltedin dam to the downstream end of the Florida Workstation property. The major threat is scarcity of water, particularly during long periods of drought. Also, fire in the watershed could result in scouring and sedimentation in the pools important as habitat for the frog. The addition of a steel tank provides dependable water for breeding that is safe from erosion or sedimentation events. Chyridiomycosis and introduced predators are potential threats, but neither has been recorded at this site. Eastern Slope of the Santa Rita Mountains Unit This unit includes 172 ac (70 ha) of Federal lands in the Coronado National Forest and 14 ac (6 ha) of private lands in the Greaterville area in Pima County, Arizona. Included in the critical habitat designation are two metal troughs in Louisiana Gulch, Greaterville Tank, Los Posos Gulch Tank, and the Granite Mountain Tank complex. The Granite Mountain Tank complex includes two impoundments and a well. All but Los Posos Gulch Tank are currently occupied breeding sites; however, the occupancy status at the time of listing for these sites is unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because it represents one of only two known occupied areas that support or likely support breeding activity for the Chiricahua leopard frog in the Santa Rita Mountains. More than 60

Chiricahua leopard frogs were observed at Los Posos Gulch Tank in 2008. It was once thought to be a robust breeding site; however, it dried, and Chiricahua leopard frogs disappeared in 2009. These four sites collectively form a metapopulation. A number of other sites in this region have been found to support dispersing Chiricahua leopard frogs; however, only a few frogs and no breeding have been observed at these sites, so they are thought to represent dispersing frogs. The occupancy status of these other sites at the time of listing is also unknown. Designated critical habitat also includes intervening drainages as follows: (1) From Los Posos Gulch upstream to a saddle, then downslope in an unnamed drainage to the confluence with another unnamed drainage, then upstream and south in that drainage to a saddle, and downslope through an unnamed drainage to its confluence with Ophir Gulch, then in Ophir Gulch to upper Granite Mountain Tank, to include an ephemeral tank near upper Granite Mountain Tank and a well; (2) from Greaterville Tank downstream in an unnamed drainage to Ophir Gulch; and (3) Louisiana Gulch from the metal tanks upstream to the headwaters of Louisiana Gulch then across a saddle and downslope through an unnamed drainage to its confluence with Ophir Gulch. Additionally, this unit has both PCEs 1 and 2. The major threat in this unit is limited surface water. The breeding habitat at Louisiana Gulch, although limited to two 6.0-ft (1.8-m) diameter steel tanks, is dependable because it is fed by a well. The other tanks are filled by runoff and susceptible to drying during drought. Nonnative predators and chytridiomycosis are not known to be imminent threats in this area. Las Cienegas National Conservation Area Unit This unit is in Pima County, Arizona, and includes 1,364 ac (552 ha) of Bureau of Land Management lands and 186 ac (75 ha) of Arizona State Land Department lands, including an approximate 4.33-mi (6.98-km) reach of Empire Gulch and 1.91 mi (3.08 km) of Cienega Creek, including the Cinco Ponds. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Close to 60 metamorphosed Chiricahua leopard frogs and 400 tadpoles were released to Las Cienegas Natural Conservation Area during the fall of 2011. At the time of listing, Empire Gulch was occupied. However, the occupancy status of Cinco Ponds at that time is unknown. Currently, Chiricahua leopard frogs are extant at Empire Gulch and Cinco Ponds. Frogs breed in a reach of Empire Gulch near Empire Ranch. This reach includes: (1) Empire Gulch from a pipeline road crossing above the breeding site downstream to Cienega Creek; and (2) Cienega Creek from the Empire Gulch confluence upstream to the approximate end of the wetted reach and where the creek bends hard to the east, to include Cinco Ponds. An enclosed Chiricahua leopard frog facility exists along Empire Gulch and is used to headstart eggs and tadpoles for release to augment the wild population. Frogs may breed periodically at Cinco Ponds. These sites are too far (more than an 8.0-mi (13-km) straight-line distance) from the next nearest population, which is in Eastern Slope of the Santa Rita Mountains; thus, the population(s) in this unit currently acts as an isolated population(s). Special management is required in this unit to improve habitat, control disease, and remove nonnative species. A collaborative, multi-partner recovery program for the Chiricahua leopard frog is ongoing at Las Cienegas; the program is funded by a substantial grant from the National Fish and Wildlife Foundation. The program focuses on creating opportunities for Chiricahua leopard frog head-starting, improving habitat, and removing nonnative species. Significant progress has been made to eliminate bullfrogs from the area, but bullfrogs are still present and represent a persistent problem. Chiricahua leopard frogs suffer from chytridiomycosis in this unit; however, the Chiricahua leopard frogs are persisting with the disease. Crayfish occur within a few miles and pose a significant threat if they reach Cienega Creek or Empire Gulch. Empire Gulch and Cienega Creek downstream of its confluence with Empire Gulch is designated critical habitat for the federally endangered Gila chub (Gila intermedia) (70 FR 66663; November 2, 2005). The chub and the federally endangered Gila topminnow (Poeciliopsis occidentalis) (32 FR 4001; March 11, 1967) occur in Cienega Creek adjacent to Empire Gulch. The Gila topminnow also occurs in Empire Gulch. Neither species occurs in Cinco Ponds. Where these federally listed species occur with the Chiricahua leopard frog, some level of protection may be afforded to Chiricahua leopard frog habitat when a Federal nexus exists for projects that may affect one of these other federally listed species. Pasture 9 Tank This was a proposed unit that includes 0.5 ac (0.2 ha), and is a former cattle pond entirely on private lands of the San Rafael Ranch, San Rafael Valley, Santa Cruz County, Arizona. For this final rule, we are excluding all 0.5 ac (0.2 ha) in this unit under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act, below). Therefore, this unit is not being designated as critical habitat in this final rule. Scotia Canyon Unit This unit includes 70 ac (29 ha) in Scotia Canyon, Huachuca Mountain, Cochise County, Arizona, and is entirely on Federal lands in the Coronado National Forest. Chiricahua leopard frogs were reestablished in this canyon via a translocation in 2009; the last record of a Chiricahua leopard frog in the canyon before that was 1986. Scotia Canyon was not occupied at the time of listing. We consider this unit to be essential to the conservation of the Chiricahua leopard frog because of its potential to host a stable breeding population of Chiricahua leopard frogs in the future and the effort that has been dedicated to the area to mitigate threats posed by nonnative predators. Additionally, this unit has both PCEs 1 and 2. The unit encompasses an approximate 1.36-mi (2.19-km) reach of the canyon with perennial pools, as well as a perennial travertine (a form of limestone) seep; a spring-fed, perennial impoundment (Peterson Ranch Pond); and an ephemeral impoundment adjacent to Peterson Ranch Pond. There is also a perennial or nearly perennial impoundment in the channel downstream of the travertine seep. Breeding habitat occurs at Peterson Ranch Pond and possibly at other perennial or nearly perennial pools. Currently, this site is isolated from other populations. Hence this site is managed as an isolated population, but there is some potential for creating connectivity to the metapopulation in Ramsey and Brown Canyons via population reestablishment in Garden Canyon at Fort Huachuca. Scotia Canyon, with its pond and stream habitats, has the potential to host a robust population. Special management is required in this unit to remove nonnative predators and disease, protect from catastrophic wildlife, and improve aquatic habitat. Scotia Canyon, and sites around it, have been the subject of intensive bullfrog eradication and habitat enhancement work in preparation for the 2009 reestablishment of the Chiricahua leopard frog. However, bullfrog reinvasion is a significant, continuing threat, and other nonnative predators could potentially reach Scotia Canyon via natural or human-assisted releases. In addition, barred tiger salamanders from the Peterson Ranch Pond tested positive for chytridiomycosis in 2009; however, in 2010, the Chiricahua leopard frogs appeared to be persisting in that same pond. Arizona Game and Fish Department biologists and Coronado National Forest staff visited the site on April 5, 2011, and verified the continued presence of salamanders (2 mature brachiates were observed). Nonetheless, disease has resulted in extirpations elsewhere in the Huachuca Mountains, and is considered a serious threat in Scotia Canyon. Further, heavy fuel loads could result in a catastrophic wildfire, which would have significant detrimental effects on the frog and its aquatic habitats. Finally, a road through the canyon is eroded in places and contributes sediment to the stream; it receives much use by recreationists and U.S. Customs and Border Protection. The critical habitat designation for the Chiricahua leopard frog largely overlaps that of critical habitat for the endangered Lilaeopsis schaffneriana var. recurva (Huachuca water-umbel). The occurrence of critical habitat and listed species provide some level of protection to Chiricahua leopard frog habitat in this unit when a Federal nexus exists on a project that may affect the endangered plant Lilaeopsis schaffneriana var. recurva (Huachuca water-umbel). However, the Chiricahua leopard frog may require additional measures to facilitate conservation and recovery in these areas. Beatty's Guest Ranch Unit This was a proposed unit that includes 10 ac (4.0 ha) of private lands in Miller Canyon on the east slope of the Huachuca Mountains, Cochise County, Arizona. For this final rule, we are excluding all 10 ac (4.0 ha) in this unit under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act, below). Therefore, this unit is not being designated as critical habitat in this final rule. Carr Barn Pond Unit This unit includes 0.6 ac (0.3 ha) of Federal lands in the Coronado National Forest in the Huachuca Mountains, Cochise County, Arizona. Carr Barn Pond is an impoundment with a small, lined pond with water provided from a well. During runoff events, the size of the pond expands considerably and then gradually shrinks back to the lined section. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCE 1 to support life-history functions essential for the conservation of the species. As with Beatty's Guest Ranch, Ramsey and Brown Canyons, this unit has been the subject of a conservation agreement and much intensive management for the Ramsey Canyon (= Chiricahua) leopard frog. The Coronado National Forest created and now maintains Carr Barn Pond consistent with the Ramsey Canyon (= Chiricahua) leopard frog conservation agreement, to which they are a signatory. This site was occupied at the time of listing and was occupied into 2009, but the population has since been eliminated, probably by chytridiomycosis. This site is too far away (3.4 mi (5.4 km) from Ramsey and Brown Canyons and about 3.0 mi (4.8 km) from Beatty's Guest Ranch by way of a straight-line distance over rugged terrain) to be part of a metapopulation; hence, it is currently considered isolated. There is some potential for connecting it to Scotia Canyon, and Ramsey and Brown Canyons (see discussion above), but additional habitat creation or enhancement and population reestablishment would be needed. The features essential to the conservation of the species in this unit may require special management considerations or protection to alleviate the threats from nonnative predators and disease. Disease is a serious threat that can be an impediment to viable frog populations. The population has been eliminated after chytridiomycosis dieoffs three times. Twice the population has subsequently been reestablished through translocations. Largemouth bass have been introduced illegally into the pond and then removed, and bullfrogs periodically invade the site, but are promptly removed before they breed. Ramsey and Brown Canyons Unit This unit includes 44 ac (18 ha) of private lands in Ramsey Canyon and 58 ac (24 ha) of Federal lands in the Coronado National Forest in Brown and Ramsey Canyons, Huachuca Mountains, Cochise County, Arizona. Ramsey Canyon was not occupied at the time of listing but Brown Canyon was; therefore, we treat this unit as occupied. The unit currently contains PCEs 1 and 2 to support life-history functions essential for the conservation of the species. This unit, along with Beatty's Guest Ranch and Carr Barn Pond, has been managed intensively for Ramsey Canyon (= Chiricahua) leopard frog conservation since 1995. This unit is managed as a metapopulation. Places where Chiricahua leopard frogs have bred and that still retain PCE 1 include Ramsey Canyon, and Trout and Meadow Ponds on private lands owned by The Nature Conservancy. These private lands are excluded from designation as critical habitat in the Ramsey Canyon Box. In Brown Canyon, the Wild Duck Pond, House Pond, and the Brown Canyon Box (on Coronado National Forest lands) are designated as critical habitat. In addition, this critical habitat unit also includes dispersal sites and corridors for connectivity among breeding ponds as follows: (1) From the eastern boundary of The Nature Conservancy's Bledsoe Parcel in the Ramsey Canyon Preserve downstream to a dirt road crossing of Ramsey Canyon at the mouth of the canyon, excluding The Nature Conservancy's University of Toronto Parcel in the Ramsey Canyon Preserve; (2) Brown Canyon from the Box downstream to the Wild Duck Pond and House Pond on the former Barchas Ranch; and (3) from the dirt road crossing of Ramsey Canyon directly overland to House Pond. The Ramsey Canyon portion of the unit was not occupied at the time of listing, but Brown Canyon was occupied. Both canyons are currently considered occupied. Chiricahua leopard frogs have bred at the Box in Brown Canyon, although the site is too small to support more than just a few frogs. Special management is required in this unit because recent die-offs associated with chytridiomycosis have significantly reduced populations in both canyons. The House and Wild Duck Ponds, as well as Ramsey Canyon, have a history of chytridiomycosis outbreaks. The Ramsey Canyon population has been eliminated twice and then reestablished; the House and Wild Duck Ponds have also undergone repeated disease-related declines and extirpations followed by reestablishments. The populations tend to persist for months or years after reestablishment only to experience chytridiomycosis outbreaks followed by declines or extirpation. Additional special management is required in this unit because nonnative species, drying, sedimentation, and fire threaten the frog. Nonnative predators threaten populations at the House and Wild Duck Ponds, where bullfrogs have been found periodically and goldfish (Carassius auratus auratus) were once introduced. Those two ponds are buffered against drought and drying by a pipeline from a spring and a windmill. However, the Box in Brown Canyon is subject to low water and drying during drought. That latter population depends upon immigration or active reestablishment for long-term persistence. The Trout and Meadow Ponds in Ramsey Canyon are fed by pipelines; thus the water supply is dependable. The Trout Pond could however be filled in with sediment during a flood. Further, a fire in the watershed could threaten aquatic breeding sites in both canyons. Lands owned by The Nature Conservancy in Ramsey Canyon are known as the Ramsey Canyon Preserve and are managed for preservation of natural features and species, including the Chiricahua leopard frog. The Ramsey Canyon Preserve is also enrolled in the Arizona Game and Fish Department's Statewide Safe Harbor Agreement, effective July 2010. Under section 4(b)(2) of the Act, the Ramsey Canyon Preserve (16 ac (6.5 ha)) is being excluded from critical habitat designation (see Application of Section 4(b)(2) of the Act, below).

Recovery Unit 3 (Chiricahua Mountain, sMalpai Borderlands-Sierra Madre, Arizona, New Mexico, and Mexico) High Lonesome Well Unit. This previously proposed unit includes 0.4 ac (0.2 ha) of privately owned lands in the Playas Valley, Hidalgo County, New Mexico. This unit consists of an elevated concrete tank into which Chiricahua leopard frogs were introduced prior to listing (Painter 2000, p. 15). The tank is supplied with water from a windmill and provides water for livestock. The site supports a robust breeding population, but is much too far from other populations to be part of a metapopulation (the nearest population is in Unit 17, 25.4 mi (40.6 km) to the west). Furthermore, although frogs can exit the tank, they cannot get back into the tank. We reevaluated the High Lonesome Well Unit and have determined that it does not meet the definition of critical habitat, because it does not have the physical or biological features that are essential for the conservation of the species. The unit does not contain the terrestrial habitat that provides opportunities for foraging and basking, and that is immediately adjacent to or surrounding breeding aquatic and riparian habitat, which is a component of PCE 1. Therefore, we have removed the High Lonesome Well Unit from this final critical habitat designation. Peloncillo Mountains Unit This unit includes 366 ac (148 ha) of Federal lands in the Coronado National Forest in Hidalgo County, New Mexico. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Aquatic habitats in this unit include Geronimo, Javelina, State Line Tanks; Maverick Spring; and pools or ponds in the Cloverdale Cienega and along Cloverdale Creek below Canoncito Ranch Tank. Breeding has occurred in State Line Tank, and possibly other aquatic sites in this unit. Geronimo Tank was occupied at the time of listing. The occupancy status of the other sites at that time is unknown. These tanks and Maverick Spring have recent records of frogs (2007 to the present) and are considered currently occupied, with the exception of State Line Tank. State Line Tank was reported dry in 2011, with no available habitat or refuge for Chiricahua leopard frogs and no frogs observed. It is not known whether the tank incurred damage or drought caused it to dry. However, because Chiricahua leopard frogs disperse from Canoncito Ranch Tank into Cloverdale Cienega, Cloverdale Creek, and surrounding tanks when water is present, State Line Tank still contains PCE 2. This unit is managed as a metapopulation. Also included in this unit are intervening drainages and uplands needed for connectivity among these aquatic sites, including: (1) Cloverdale Creek from Canoncito Ranch Tank downstream, including Cloverdale Cienega, and excluding portions of Cloverdale Creek and the cienega within private lands of Canoncito Ranch; (2) from Geronimo Tank downstream in an unnamed drainage to its confluence with Clanton Draw, then upstream to the confluence with an unnamed drainage, and upstream in that drainage to its headwaters, across a mesa to the headwaters of an unnamed drainage, then downslope through that drainage to State Line Tank; (3) from State Line Tank upstream in an unnamed drainage to a mesa, then directly overland to the headwaters of Cloverdale Creek, and then downstream in Cloverdale Creek to Javelina Tank; and (4) from Javelina Tank downstream in Cloverdale Creek to the Canoncito Ranch Tank, to include Maverick Spring. Special management is required in this unit because periodic drought dries most of the aquatic sites completely or to small pools, which limits population growth potential. Nonnative sportfish are present at Geronimo Tank and may preclude successful recruitment. Occurrence of chytridiomycosis in this area has not been investigated, but may also be a limiting factor. Sky Island Alliance is working with partners to restore the Cloverdale Cienega, which should improve aquatic habitats for Chiricahua leopard frogs. The owner of the Canoncito Ranch has signed onto a safe harbor agreement for the Chiricahua leopard frog. Under section 4(b)(2) of the Act, the private lands in this unit (289 ac (117 ha)) are excluded from the final rule for critical habitat (see Application of Section 4(b)(2) of the Act, below). Cave Creek Unit This unit includes 234 ac (95 ha) of Federal lands in the Coronado National Forest in the Chiricahua Mountains, Cochise County, Arizona. This unit was occupied at the time of listing, is currently occupied, and currently contains both PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Chiricahua leopard frogs and tadpoles were released during the fall of 2011, into a pond on the Southwestern Research Station, where they were initially reared in an onsite ranarium. Released frogs are expected to distribute themselves throughout Cave Canyon during ensuing years. Included in this unit is an approximate 4.76-mi (7.66-km) reach of Cave Creek and associated ponds in or near the channel, from Herb Martyr Pond downstream to the eastern U.S. Forest Service boundary. PCEs 1 and 2 are present. This site will be managed as a metapopulation. Herb Martyr Pond is the type locality for the Chiricahua leopard frog; however, no frogs have been observed at the site since 1977. This pond requires special management because the pool behind the dam is entirely silted in, and pools at the base of the dam are probably not adequate for Chiricahua leopard frog survival or reproduction. With restoration, this site could support a breeding population of Chiricahua leopard frogs. The pond below the dam at John Hands appears suitable for occupancy, but Chiricahua leopard frogs have not been recorded there since 1966. Chiricahua leopard frogs were occasionally seen in Cave Creek through 2002. Special management is required in this unit because scarcity of water can occur in drought years, and bullfrogs occur to the east but have never been recorded in the unit. The current status and past history of chytridiomycosis in this unit are unknown. Rainbow trout were present and occurred concurrently with Chiricahua leopard frogs at Herb Martyr Pond, but no trout are currently known in the unit. The Southwestern Research Station, owned by the American Museum of Natural History, maintains habitat occupied by the Chiricahua leopard frog, has signed a safe harbor agreement for the Chiricahua leopard frog, and is an active participant in recovery. The Service and Arizona Game and Fish Department (AGFD) are working with additional private landowners downstream of the designated critical habitat to bring them into the safe harbor agreement. Under section 4(b)(2) of the Act, the American Museum of Natural History lands (92 ac (37 ha)) are being excluded from critical habitat designation (see Application of Section 4(b)(2) of the Act, below). Leslie Creek Unit The unit consists of 26 ac (11 ha) of National Wildlife Refuge (NWR) (Federal) lands on Leslie Canyon NWR, Cochise County, Arizona. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCE 1 to support lifehistory functions essential for the conservation of the species. This unit is a stream system with intermittent pools and two small impoundments. The upstream boundary is the Leslie Canyon NWR, and its downstream limit is the crossing of Leslie Canyon Road, an approximate stream distance of 4,094 ft (1,248 m). Chiricahua leopard frogs were present in this unit at the time of listing and are currently extant. This population is too far (24.8 mi (36.7 km)) from the next nearest breeding site, North Tank, to be part of a metapopulation. Hence it is managed as an isolated population. Special management is required in this unit because drought and lack of pools are limiting factors in this unit. Also, Chiricahua leopard frogs are positive for chytridiomycosis at this site, and although they are persisting with the disease, the population is not robust, and the effects of the disease may be responsible in part. Bullfrogs occur in ponds to the east, but have never been recorded in Leslie Creek. The endangered plant Lilaeopsis schaffneriana var. recurva (Huachuca water-umbel), endangered Yaqui chub (Gila purpurea), and endangered Yaqui topminnow (Poeciliopsis occidentalis sonoriensis) all occur in Leslie Creek, and the area is managed to conserve the aquatic and riparian habitats of the canyon. While current management prescriptions for the Yaqui fishes will benefit the Chiricahua leopard frog in this area, additional actions may be necessary to conserve and recover the Chiricahua leopard frog in this area. A landowner adjacent to the the refuge has signed a safe harbor agreement for the Chiricahua leopard frog and other species. With future habitat renovations and population reestablishments, there is some potential for developing additional populations of Chiricahua leopard frogs in this area, which could form a metapopulation with the Leslie Canyon population. Rosewood and North Tanks Unit This was a proposed unit that includes 19 ac (8 ha) of private land and 78 ac (31 ha) of land owned by the Arizona State Land Department in the San Bernardino Valley, Cochise County, Arizona. For this final rule, we are excluding all 97 ac (39 ha) of this unit under section 4(b)(2) of the Act (see Application of Section 4(b)(2) of the Act, below). Therefore, this unit is not being designated as critical habitat in this final rule.

Recovery Unit 4 (Pin˜ aleno-GaliuroDragoon Mountains, Arizona) Deer Creek Unit This unit consists of 17 ac (7 ha) of Federal lands in the Coronado National Forest, 69 ac (28 ha) of Arizona State Land Department lands, and 34 ac (14 ha) of private lands in the Galiuro Mountains, Graham County, Arizona. This unit was occupied at the time of listing and contains the features essential to the conservation of the species (PCEs 1 and 2). Included in designated critical habitat are Home Ranch, Clifford's, Vermont, and Middle Tanks, a series of 10 impoundments on the Penney Mine lease, and intervening drainages, primarily Deer Creek, and associated uplands and ephemeral tanks that provide corridors for movement among these tanks. Breeding has been confirmed on Deer Creek above Clifford's Tank, and in Home Ranch and Vermont Tanks, and is suspected in the other three sites named above when water is present long enough for tadpoles to metamorphose into adults (3 to 9 months). Home Ranch Tank supports a large population of Chiricahua leopard frogs. This unit functions as a metapopulation. Intervening drainages include: (1) Deer Creek from a point where it exits a canyon and turns abruptly to the east, upstream to its confluence with an unnamed drainage, upstream in that drainage to a confluence with four other drainages, upstream from that confluence in the western drainage to Clifford's Tank, upstream from that confluence in the west-central drainage to an unnamed tank, then directly overland southeast to another unnamed tank, then downstream from that tank in an unnamed drainage to the aforementioned confluence and upstream in that unnamed drainage to a saddle, and downstream from that saddle in an unnamed drainage to its confluence with an unnamed tributary to Gardner Canyon, and upstream in that unnamed tributary to Home Ranch Tank; (2) from the largest of the Penney Mine Tanks directly overland and southwest to an unnamed tank, and downstream from that tank in an unnamed drainage to the aforementioned confluence, to include another unnamed tank situated in that drainage; (3) from Vermont Tank directly overland and east to Deer Creek; and (4) from Middle Tank upstream in an unnamed drainage to a saddle, and then directly downslope to Deer Creek. Special management is required in this unit to alleviate periodic drought, which results in breeding sites drying. During a severe drought in 2002, all but one of the waters in the unit dried. Frogs reportedly died for unknown reasons in the 1980s (Goforth 2005, p. 2), possibly indicative of chytridiomycosis; however, no Chiricahua leopard frogs have tested positive for the disease from this unit. The only nonnative aquatic predator recorded in this unit is the barred tiger salamander. Recovery work has occurred in this unit, including head-starting of egg masses and reestablishment and augmentation of populations. The Service, AGFD, Arizona State Land Department, and an agate miner (Penney Mine Tanks) have drafted a conservation plan for managing habitats on the mine lease, but funds are lacking to implement that plan. Oak Spring and Oak Creek Unit This unit consists of 27 ac (11 ha) of Federal lands in the Coronado National Forestin the Galiuro Mountains, Graham County, Arizona. Occupancy status at the time of listing was unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because this unit contains important breeding sites necessary for recovery. It is just north of Deer Creek, but is too far (about 1.6 mi (2.6 km)) overland (via straightline distance) from the nearest aquatic sites (Home Ranch and Clifford's Tanks) in that unit. Connectivity is further complicated by a ridgeline between Oak Spring and Home Ranch Tank. Hence, this unit is managed as an isolated population. Additionally, both PCEs 1 and 2 are present in this unit. This unit is currently occupied; however, the site does not support enough Chiricahua leopard frogs to be considered a robust population. This unit is an approximate 1.06-mi (1.71- km) intermittent reach of an incised canyon punctuated by pools of varying permanence, from Oak Spring downstream in Oak Creek to where a hiking trail intersects the creek. The largest pool, Cattail Pool, typically contains water and supports several breeding Chiricahua leopard frogs. The stream reach designated for critical habitat includes the area where Chiricahua leopard frogs occur. The primary threat in this unit is extended periods of drought, which have caused all the pools to be subject to reduction or drying. Cattail Pool is spring-fed, and is likely the last pool to dry. Oak Spring is also used for water developments, which may limit the capability of the site to support frogs. Chiricahua leopard frogs have been headstarted and released at this site to augment the population. Dragoon Mountains Unit This unit includes 74 ac (30 ha) of Federal lands in the Coronado National Forest in Cochise County, Arizona. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Shaw Tank and Tunnel Spring in Middlemarch Canyon are designated as critical habitat in this unit and are currently occupied breeding sites. The latter is a robust population that was occupied at the time of listing. Shaw Tank is a reestablishment site that was not known to be occupied in 2002. Also included in the designated critical habitat is Halfmoon Tank, which supported a robust population of Chiricahua leopard frogs until 2002. It is unknown whether this tank supported Chiricahua leopard frogs at the time of listing. PCE 1 at Halfmoon Tank has been compromised by siltation and recent drought, which affects the amount and persistence of water. The tank is in need of renovation so that it may again dependably hold water and support breeding. Special management is required in this unit because currently not enough breeding sites exist to comprise a metapopulation (four are necessary) in this unit. However, with additional habitat creation or renovation, a metapopulation may be possible, which is needed for this Recovery Unit (the only other metapopulation in this Recovery Unit is in Deer Creek). Also included in this critical habitat designation are intervening drainages for connectivity, including Stronghold Canyon from Halfmoon Tank to Cochise Spring, then upstream in an unnamed canyon to Shaw Tank, and continuing upstream to the headwaters of that canyon, across a saddle and downstream in Middlemarch Canyon to Tunnel Spring. Special management is also required in this unit because of scarcity of suitable breeding habitat and loss of that habitat during drought. Tunnel Spring is spring-fed and thus buffered against drought; however, Shaw and Halfmoon Tanks are filled with runoff. Neither nonnative predators nor chytridiomycosis has been noted in these populations and habitats, although if introduced either would constitute an additional threat. Recovery work, including headstarting of eggs collected from Tunnel Spring and establishment of a new population at Shaw Tank with reared tadpoles and frogs, has been accomplished in this unit, and the U.S. Forest Service's livestock permittee has been a participant in those recovery activities.

Recovery Unit 5 (Mogollon Rim-Verde River, Arizona) Buckskin Hills Unit This unit includes 232 ac (94 ha) of Federal lands in the Coconino National Forest in Yavapai County, Arizona. This unit is designated as critical habitat because it was occupied at the time of listing and has the features essential to the conservation of the species (PCEs 1 and 2). Included in this designated critical habitat unit are six tanks occupied at the time of listing (Sycamore Basin, Middle, Walt's, Partnership, Black, and Buckskin) that form a metapopulation. Frogs currently occur at Middle and Walt's Tanks. Also included in the critical habitat designation are two tanks occupied in 2001 that probably dried during a drought in 2002: Doren's Defeat and Needed Tanks. The former holds water well in years with average precipitation and is about 0.5 mi (0.8 km) from Partnership Tank and 0.67 mi (1.07 km) from Walt's Tank. Needed Tank may not hold water long enough for breeding, but it provides a habitat for dispersing frogs. This designated critical habitat also includes drainages and uplands likely used as dispersal corridors among these tanks, including: (1) From Middle Tank downstream in Boulder Canyon to its confluence with an unnamed drainage that comes in from the northwest, to include Black Tank, then upstream in that unnamed drainage to a saddle, to include Needed Tank, downstream from the saddle in an unnamed drainage to its confluence with another unnamed drainage, downstream in that drainage to the confluence with an unnamed drainage, to include Walt's Tank, and upstream in that unnamed drainage to Partnership Tank; (2) from Doren's Defeat Tank upstream in an unnamed drainage to Partnership Tank; (3) from the confluence of an unnamed drainage with Boulder Canyon west to a point where the drainage turns southwest, then directly overland to the top of Sycamore Canyon, and then downstream in Sycamore Canyon to Sycamore Basin Tank; and (4) from Buckskin Tank upstream in an unnamed drainage to the top of that drainage, then directly overland to an unnamed drainage that contains Walt's Tank. Special management is required in this unit because of nonnative species and drought. Divide Tank, which is adjacent to Highway 260, has supported nonnatives in the past and is a likely place for future illegal stockings of nonnative predatory fish or bullfrogs. If established, nonnatives could spread to sites designated in this rule as critical habitat. All of the tanks designated as critical habitat are filled by runoff; hence, they are vulnerable to drying during drought. When the species was proposed for listing, the populations in the Buckskin Hills were unknown; however, during 2000–2001, frogs were found at 11 sites. After a severe drought in 2002, frogs only remained at Sycamore Basin and Walt's Tanks. Because the tanks depend on runoff, and as most tanks went dry in 2002, protecting more than the minimum four breeding sites needed for a metapopulation is warranted. Chytridiomycosis has not been found in any frogs in the Buckskin Hills; however, the disease occurs in Arizona treefrogs (Hyla wrightorum) and western chorus frogs (Pseudacris triseriata) less than 10 mi (16 km) to the east, and frogs collected from Walt's Tank subsequently tested positive for the disease in captivity. It is unknown whether they contracted the disease in the wild or while captive. Much recovery work has been accomplished in this unit, including captive rearing, population reestablishments, tank renovations, erosion control, fencing, and elimination of nonnative predators such as nonnative fish and crayfish. Crouch, Gentry, and Cherry Creeks, and Parallel Canyon Unit This unit includes 334 ac (135 ha) of Federal lands in the Tonto National Forest, 64 ac (26 ha) of AGFD lands, and 6 ac (3 ha) of private lands in Gila County, Arizona. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Included as designated critical habitat are Trail Tank, HY Tank, Carroll Spring, West Prong of

Gentry Creek, Pine Spring, and portions of Cherry and Crouch Creeks, all of which provide breeding or potential breeding habitat. Also included are intervening drainages and uplands needed for connectivity among breeding sites, including: (1) Cherry Creek from Rock Spring upstream to its confluence with an unnamed drainage, upstream in that drainage and across a saddle, then downstream in an unnamed drainage to Trail Tank; (2) Crouch Creek from its headwaters just south of Highway 288 downstream to an unnamed drainage leading to Pine Spring, to include Cunningham Spring and Carroll Spring, then upstream in that unnamed drainage from Crouch Creek to Pine Spring; (3) from HY Tank downstream in an unnamed drainage to Cherry Creek, to include Bottle Spring; (4) from Cunningham Spring east across a low saddle to West Prong of Gentry Creek where the creek turns southwest; and (5) from Bottle Spring south over a low saddle to the headwaters of Crouch Creek. At the time of listing, Chiricahua leopard frogs occurred in Crouch Creek, Carroll Spring, HY Tank, Bottle Spring, and West Prong of Gentry Creek. Trail Tank has nearly permanent water and is in the Parallel Canyon drainage, but close to the divide with Cherry Creek. In May 2010, it was renovated to remove a breeding population of bullfrogs and green sunfish. Additional follow-up removal of bullfrogs occurred in July 2010 and again in May 2011, after bullfrog tadpoles were rediscovered in Trail Tank in the fall of 2010. Bullfrogs at the nearby ephemeral unnamed 102 Roadside Tank were also eliminated in 2010. Special management is required in this unit because of bullfrogs. Once bullfrogs are confirmed absent, plans will move forward to translocate Chiricahua leopard frogs to Trail Tank. Chiricahua leopard frogs were moved to Pine Spring in 2006, and habitat work was accomplished there to improve pool habitats. However, no frogs were observed during a site visit in May 2010. The connectivity of Pine Spring to Cunningham Spring and other sites upstream in Crouch Creek is complicated by a waterfall below Cunningham Spring; however, an overland route of less than a mile provides access around the waterfall. Chiricahua leopard frogs were first noted in Cherry Creek in 2008, just before additional frogs were released into that site. Reproduction has been noted, and Chiricahua leopard frogs were observed in Cherry Creek in 2010. Special management is required in this unit because of predation by nonnative species, including bullfrogs, crayfish, and sportfish; chytridiomycosis, which was found in a Cherry Creek frog in 2009; and scarcity of water. None of the populations are robust due to the small size of breeding habitats. We believe that Trail Tank may provide enough aquatic habitat for a robust population. Ellison and Lewis Creeks Unit This unit includes 83 ac (34) of Federal lands in the Tonto National Forest and 15 ac (6 ha) of private lands in Gila County, Arizona. Occupancy status at the time of listing was unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because it contains important breeding habitat needed for recovery. Chiricahua leopard frogs have occasionally been found in Ellison Creek. In 1998, small numbers of frogs were observed, but were not seen again until 2006. Despite intensive surveys, no frogs were found in 2007 or 2008. In 2009, egg masses from Crouch Creek were headstarted, and tadpoles and subadult frogs were stocked at the four sites listed above as potential breeding sites. Frogs from those releases appeared to be persisting at all four sites in 2010. Additional releases of Crouch Creek frogs occurred in July 2010. Additionally, this unit contains both PCEs 1 and 2. Included in this critical habitat proposal are potential breeding sites at Moore Saddle Tank #2, Ellison Creek just east of Pyle Ranch, Lewis Creek downstream of Pyle Ranch, and Low Tank. Intervening drainages that provide connectivity among the latter three sites are also designated as critical habitat as follows: (1) Unnamed tributary to Ellison Creek from its confluence with an unnamed drainage downstream to Ellison Creek; (2) then directly west across the Ellison Creek floodplain and over a low saddle to Lewis Creek below Pyle Ranch; (3) then downstream in Lewis Creek to its confluence with an unnamed drainage; and (4) then upstream in that unnamed drainage to Low Tank. Moore Saddle Tank #2 is about 0.8 mi (1.3 km) overland from Low Tank. Hence, it is within the one-mile overland distance for reasonable dispersal likelihood. However, there are four drainages that bisect that route, and it is likely that any Chiricahua leopard frogs traversing those uplands would move down or upstream in one of those drainages rather than crossing them. As a result, Moore Saddle Tank #2 will be managed as an isolated and potentially robust population, leaving the other sites one short of the four needed to form a metapopulation. However, no other sites in the area are known that contain the PCEs or have the potential for developing the PCEs. Additional exploration of the area, and likely some habitat renovation, will be needed to secure a fourth site.

Recovery Unit 6 (White Mountains, Upper Gila, Arizona and New Mexico) Concho Bill and Deer Creek Unit This unit includes 17 ac (7 ha) of Federal lands in the Apache-Sitgreaves National Forest in Apache County, Arizona. Occupancy status at the time of listing was unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because it contains important breeding habitat necessary for recovery. This is an isolated population that was established through captive breeding and translocation of stock from Three Forks, which is also in Recovery Unit 6 in Arizona. Frogs were first released at the spring pool in 2000; subsequent releases have augmented the population. Whether or not the frogs persisted after that initial release until the time of listing is unknown. The population is small, and generally only a few frogs if any are detected during surveys. Included in this critical habitat designation is a spring at Concho Bill and a meadow-ephemeral stream reach extending for approximately 2,667 ft (813 m) below the spring. Additionally, PCE 1 is present in this unit. The primary threat is the limited pool habitat for breeding and overwintering, which thus far has limited the size of the population. Small populations are subject to extirpation from random variations in demographics of age structure and sex ratio, and from disease and natural events (Service 2007, p. 38). In addition, crayfish are nearby in the Black River and could invade this site. Campbell Blue and Coleman Creeks Unit The unit includes 174 ac (70 ha) of Federal lands in the Apache-Sitgreaves National Forest in Greenlee County, Arizona. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCE 1 to support life-history functions essential for the conservation of the species. Included as critical habitat is an approximate 2.04-mi (3.28-km) reach of Campbell Blue Creek from the western boundary of Luce Ranch upstream to the Coleman Creek confluence, and Coleman Creek from its confluence with Campbell Blue Creek upstream to its confluence with Canyon Creek, an approximate stream distance of 1.04 mi (1.68 km). This unit is too far from other known Chiricahua leopard frog populations to be considered part of a metapopulation. The nearest population is about 12.2 mi (19.6 km) to the northwest in the Concho Bill and Deer Creek Unit. Frogs were observed in Campbell Blue and Coleman Creeks in 2002, and then again in 2010. No more than a few frogs were seen during surveys (e.g., two were observed in 2010); however, the site is difficult to survey with its complex habitat characteristics, and frogs may easily elude observation. Special management is required in this unit because crayfish and rainbow trout are present throughout this stream system, which likely limit recruitment of frogs. In 2010, the creeks had numerous beaver (Castor canadensis) ponds and vegetation cover that are probably important as protection from predators. Off-channel pools provide better habitat than swiftly moving, shallow creeks. The presence of chytridiomycosis has not been investigated in this unit. Tularosa River Unit This unit contains 335 ac (135 ha) of Federal lands in the Gila National Forest and 1,575 ac (637 ha) of private lands in Catron County, New Mexico. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains both PCEs 1 and 2 to support life-history functions essential for the conservation of the species. This unit is an approximate 19.3-mi (31.1-km) reach of the Tularosa River from Tularosa Spring downstream to the entrance to the canyon below Hell Hole. Frogs were observed in this reach in 2002, at the time of listing, and continue to persist. This unit is isolated from other populations, but is a large system potentially capable of supporting a robust population. Special management is required in this unit because in 2009, small numbers of frogs were found at two sites in the unit. The frogs may occur throughout this reach of the river, but breeding is likely limited to isolated localities where nonnative predators are rare or absent. Crayfish and rainbow trout are present, and bullfrogs have recently been found downstream of the Apache Creek confluence and just below Hell Hole. Both bullfrogs and crayfish are relatively recent arrivals to this system. Chytridiomycosis is also present. The first Chiricahua leopard frogs to test positive for the disease in New Mexico (1985) were found at Tularosa Spring. The frogs were found at that site through 2005, but none have been observed since. A robust population was also present nearby at a pond in a tributary to Kerr Canyon, in Kerr Canyon, and at Kerr Spring, but experienced a die-off from chytridiomycosis in 2009; it is unknown if frogs persist in those areas today. Chytridiomycosis is considered a serious threat in this unit. The designated critical habitat extends just below Hell Hole, but not farther, because Chiricahua leopard frogs have not persisted below Hell Hole since the 1980s, likely because the area lacks the physical or biological features to support life-history functions. Deep Creek Divide Area Unit This unit consists of 408 ac (165 ha) of Federal lands in the Gila National Forest and 102 ac (41 ha) of private lands in Catron County, New Mexico. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains both PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Included as designated critical habitat are three livestock tanks (Long Mesa, Cullum, and Burro Tanks) in the Deep Creek Divide area and connecting reaches of North and South Fork of Negrito Creek above their confluence. Long Mesa Tank is currently occupied; surveys in 2010 did not find frogs at Cullum Tanks or the North Fork of Negrito Creek, although Chiricahua leopard frogs occupied these sites in 2009. Frogs were last found in South Fork of Negrito Creek in 2006, and at Burro Tank in 2002. Four impoundments on private lands along South Fork of Negrito Creek have not been surveyed for frogs; however, it is presumed they serve or once served as habitat for Chiricahua leopard frogs. Long Mesa, Cullum, and Burro Tanks, and the South Fork of Negrito Creek, were occupied at the time of listing. Also included in this designated critical habitat are intervening drainages and uplands for movement among these breeding sites as follows: (1) From Burro Tank downstream in Burro Canyon to Negrito Creek, then upstream in Negrito Creek to the confluence of South Fork and North Fork of Negrito Creek; (2) from Long Mesa Tank overland and east to Shotgun Canyon, then downstream in that canyon to Cullum Tank; and (3) from Cullum Tank downstream in Shotgun and Bull Basin Canyons to an unnamed drainage, then upstream in that drainage to its confluence with a minor drainage coming off Rainy Mesa from the east-northeast, then upstream in that drainage and across Rainy Mesa to Burro Tank. Special management is required in this unit because populations have suffered from chytridiomycosis. A complex of tanks, springs, and streams in the Deep Creek Divide area was once a stronghold for the Chiricahua leopard frog on the Gila National Forest. However, most of those populations contracted the disease, suffered die-offs, and disappeared. Chiricahua leopard frogs on the North Fork of Negrito Creek were few in number and appeared sick in 2008. Their possible absence in 2010 may be a result of a disease-related dieoff. Main Diamond Creek Unit This unit consists of 53 ac (21 ha) of Federal lands in the Gila National Forest and along Main Diamond Creek downstream of Links Ranch, Catron County, New Mexico. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCE 1 to support lifehistory functions essential for the conservation of the species. This site currently supports a robust population. Chiricahua leopard frogs may occur periodically or regularly at an impoundment at Links Ranch, but that impoundment also contains bullfrogs and may have sportfish. This designated critical habitat includes an approximate 3,980-ft (1,213-m), perennial or nearly perennial reach of Main Diamond Creek from the downstream (western) boundary of Links Ranch downstream through a meadow to the confluence of a drainage that comes in from the south, which is also where the creek enters a canyon. This population is about a 4.6-mi (7.4- km), straight-line distance over rugged terrain to the next nearest population at Beaver Creek. As a result, it is managed as an isolated, robust population. Special management is required in this unit because bullfrogs at the impoundment likely prey upon Chiricahua leopard frogs. Also, chytridiomycosis has not been found in this population, but is a potential threat. The creek is primarily privately owned, and the landowner's future plans regarding land management in the area are unknown. Beaver Creek Unit This unit consists of 132 ac (54 ha) of Federal lands in the Gila National Forest and 25 ac (10 ha) of private lands near Wall Lake, Catron County, New Mexico. This unit is an approximate 5.59-mi (8.89-km) portion of Beaver Creek beginning at a warm spring and running VerDate Mar2010 16:12 Mar 19, 2012 Jkt 226001 PO 00000 Frm 00035 Fmt 4701 Sfmt 4700 E:\FR\FM\20MRR2.SGM 20MRR2 tkelley on DSK3SPTVN1PROD with RULES2 16358 Federal Register / Vol. 77, No. 54 / Tuesday, March 20, 2012 / Rules and Regulations downstream to its confluence with Taylor Creek. Below that confluence, the stream is known as the East Fork of the Gila River. Occupancy status at the time of listing was unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because Beaver Creek could support a robust population as it contains important breeding sites necessary for recovery. The nearest known population of Chiricahua leopard frogs is at Main Diamond Creek, approximately a 4.6-mi (7.4-km), straight-line distance away over rugged terrain. As a result, this site is managed as an isolated population. Additionally, PCE 1 is present in this unit. Chiricahua leopard frogs are currently present; however, the population is not well studied. The main threat in this unit is nonnative predators. Rainbow trout, bass (Micropterus sp.), and bullfrogs reportedly occur along Beaver Creek with Chiricahua leopard frogs, although trout are limited to the cooler waters near the confluence with Taylor Creek (Johnson and Smorynski 1998, pp. 44–45). The mechanisms by which Chiricahua leopard frogs coexist with these nonnative predators are unknown. However, habitat complexity and adequate cover are likely important features that may need special management. Also, if chytridiomycosis is present in this unit, the spring at the upstream end of the unit is a warm spring, which may help frogs survive with the disease (Johnson and Smorynski 1998, p. 45; Service 2007, p. 26). Kerr Canyon Unit This unit contains 19 ac (8 ha) of Federal lands in the Gila National Forest land and 6 ac (2 ha) of private land in Catron County, New Mexico. The 1.0-mi (1.6-km) reach extends from Kerr Spring, located on the Gila National Forest, through an intermittent drainage to Kerr Canyon Pond (sometimes referred to as the Kerr Canyon Trick Tank) to include the adjacent private property in Kerr Canyon. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCE 1 to support lifehistory functions essential for the conservation of the species. Our records indicate that this area contained a robust breeding population of Chiricahua leopard frogs from 2002 through 2007 (Service 2008, pp. 1–2). However, during surveys conducted in 2008 and 2009, few individuals were observed (Service 2009a, p. 2). We believe the population experienced a mass mortality event or die-off from chytridiomycosis (Service 2009a, p. 2; Service 2009b, p. 1; Service 2009c, p. 1). Tiger salamanders have also recently been found in Kerr Canyon Pond (Service 2009a, p. 2); however, the abundance of these Chiricahua leopard frog predators is currently unknown. Partial surveys of Kerr Canyon Creek and Pond were conducted in 2010 and 2011, with no Chiricahua leopard frogs observed; however, the area is still considered potentially occupied until more complete surveys can be conducted to determine whether Chiricahua leopard frogs persist in the area. Kerr Canyon will be managed as an isolated population, as it is currently separated from other populations in Tularosa Creek that are at least 6.5 mi (10.4 km) away. As recently as 2007, Kerr Canyon supported a robust breeding population (Service 2007a, p. 2). However, the current population status is greatly reduced from 2007 numbers, or may possibly be extirpated. We suspect that observed declines in Chiricahua leopard frog abundance can be attributed to chytridiomycosis or predation. Because of the disease and competition with nonnative species, we find that the essential features in this area may require special management considerations or protection. West Fork Gila River Unit This unit contains 177 ac (72 ha) of Federal lands in the Gila National Forest in Catron County, New Mexico. This 7.0-mi (11.2-km) reach runs from Turkeyfeather Spring, through an intermittent drainage to the confluence with the West Fork Gila River, then downstream in the West Fork Gila River to confluence with White Creek. Within this unit, the Upper West Fork is divided into two perennial segments by a 1.2-mi (2.0-km) long, ephemeral reach between Turkeyfeather Creek and White Creek. The area within this unit was occupied at the time of listing and currently contains PCE 1 to support lifehistory functions essential for the conservation of the species. The West Fork Gila River unit was occupied at the time of listing, and Chiricahua leopard frogs are currently present. The species has been observed in West Fork Gila River since 1995, with reproduction observed in 2001 (Blue Earth Ecological Consultants 2002, pp. 16–17; Service 2007, pp. B–64; Service 2009, p. 15). The population is not well studied; however, this section of the West Fork Gila River is long enough that it could support a robust population. This unit will be managed as an isolated population because it is likely occupied by low numbers of frogs and the nearest known, robust breeding population occurs in the Main Diamond Creek Unit, which is more than 5 mi (8 km) away along a perennial water course. Special management is required in this unit because there may be some potential for linking these populations if aquatic habitat between the units could be identified, renovated as needed, and populations of frogs established. However, potential sites and the presence or absence of PCE 2 in these connecting areas have not been investigated in any detail. Also, special management is required because chytridiomycosis has been found on

Chiricahua leopard frogs within this unit. The Gila National Forest considers this unit to be free of nonnative predators.

Recovery Unit 7 (Upper Gila-Blue River, Arizona and New Mexico) Left Prong of Dix Creek Unit This unit contains 13 ac (5 ha) of Federal lands in the Apache-Sitgreaves National Forest in Greenlee County, Arizona. Occupancy status at the time of listing was unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because it contains breeding habitat necessary for recovery. Additionally, this unit contains PCE 1. This reach runs from a warm spring above ''The Hole'' and continues to the confluence with the Right Prong of Dix Creek, an approximate stream distance of 4,248 ft (1,296 m). This population was discovered in 2003; Chiricahua leopard frogs were observed again in 2005. In 2010, the warm spring was not surveyed because a large boulder has lodged itself in the canyon, blocking access to the spring. In 2003, Chiricahua leopard frogs were also reported from below a warm spring in the Right Prong of Dix Creek. However, surveys in 2010 only found lowland leopard frogs. Currently, the population in the Left Prong is isolated. The next nearest known Chiricahua leopard frog population is at Rattlesnake Pasture Tank, about a 6.0-mi (9.6-km), straight-line distance over rough terrain. A number of stock tanks have potential to connect these two sites and form a metapopulation; however, they have not been investigated in enough detail to understand whether PCEs are present or have the potential to be developed. No Chiricahua leopard frogs have ever been found in these tanks. This designated critical habitat overlaps that of critical habitat for Gila chub, which provides a level of protection for this unit. A healthy population of Gila chub, as well as other native fish, occurs in the Left Prong of Dix Creek. A natural rock barrier about a mile below the confluence of the Right and Left Prongs serves as a barrier to upstream movement of nonnative fish from the San Francisco River. The warm waters of the spring may allow persistence of Chiricahua leopard frogs if chytridiomycosis is present or if it colonizes this area in the future. A rough dirt road crosses the left prong of Dix Creek in the designated critical habitat unit. The major related threat is likely sediment flowing into the stream. Rattlesnake Pasture Tank and Associated Tanks Unit This unit contains 59 ac (24 ha) of Federal lands in the Apache-Sitgreaves National Forest in Greenlee County, Arizona. Occupancy status at the time of listing was unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because it contains three tanks, along with dispersal corridors, that could help support a metapopulation. Additionally, both PCEs 1 and 2 are present in this unit. Included in the designated critical habitat are three stock tanks: Rattlesnake Pasture, Rattlesnake Gap, and Buckhorn. Also included are intervening drainages and uplands for connectivity, including: (1) From Rattlesnake Pasture Tank downstream in an unnamed drainage to Red Tank Canyon (including Buckhorn Tank), then upstream in Red Tank Canyon to Rattlesnake Gap Tank; and (2) from Rattlesnake Gap Tank upstream in an unnamed drainage to its confluence with a minor drainage, then upslope to a saddle, and across that saddle and directly downslope to Rattlesnake Pasture Tank. Chiricahua leopard frogs were discovered at Rattlesnake Pasture Tank in 2003, and are currently extant. The species has not been found at Rattlesnake Gap or Buckhorn Tanks; however, all three tanks are well connected via drainages to allow movement of frogs from Rattlesnake Pasture Tank to the other tanks. Rattlesnake Gap and Buckhorn Tanks have historically contained water. Other tanks in the area, including Cold Spring Mountain Tank and Rattlesnake Tanks #1 and 2, do not hold water for a long enough period to support a breeding population of frogs, and Chiricahua leopard frogs have not been found at these other tanks. The three tanks designated could help support a metapopulation; however, habitat work that secures water availability will be needed to achieve the fourth breeding site of the metapopulation. The major threat in this unit is nonnative predators, such as tiger salamanders, that occur in all three tanks and likely prey upon Chiricahua leopard frogs. However, a healthy population of Chiricahua leopard frogs occurs with native Arizona tiger salamanders at Rattlesnake Pasture Tank. Three juvenile to small adult bullfrogs, which were likely immigrants from another site, were found at Rattlesnake Gap Tank in June 2010. There is potential for bullfrogs to become established at Rattlesnake Gap Tank. These tanks are filled by rainfall, but Rattlesnake Pasture Tank may be spring-fed as well. Nonetheless, there is some risk that these tanks, particularly Buckhorn Tank, could dry during an extended drought. Coal Creek Unit This unit consists of 7 ac (3 ha) of Federal lands in the Apache-Sitgreaves National Forest in Greenlee County, Arizona. This is an approximate 3,447- ft (1,051-m) reach of Coal Creek from Highway 78 downstream to the confluence with an unnamed drainage. Occupancy status at the time of listing was unknown. We consider this unit to have been unoccupied at the time of listing for the purpose of this critical habitat designation. We have determined this unit to be essential to the conservation of the species because it contains important breeding habitat necessary for recovery. This creek dries to isolated pools, without the effect of snowmelt and summer precipitation, where Chiricahua leopard frogs take refuge. However, during the spring and summer, Coal Creek typically carries water, and the Chiricahua leopard frogs distribute themselves throughout this reach. Additionally, this unit contains PCE 1. This population was discovered in 2003, and is still considered extant. This unit is isolated from other Chiricahua leopard frog populations; the nearest is Rattlesnake Pasture Tank, which is 5.1 mi (8.2 km) to the west over rugged terrain. Neither chytridiomycosis nor nonnative predators is known to be a problem in this unit. However, one major threat in this unit is the potential for wildfires that could result in ash flow, sedimentation, and erosion in Coal Creek, which would degrade or eliminate habitat for Chiricahua leopard frogs. Another primary threat is extended drought, during which the aquatic habitats of the frog could be severely limited or could dry out completely, resulting in extirpation of this isolated population. Blue Creek Unit This unit includes 24 ac (10 ha) of Bureau of Land Management land and 12 ac (5 ha) of private lands in Grant County, New Mexico. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCE 1 to support lifehistory functions essential for the conservation of the species. Included in this unit is an approximate 2.37-mi (3.81-km) reach of Blue Creek from adjacent to a corral on private lands downstream to the confluence of a drainage that comes in from the east. This is an area where Chiricahua leopard frogs currently breed. Additional habitat may occur upstream on private or State lands. However, the private reach immediately above the designated critical habitat lacks breeding pools, and no Chiricahua leopard frogs have been observed (Barnitz 2010, p. 1). The lands upstream of the private land have not been surveyed. The nearest Chiricahua leopard frog population is at Coal Creek more than a 22 mi (35 km), straight-line distance, which is too great a distance to be considered part of a metapopulation. Special management is required because the primary limiting factors in this unit are lack of perennial flow and periodic scouring flash flooding during the summer that likely wash tadpoles downstream. In some years, the entire reach goes dry in

June; however, in other years with normal to above normal precipitation, frogs breed throughout this reach. Nonnative aquatic predators are absent. Although a Chiricahua leopard frog tested positive for chytridiomycosis in 2009, no die-offs have been noted. Also, special management is required because wildfire could result in ash flow, sedimentation, and erosion in Blue Creek, which would degrade or eliminate habitat for Chiricahua leopard frogs.

Recovery Unit 8 (Black-Mimbres-Rio Grande, New Mexico) Seco Creek Unit This unit includes 66 ac (27 ha) of Federal lands in the Gila National Forest in Sierra County, New Mexico. This area was occupied at the time of listing and currently contains both PCEs 1 and 2 to support life-history functions essential for the conservation of the species. The designated critical habitat includes the North Fork of Seco Creek from Sawmill Well downstream to its confluence with Middle Seco Creek, to include Sucker Ledge, but excludes the portion of North Seco Creek on private lands. This amounts to an approximate drainage distance of 3.32 miles (5.34 km). Breeding of Chiricahua leopard frogs has not been observed at Sawmill or Sucker Ledge, but has been observed at Davis Well. At the time of listing, Chiricahua leopard frogs were extant at Sucker Ledge and Davis Well, and the status at Sawmill Well at that time was unknown. The North Fork of Seco Creek, including Sawmill Well, Sucker Ledge, and Davis Well, is currently occupied. PCEs 1 and 2 are present in the unit. This unit contributes to a metapopulation, and Chiricahua leopard frogs move among these sites and sites on the Ladder Ranch using the intervening creeks. This unit with the areas on the Ladder Ranch comprises the most stable metapopulation in New Mexico. Special management is required in this unit because chytridiomycosis has caused extirpations in this region, and in 2001, four tadpoles from Seco Creek appeared to show signs of the disease. In June 2007, a single sample (out of seven samples) from Artesia Well and a single sample (out of nine samples) from LM Bar Well tested positive for chytridiomycosis. Both of these were considered ‘‘weak positive’’ by the laboratory and may have been false positives. Extensive testing since then has failed to produce additional positive tests. Bullfrogs have been found occasionally on adjacent private lands, but the Ladder Ranch has made efforts to remove and control them to the best of their ability. Barred tiger salamanders occur in most waters in the area and likely prey upon Chiricahua leopard frog tadpoles and small adults, but do not appear to threaten the Chiricahua leopard frog population as a whole. Turner Endangered Species Fund, Turner Enterprises, and the Ladder Ranch have over a 10-year record of implementing recovery and conservation measures for the Chiricahua leopard frog on the Ladder Ranch. The 156,439-acre Ladder Ranch is owned by Turner Enterprises and is managed for its biodiversity. The Ladder Ranch has been an active participant in the conservation of a number of rare and listed species, including the Mexican wolf (Canis lupus baileyi), Bolson tortoise (Gopherus flavomarginatus), Chiricahua leopard frog, black-tailed prairie dog (Cynomys ludovicianus), American bison (Bison bison), and Rio Grande cutthroat trout (Oncorhynchus clarki virginalis). Recovery actions for the Chiricahua leopard frog have included fencing some of the waters from the bison, monitoring and researching Chiricahua leopard frog populations and habitat, maintaining perennial water for frogs, improving habitat for Chiricahua leopard frogs, removing and controlling bullfrogs, using steel rim tanks for refugia populations, and most recently constructing a captive breeding facility to rear Chiricahua leopard frogs for population augmentation and reestablishment to contribute to the range-wide recovery of the Chiricahua leopard frog. The Service has provided funding for the captive-breeding program under the Partners for Fish and Wildlife Program and other granting authorities. The Ladder Ranch maintains captive-propagation facilities for the Chiricahua leopard frog under a section 10(a)(1)(A) enhancement of survival permit from the Service. Under section 4(b)(2) of the Act, private lands on the Ladder Ranch in this unit (310 ac (247 ha)) are excluded from critical habitat designation (see Application of Section 4(b)(2) of the Act, below). Alamosa Warm Springs Unit This unit consists of 54 ac (22 ha) of private, 25 ac (10 ha) of New Mexico State, and 0.2 ac (0.1 ha) of Bureau of Land Management lands at the headwaters of Alamosa Creek, Socorro County, New Mexico. This unit is designated as critical habitat because it was occupied at the time of listing and currently contains PCE 1 to support lifehistory functions essential for the conservation of the species. Designated critical habitat includes an approximate 4,974-ft (1,516-m) spring run from the confluence of Wildhorse Canyon and Alamosa Creek downstream to the confluence with a drainage that comes in from the north, which is below the gauging station in Monticello Box. This reach includes areas where frogs have been found as recent as 2006 (Christman 2006b, p. 11). At its source, waters at Alamosa Warm Springs range from 77 to 85 °F (25.0 to 29.3 °C) (Christman 2006b, p. 3). Chytridiomycosis is present in this population, but the Chiricahua leopard frogs persist, presumably aided by the warm waters. This is a robust breeding population, but it is too far removed from other Chiricahua leopard frogs to be part of a metapopulation. The nearest population is Unit 38, 20.3 mi (32.5 km) to the south-southeast. As a result, this site is managed as an isolated, robust population. Alamosa Warm Springs is at the northeastern edge of the distribution of the Chiricahua leopard frog. This site is drought-resistant because of perennial spring flow. Nonnative aquatic predators are unknown at this site, but if introduced, they could pose a serious threat to the population. Special management is required in this unit because heavy livestock grazing on the site and in the watershed, and a dirt road through the canyon, have degraded the habitat for Chiricahua leopard frogs, and flooding likely flushes tadpoles out of the unit periodically (Christman 2006b, pp. 5–6). The endangered Alamosa springsnail (Tryonia alamosae) occurs at Alamosa Warm Springs; its presence may provide some additional level of protection to Chiricahua leopard frog. The future land management plans of the landowners are unknown. Cuchillo Negro Warm Springs and Creek Unit This unit consists of 3 ac (1 ha) of Bureau of Land Management and 3 ac (1 ha) of New Mexico State lands in Sierra County, New Mexico. This unit was occupied at the time of listing and currently contains both PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Two springs on Bureau of Land Management land are the source of stream that runs for about 6.0 mi (9.6 km) down Cuchillo Negro Creek; however, Chiricahua leopard frogs are rarely found more than 1.2 mi (2.0 km) downstream of the warm springs (Christman 2006a, p. 8). Critical habitat begins at the upper of the two springs and follows Cuchillo Negro Creek downstream to the confluence with an unnamed drainage that comes in from the snorth, excluding the portion of Cuchillo Negro Creek on privately owned lands, for an approximate stream distance of 2,518 feet (768 meters). Special management is required in this unit because chytridiomycosis is present in this population, and it is likely that Chiricahua leopard frogs persist where the water is warm, but succumb to the disease in the cooler waters downstream. Chiricahua leopard frogs currently persist in very low numbers in this unit. PCE 1 is present in this unit; however, this site is too far from other Chiricahua leopard frog populations to be considered part of a metapopulation. The nearest population is Seco Creek, about 12.7 mi (20.3 km) to the southsouthwest. Hence, this population is managed as an isolated population. Chiricahua leopard frogs coexist with plains leopard frogs at this site, and it is likely the plains leopard frogs occasionally prey upon Chiricahua leopard frog tadpoles and small frogs. Plains leopard frogs, however, probably do not threaten the Chiricahua leopard frog. Bullfrogs have been recorded in Cuchillo Negro Creek, but only rarely, and do not appear to breed or persist in the reach with the leopard frogs (Christman 2006a, p. 9). Special management is required in this unit because the primary threats in this unit are cleaning out of the channel by the Cuchillo Acequia Association, periodic flooding that flushes tadpoles downstream and results in silts in pools, and chytridiomycosis. The springs located on Bureau of Land Management land are the source of downstream irrigation water, and the Cuchillo Acequia Association has maintained two trenches through the springs reportedly to improve flow, although that flow resulted in extensive damage to the springs, stream, and riparian vegetation (67 FR 40802; June 13, 2002). The private landowner downstream is the Ladder Ranch, and as described above, the ranch is an active participant in Chiricahua leopard frog recovery. Under section 4(b)(2) of the Act, the private lands in this unit (23 ac (9 ha)) are excluded from critical habitat designation (see Application of Section 4(b)(2) of the Act, below). Ash and Bolton Springs Unit This unit consists of 49 ac (20 ha) of private lands east of Hurley in Grant County, New Mexico. This unit was occupied at the time of listing and currently contains both PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Included in this unit are Ash and Bolton Springs, and ephemeral or intermittent drainages and uplands needed for movement of frogs among these two breeding sites as follows: (1) From the spring box at Ash Spring downstream in a drainage to a dirt road crossing; and (2) west and overland from the ruins of an old house below Ash Spring to a low saddle, then downslope into an unnamed drainage, and downstream in that drainage to its confluence with another unnamed drainage, downstream in that unnamed drainage its confluence with another unnamed drainage, then upstream in that unnamed drainage to the top of that drainage and directly downslope and west to another unnamed drainage, downstream in that unnamed drainage to its confluence with Bolton Canyon, and upstream in Bolton Canyon to the locally known Bolton Springs. Populations of Chiricahua leopard frogs at Ash and Bolton Springs were present at the time of listing and currently persist. These sites were once part of a metapopulation, but all other sites have been extirpated. There may be potential in the future to rebuild a metapopulation through natural recolonization or population reestablishments, if threats can be managed. The lands are owned by FreeportMcMoRan Copper and Gold Subsidiaries as part of the Chino Copper Mine, which is based in nearby Santa Rita and Hurley. In December 2008, Freeport-McMoRan announced plans to suspend mining and milling activities at Chino. The majority of the work force was laid off in 2009. To our knowledge, no current plans exist to expand the mine into the area designated for critical habitat, and Freeport-McMoRan and its predecessor, Phelps-Dodge, have been cooperative in conservation of the Chiricahua leopard frog. Special management is required in this unit because chytridiomycosis is a threat. Large numbers of dead frogs were found at Ash Spring in 2007. However, the frogs at Bolton Springs have shown no signs of disease. Both populations exist in small aquatic sites that cannot sustain large populations; hence, they are also vulnerable to variations in environmental conditions and population demographics. Mimbres River Unit This unit consists of 1,097 ac (444 ha) of private lands in Grant County, New Mexico. The unit was occupied at the time of listing and currently contains PCE 1 to support life-history functions essential for the conservation of the species. The unit is divided into two disjunct reaches of the Mimbres River that are separated by a 6.6-mi (10.6-km), intermittent reach. However, the two reaches may be too far apart to reasonably expect frogs to move between the two sites, and the next nearest Chiricahua leopard frog population is in the Ash and Bolton Springs Unit, more than 10 mi (16 km) away from the lower Mimbres River reach across rugged terrain. Critical habitat in the upper Mimbres River includes an approximate 2.42-mi (3.89-km) reach that begins where the river flows into The Nature Conservancy's property and continues downstream to the confluence with Bear Canyon. The approximate 5.82-mi (9.36- km) lower critical habitat reach begins at the bridge over the Mimbres River just west of San Lorenzo and continues downstream to where it exits the The Nature Conservancy's Disert parcel near Faywood. The two critical habitat reaches are largely perennial, although portions of the river dry out during drought. Chiricahua leopard frogs are currently present in both reaches of the Mimbres River. The best breeding site in the upper reach is Moreno Spring, which harbors a relatively stable population of Chiricahua leopard frogs. In the upper reach, Chiricahua leopard frogs have been observed to breed in the river and at off-channel pools on nearby private property. Breeding occurs in the lower river reach as well, where an additional robust population is present near San Juan. Special management is required in this unit because chytridiomycosis is present in this unit. However, frogs are persisting with the disease. Moreno Spring is a warm spring that likely provides some buffer against the effects of the chytridiomycosis. Special management is also required in this unit because agricultural and rural development, water diversions, groundwater pumping, and leveeing and bankline work to protect properties from flooding are threats. Periodic flooding probably washes some tadpoles out of the system and results in silts in pools used for breeding. No bullfrogs or crayfish have been found in this unit; if introduced, they could pose a significant threat. The threatened Chihuahua chub (Gila nigrescens) occurs in the upper reach, and rainbow trout, a nonnative species, occur throughout the areas where there is water. Both trout and chub likely prey upon Chiricahua leopard frog tadpoles. Bear Canyon Reservoir in Bear Canyon near the town of Mimbres reportedly supports populations of channel catfish (Ictalurus punctatus), black crappie (Pomoxis nigromaculatus), largemouth bass, and bluegill (Lepomis macrochirus), and rainbow trout (Johnson and Smorynski 1998, p. 132). These species may escape from the reservoir periodically into the Mimbres River. Presence of the Chihuahua chub may provide some level of protection to the upper reach. In addition, The Nature Conservancy owns the majority of the river in the upper reach (510 ac (206 ha)) (not including Moreno Spring or Milagros Ranch (formerly known as Emory Oak Ranch)) and significant parcels in the lower reach. These lands, known as The Mimbres River Preseve, are managed for the benefit of the Chihuahua chub, Chiricahua leopard frog, and other riparian and aquatic resources, although no formal conservation plan has been developed for this area or its resources. Therefore, under section 4(b)(2) of the Act, private lands owned by The Nature Conservancy in this unit (510 ac (206 ha)) are not excluded from critical habitat designation (see Application of Section 4(b)(2) of the Act, below). South Fork Palomas Creek Unit This unit consists of 23 ac (9 ha) of Federal lands in the Gila National Forest land in Sierra County, New Mexico. This 4.5-mi (7.3-km) reach of South Fork Palomas Creek runs downstream from Wagonbed Canyon to the boundary with the Ladder Ranch. This unit was occupied at the time of listing, is currently occupied, and contains both PCEs 1 and 2 to support life-history functions essential for the conservation of the species. Special management is required in this unit to control bullfrogs. Under section 4(b)(2) of the Act, 106 ac (43 ha) of private lands in this unit, which are part of the Ladder Ranch, are excluded from critical habitat designation (see Application of Section 4(b)(2) of the Act, below). Management for the Chiricahua leopard frog on the Ladder Ranch included fencing the ranch's waters from bison that graze the area, reestablishing of populations using wild-to-wild translocations, maintaining of wells and tanks, and controlling bullfrogs. The Ladder Ranch also monitors the Chiricahua leopard frogs and habitats, and has recently initiated a captive-breeding facility and program to rear frogs for population augmentation and reestablishment.

Primary Constituent Elements/Physical or Biological Features

Critical habitat units are designated for Apache, Cochise, Gila, Graham, Greenlee, Pima, Santa Cruz, and Yavapai Counties, Arizona; and Catron, Grant, Hidalgo, Sierra, and Socorro Counties, New Mexico. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of the Chiricahua leopard frog are:

(i) Aquatic breeding habitat and immediately adjacent uplands exhibiting the following characteristics: (A) Standing bodies of fresh water (with salinities less than 5 parts per thousand, pH greater than or equal to 5.6, and pollutants absent or minimally present), including natural and manmade (e.g., stock) ponds, slowmoving streams or pools within streams, off-channel pools, and other ephemeral or permanent water bodies that typically hold water or rarely dry for more than a month. During periods of drought, or less than average rainfall, these breeding sites may not hold water long enough for individuals to complete metamorphosis, but they would still be considered essential breeding habitat in non-drought years. (B) Emergent and or submerged vegetation, root masses, undercut banks, fractured rock substrates, or some combination thereof, but emergent vegetation does not completely cover the surface of water bodies. (C) Nonnative predators (e.g., crayfish (Orconectes virilis), bullfrogs (Lithobates catesbeianus), nonnative predatory fish) absent or occurring at levels that do not preclude presence of the Chiricahua leopard frog. (D) Absence of chytridiomycosis, or if present, then environmental, physiological, and genetic conditions are such that allow persistence of Chiricahua leopard frogs. (E) Upland habitats that provide opportunities for foraging and basking that are immediately adjacent to or surrounding breeding aquatic and riparian habitat.

(ii) Dispersal and nonbreeding habitat, consisting of areas with ephemeral (present for only a short time), intermittent, or perennial water that are generally not suitable for breeding, and associated upland or riparian habitat that provides corridors (overland movement or along wetted drainages) for frogs among breeding sites in a metapopulation with the following characteristics: (A) Are not more than 1.0 mile (1.6 kilometers) overland, 3.0 miles (4.8 kilometers) along ephemeral or intermittent drainages, 5.0 miles (8.0 kilometers) along perennial drainages, or some combination thereof not to exceed 5.0 miles (8.0 kilometers). (B) In overland and nonwetted corridors, provide some vegetation cover or structural features (e.g., boulders, rocks, organic debris such as downed trees or logs, small mammal burrows, or leaf litter) for shelter, forage, and protection from predators; in wetted corridors, provide some ephemeral, intermittent, or perennial aquatic habitat. (C) Are free of barriers that block movement by Chiricahua leopard frogs, including, but not limited to, urban, industrial, or agricultural development; reservoirs that are 50 acres (20 hectares) or more in size and contain predatory nonnative fish, bullfrogs, or crayfish; highways that do not include frog fencing and culverts; and walls, major dams, or other structures that physically block movement.

Special Management Considerations or Protections

With the exception of impoundments, livestock tanks and other constructed waters, critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

All areas designated as critical habitat will require some level of management to address the current and future threats to the Chiricahua leopard frog and to maintain or restore the PCEs. Special management in aquatic breeding sites will be needed to ensure that these sites provide water quantity, quality, and permanence or near permanence; cover; and absence of extraordinary predation and disease that can affect population persistence. In dispersal habitat, special management will be needed to ensure frogs can move through those sites with reasonable success. The designation of critical habitat does not imply that lands outside of critical habitat do not play an important role in the conservation of the Chiricahua leopard frog. Federal activities that may affect areas outside of critical habitat are still subject to review under section 7 of the Act if they may affect the Chiricahua leopard frog because effects to the species and its critical habitat must be considered independently. The prohibitions of section 9 of the Act also continue to apply both inside and outside of designated critical habitat.

Life History

Food/Nutrient Resources

Food Source

Adult: Invertebrates, fish, snails

Food/Nutrient Narrative

Juvenile: Leopard frog tadpoles are primarily herbivorous and their diet can include a range of species, such as bacteria, diatoms, phytoplankton, periphyton, filamentous green algae, water milfoil, duckweed, and detritus (USFWS 2007 p. 11, SESAT 2008 p. I-5, USFWS 2011 p. 11).

Adult: Chiricahua leopard frogs are opportunistic invertivores, feeding on invertebrates, snails, and (sometimes) fish. While the frog eats fish and snails, its primary diet mainly consits of invertebrates, such as beetles, flies, and true bugs (SESAT 2008 p. I-7, USFWS 2011 p. 11). Adult leopard frogs forage within submerged vegetation, open banklines out to the edge of riparian vegetation, and uplands adjacent to water (USFWS 2011 p. 20).

Reproductive Strategy

Adult: R-selected

Lifespan

Egg: Eggs hatch in 8-14 days

Adult: As much as 10 years

Breeding Season

Egg: Eggs are laid mainly from February into October

Adult: March through August

Key Resources Needed for Breeding

Adult: Water temperatures = 14° C (which typically occurs between March - August) (SESAT 2008 p. I-4); appropriate aquatic habitat (see Habitat).

Reproduction Narrative

Egg: Eggs are laid mainly from February into October, with most masses found in the warmer months. Eggs hatch in 8-14 days, depending on water temperature. (USFWS 2007). (NatureServe 2015)

Juvenile: Larvae metamorphose in the year they were oviposited or may overwinter as tadpoles (Platz and Grudzien 1993, Platz et al. 1997). Larvae metamorphose in as few as 100 days in captivity, but frequently take 160 to 200 days (M. Demlong, unpublished data).

Adult: Chiricahua leopard frogs breed in water temperatures = 14° C (which typically occurs between March - August) (SESAT 2008 p. I-4). It appears that water temperature is more important in breeding than season because the species has been reported to breed in the winter where warmer water springs maintain higher water temperatures (SESAT 2008 p. I-4). Males vocalize from at least mid -March through mid-July (Platz 1993). Egg masses have been recorded from mid-March through early October (AGFD, unpublished data).

Habitat Type

Egg: Aquatic vegetation

Adult: Upland; Riparian

Habitat Vegetation or Surface Water Classification

Juvenile: Semi-desert; Aquatic vegetation

Adult: Semi-desert; Aquatic vegetation

Dependencies on Specific Environmental Elements

Egg: Submerged vegetation for shelter; permanent or semi-permanent water 12-31.5°C

Juvenile: Aquatic vegetation; course woody debris for sheltering and feeding.

Adult: Water temperature = 14° C; submerged, emergent vegetation

Geographic or Habitat Restraints or Barriers

Adult: Busy major highway, especially at night, such that frogs rarely if ever cross successfully; urban development dominated by buildings and pavement; habitat in which site-specific data indicate the frogs virtually never occur (unsuitable). Unsuitable habitat refers to upland habitat devoid or nearly devoid of wetlands, streams, ponds, or lakes. Bodies of water dominated by predatory fishes may be barriers to some species but suitable habitat for others; in most cases, such waters probably should be regarded as unsuitable habitat.

Environmental Specificity

Adult: High

Tolerance Ranges/Thresholds

Egg: Water temperature range between 12-31.5°C for normal development.

Site Fidelity

Adult: High

Habitat Narrative

Egg: Spherical egg masses are attached by the female frog to submerged vegetation (USFWS 2011 p. 11), typically 5 cm from the surface where water temperature and oxygen content is highest (SESAT 2008 p. I-4, USFWS 2007 p. 18). Attachment to submerged vegetation prevents the eggs from being wahed downstream and ensures that they remain in in place to take advantage of warmer temperatures and DO levels. Eggs cannot survive desication and must remain submerged throughout development (SESAT 2008 p. I-4). Vegetation associated with egg masses includes Potamogeton spp., Rorippa sp., Echinochloa sp., and Leersia sp. (USFWS 2007 p. 18). Eggs are laid primarily from February and into October (USFWS 2007 p. 10). Eggs are strictly aquatic and must remain in aquatic habitats throughout development (SESAT 2008 p. I-4). Eggs are laid as spherical masses that are attached to submerged aquatic vegetation (typically within 5 cm of the waters surface (SESAT 2008 p. I-4) where water temperature and DO levels are highest. Eggs are typically laid in water temperatures = 14°C, commonly between March - August in Arizona and New Mexico (SESAT 2008 p. I-4). Eggs take between 8-14 days to hatch, depending on water temperature (USFWS 2007 p. 10, USFWS 2011 p. 11). In lab experiments under constant temperature, this species requires the water temperature to range between 12-31.5°C for normal development (Zweifel 1968 p. 24-25).

Juvenile: Tadpoles are strictly aquatic, requiring water to breathe, feed, and avoid desication (SESAT 2008 p. I-5, USFWS 2007 p. 9). Aquatic habitats must be permanent enough to support tadpole development to metamorphosis 3-9 months after hatching (USFWS 2011 p. 19). Shallow water with abundant vegetation aids the species in avoiding predation (SESAT 2008 p. I-5). Tadpoles may passively disperse downstream with water flow. Aquatic vegetation or coarse woody debris provides tadpoles with refuge from predators (SESAT 2008) as well as habitat for food items.

Adult: Upland vegetation adjacent to water provides leopard frogs with necessary forage, protection from terrestrial predators, thermoregulation basking sites, and dispersal corridors for adult leopard frogs (USFWS 2011 p. 20). Uplands are primarily used during the summer rainy season (USFWS 2011 p. 20) and provide the species a forage base of terrestrial invertebrates, as well as providing cover and concealment from predators. The species also uses these vegetated areas to bask, aiding in thermoregulation. Adult and juvenile Chiricahua leopard frogs need aquatic breeding and overwintering sites, as well as corridors for dispersal (see Disperal Narrative for description of dispersal habitat), in the context of metapopulations and as isolated populations. Aquatic breeding habitat consists of permanent or nearly permanent aquatic habitats from about 3200-8,900 ft (975-2,715 m) elevation with deep (greater than 20 in (0.5 m)) pools in which nonnative predators are absent or occur at such low densities and in complex habitats to allow persistence of Chiricahua leopard frogs (USFWS 2007). Included are cienegas or springs, pools, livestock tanks, lakes, reservoirs, streams, and rivers. Chiricahua leopard frogs burrow into mud at the bottom of water resources as hibernacula to survive over-wintering (SESAT 2008 p. I-2). Sites as small as 6.0 ft (1.8 m) diameter steel troughs can serve as important breeding sites, particularly if that population is part of a metapopulation that can be recolonized from adjacent sites if extirpation occurs. Some of the most robust extant breeding populations are in dirt livestock tanks.

Dispersal/Migration

Motility/Mobility

Egg: None

Juvenile: Low

Adult: Low

Dispersal

Juvenile: No data available

Adult: Chiracahua leoopard frogs have limited dispersal and colonization abilities; this species can disperse to avoid competition, predation, and unfavorable environmental conditions (USFWS 2011 p. 12). The maximum distance moved by this species by a radio-telemetered frog is 3.5 km (USFWS 2011 p. 12). Frogs were documented to move on average 7.43 km with a range of dispersal rangers of 1.77-15.13 km (USFWS, 2023)

Dispersal/Migration Narrative

Adult: Dispersal habitat provides routes for connectivity and gene flow among local populations within a metapopulation, which enhances the likelihood of metapopulation persistence and allows for recolonization of sites that are lost due to drought, disease, or other factors (Hanski and Gilpin 1991, USFWS 2007). The most likely dispersal routes may include combinations of ephemeral, intermittent, and perennial drainages, as well as uplands. Some vegetation cover for protection from predators, and aquatic sites that can serve as buffers against desiccation (drying) and stop overs for foraging (feeding), are desirable along dispersal routes. A lack of barriers that would block dispersal is critical. Features on the landscape likely to serve as partial or complete barriers to dispersal include cliff faces and urban areas (USFWS 2007), reservoirs 20 acres (ac) (50 hectares (ha)) or more in size that are stocked with sportfishes or other nonnative predators, highways, major dams, walls, or other structures that physically block movement (Todd and Andrews 2008, Eigenbrod et al. 2009, 75 FR 12818). The effects of highways on frog dispersal can be mitigated with frog fencing and culverts (USFWS 2007). Unlike some other species of leopard frogs, Chiricahualeopard frogs have only rarely been found in association with agricultural fields; hence, agriculture may also serve as a barrier to movement. Detailed studies ofdispersal and metapopulation dynamics of Chiricahua leopard frogs have not been conducted; however, Jennings and Scott (1991) noted that maintenance of corridors used by dispersing juveniles and adults that connect separate populations may be critical to conserving populations of frogs. The maximum distance moved by this species by a radio-telemetered frog is 3.5 km (USFWS 2011 p. 12). In a 2014-2015 telemetry study investigating the summer (June-September) and wintertime (October-February) movements and habitat use of 46 Chiricahua leopard frogs in Gardner Canyon, Greaterville Tank, Apache Springs, and Milo Tank, Arizona, researchers found that frogs remained active, despite near freezing temperatures, with one frog at the Gardner Canyon study site moving 135 meters (m) in one week, and a total of 240 m over ten weeks (AZGFD 2015). The lack of wintertime shelter use at Gardner Canyon and Greaterville Tank suggest that Chiricahua leopard frogs do not utilize hibernacula, rather they seek temporary shelter between periods of activity. During the summer, only three tagged frogs dispersed, all from Apache Springs, with none traveling further than 1.2 kilometers (km). All three frogs made their longest movements in the week following the first and heaviest precipitation of the season (AGFD 2015). A 2014-2019 mark and recapture study of Chiricahua leopard frogs at Las Ciénegas National Conservation Area (LCNCA) in Sonoita, Arizona found that Chiricahua leopard frogs moved long distances and colonized sites that had become extirpated due to both physical and disease related factors. Frogs were documented to move on average 7.43 km with a range of dispersal rangers of 1.77-15.13 km (USFWS, 2023).

Population Information and Trends

Population Trends:

Unknown

Species Trends:

Unknown

Population Growth Rate:

Unknown

Number of Populations:

Unknown

Population Size:

Unknown

Minimum Viable Population Size:
Unknown

Resistance to Disease:
Low

Adaptability:
Moderate

Population Narrative:
The effects of genetic and stochastic events manifest in small populations, which can be related to genetic and demographic limitations, as well as environmental events and random catastrophies. Small populations are vulnerable to extirpation due to random variations in age structure and sex ratios, as well as from disease or other natural events that a larger population is more likely to survive. Inbreeding depression and loss of genetic diversity in small populations can also reduce the fitness of individuals and the ability of a population to adapt to change. Currently there is no evidence that the Chiricahua leopard frog is declining across its range. Although full recovery is still distant in most recovery units, significant progress has been made to secure existing populations and establish new populations.

Threats and Stressors

Stressor: Predation by introduced aquatic species
Exposure: See narrative
Response: See narrative
Consequence: See narrative
Narrative: Introduced American bullfrogs, crayfish, salamanders, and fish species are known to be highly predaceous and are believed to negatively impact the Chiricahualeopard frog. Witte et al. (2008) found that sites with disappearances of Chiricahua leopard frogs were 2.6 times more likely to have introduced crayfish than were control sites. Unfortunately, few sites with bullfrogs were included in the Witte et al. (2008) and at many sites, there was no identification of the species of fish present. Prior to the invasion of perennial waters by predatory, non-native species (American bullfrog, crayfish, fish species), the frog was historically found in a variety of aquatic habitat types. Today, leopard frogs in the Southwest, are so strongly impacted by harmful non-native species, which are most prevalent in perennial waters, that their occupied niche is increasingly restricted to the uncommon environments that do not contain these non-native predators, and these now tend to be ephemeral and unpredictable. This increasingly narrow realized niche is a primary reason for the threatened status of the Chiricahua leopard frog.

Stressor: Inadequacy of existing regulatory mechanisms
Exposure: See narrative
Response: See narrative

Consequence: See narrative
Narrative: Non-native species used for fishing baits in Chiricahua leopard frog habitats present a vehicle for the distribution of these often predatory or competitive baitspecies into frog habitat and for the dissemination of deadly diseases to the frog, posing a significant threat. Picco and Collins (2008) found waterdogs (tigersalamanders; Ambystoma tigrinum) infected with Bd in Arizona bait shops, and waterdogs infected with ranavirus in Arizona, New Mexico, and Colorado bait shops. Furthermore, they found that 26–67 percent of anglers released tiger salamanders bought as bait into the waters where they fish, and 4 percent of baitshops released tiger salamanders back into the wild after they were housed in shops with infected animals, despite the fact that release of live salamanders is prohibited by Arizona Game and Fish Commission Orders. This study clearly showed the inadequacy of current State regulations in regard to preventing the spread of amphibian diseases via the waterdog bait trade. Additional regulation and/or increased enforcement of existing regulations are needed to stop the spread of amphibian diseases via use of waterdogs for bait.

Stressor: Genetic and stochastic effects on small populations
Exposure: See narrative
Response: See narrative
Consequence: See narrative
Narrative: Among the potential threats are genetic and stochastic effects. These effects manifest in small populations, which can be related to genetic and demographic limitations, as well as environmental events and random catastrophies. Specifically, small populations are vulnerable to extirpation due to random variations in age structure and sex ratios, as well as from disease or other natural events that a larger population is more likely to survive. Inbreeding depression and loss of genetic diversity in small populations can also reduce the fitness of individuals and the ability of a population to adapt to change. The recent genetic study (Herrmann et al. 2009) revealed no systemic lack of genetic diversity within the Chiricahua leopard frog. In fact, populations were quite variable (up to 16 different genetic groupings were found). This does not preclude the possibility that individual populations may suffer from genetic or demographic problems, particularly if only a few individuals are available as mates or potential mates cannot be accessed due to their sparse distributions.

Stressor: Global climate change resulting in increased temperatures and drying
Exposure: See narrative
Response: See narrative
Consequence: See narrative
Narrative: In the American Southwest, increasing temperatures and a drying trend, at least in the winter months, are anticipated symptoms of climate change driven by unprecedented levels of greenhouse gases. Precisely how the Chiricahua leopard frog and its habitat will be affected is unclear, in part because of interrelated and indirect effects revolving around the response of nonnative predators and disease to climate change, the frog's two most significant threats at this time. In particular, persistence of Chiricahua leopard frogs infected with the fungal skin disease, chytridiomycosis, is enhanced in warmer waters, but introduced predators are often carriers of chytridiomycosis, and drought driven by climate change could limit their numbers or ability to

move about on the landscape. Furthermore, some Chiricahua leopard frog sites are buffered from the effects of drought by wells or other anthropogenic water supplies.

Stressor: Disease (chytridiomycosis)
Exposure: See narrative
Response: See narrative
Consequence: See narrative
Narrative: In some areas, Chiricahua leopard frog populations are known to be seriously affected by chytridiomycosis. Chytridiomycosis is an introduced fungal skin disease caused by the organism Batrachochytrium dendrobatidis or “Bd”. Voyles et al. (2009) hypothesized that Bd disrupts normal regulatory functioning of frog skin, and evidence suggests that electrolyte depletion and osmotic imbalance that occurs in amphibians with severe chytridiomycosis are sufficient to cause mortality. This disease has been associated with numerous population extirpations, particularly in recovery unit 6 in New Mexico, and with major die-offs in other populations of Chiricahua leopard frogs (USFWS 2007).

Recovery

Reclassification Criteria:
Recovery Priority Number: 2C

Delisting Criteria:
The Chiricahua leopard frog will be considered for delisting when the following quantitative criteria are met in each RU:

1. At least two metapopulations located in different drainages (defined here as USGS 10-digit Hydrologic Units) plus at least one isolated and robust population in each RU exhibit longterm persistence and stability (even though local populations may go extinct in metapopulations) as demonstrated by a scientifically acceptable population monitoring program (see Appendix K for definitions of metapopulation, robust population, long-term persistence, and stability). Interpretation of monitoring results will take into account precipitation cycles of drought or wet periods and the effects of such cycles on population persistence.

2. Aquatic breeding habitats, including suitable, restored, and created habitats necessary for persistence of metapopulations and isolated populations identified in criterion 1, are protected and managed in accordance with the recommendations in the Recovery Plan (USFWS 2007).

3. The additional habitat needed for population connectivity, recolonization, and dispersal is protected and managed for Chiricahua leopard frogs, in accordance with the recommendations in the Recovery Plan (USFWS 2007).

4. Threats and causes of decline have been reduced or eliminated, and commitments of longterm management are in place in each RU such that the Chiricahua leopard frog is unlikely to need protection under the ESA in the foreseeable future.

Recovery Actions:

- Protect remaining populations of Chiricahua leopard frogs.
- Identify, protect, restore, or create as needed, currently unoccupied recovery sites in each RU necessary to support viable populations and metapopulations of Chiricahua leopard frogs.
- Establish new or re-establish former populations at selected recovery sites.
- Augment populations in MAs as needed to increase persistence.
- Monitor Chiricahua leopard frog populations and their habitats; monitor implementation of the Recovery Plan (USFWS 2007).
- Implement research needed to support recovery actions and adaptive management.
- Develop and implement public outreach and broad-based community planning to promote public support, participation in, and understanding of recovery actions.
- Develop cooperative conservation projects, such as Safe Harbor Agreements and Habitat Conservation Plans, with willing landowners to implement recovery on non-federal land.
- Develop and amend land use plans, habitat management plans, and other plans as needed to implement recovery actions.
- Work with Tribal partners to promote recovery on Tribal lands.
- Work with Mexican partners to promote recovery in Mexico.
- Practice adaptive management in which recovery tasks are revised by the U.S. Fish and Wildlife Service in coordination with the Recovery Team Subgroups as pertinent new information becomes available.
- Protect remaining populations of Chiricahua leopard frogs (fence, remove/control predators, remove/control non-native species, etc.).
- Identify, protect, restore, or create as needed, currently unoccupied recovery sites in each RU necessary to support viable populations and metapopulations of Chiricahua leopard frogs (fence, remove/control predators, remove/control non-native species, etc.).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS All of the recommendations for future actions given in Section 4.0 of the 2011 5-year status review remain valid recommendations moving forward and should be considered ongoing recommendations of this 5-year status review. However, we include a few addition specific recommendation that surfaced as a result of our current analysis and review. 1. The current approach and thinking based on the existing recovery plan model related to the metapopulation theory and establishing isolated robust metapopulations may be flawed. If possible given workloads, we recommend revising the recovery plan sections related to this model. 2. There are some issues and difficulties with the existing recovery criteria because leopard frogs have boom and bust nature of populations and knowing what is going on at a site with regard to population viability is very difficult (identifying what is natural versus what is from threats). In general, we make a lot of assumptions where frogs are dispersing. If possible given workloads, we recommend completing a Species Status Assessment and updating the recovery plan, including revising recovery criteria to better address what is long-term stability of a site and how do we account for the cyclical nature of occupancy at sites in determining recovery. 3. We know that Bd, frogs, habitat all interact, but we do not know exactly how. We presume having areas of shallow water for basking is important during cold months so they can warm up and clear infections. We think sites need deeper water for cover from predators and shallow breeding areas and that flowing water from groundwater sources or wells, or flowing springs are good for addressing Bd. We recommend continued investigation of these issues related to habitat and Bd. We recommend researching the answer to questions sucha as: Are tank habitats a good long-term solution? Or is it really just good for shortterm and for metapopulation dynamics? Getting water back into lotic systems where nonnative fish species are is potentially going to be important considerations for long-term recovery of the species. 4. We recommend continued use of presence/absence VES monitoring efforts of CLF populations until the comprehensive monitoring plan is developed. We spend a considerable amount of time monitoring and with data management that includes planning and implementing surveys in Arizona and New Mexico, managing the statewide survey database, and summarizing data for annual reporting. A rigorous and statistically defensible monitoring program will make monitoring more effective and efficient and should be a priority for CLF partners. Ideally, a CLF monitoring strategy would track presence/absence status throughout the range, allowing an assessment of metapopulations and isolated robust populations. In addition, because of the time investment, a subset of populations should be targeted for intensive surveys to track relative density, recruitment, demography, and natural population fluctuations. An understanding of detection probabilities would allow for defensible population estimates, and we could evaluate the probability of population persistence (USFWS 2007, Appendix C). We should focus on a monitoring framework, such as occupancy, that can easily incorporate the existing long-term dataset. Occupancy, as opposed to capture-recapture methods, is also advantageous because it does not require counts of frogs, which is problematic during diurnal surveys. Such a monitoring program would permit more inference about range-wide status and trends, make surveys more efficient, and allow for personnel resources to be applied to other recovery actions (AGFD 2019). 5. While the final CLF recovery plan outlined surveying protocols, there is still a need for a scientifically rigorous, long-term monitoring program across the species' range that would allow for inferences about the species' status over time. Current population assessments in Arizona are made annually based on the number of sites in which we document frogs, breeding, and a robust population, as defined in the Recovery Plan (USFWS 2007, AGFD 2020). For example, the number of occupied sites in Arizona fluctuates annually based on persistence of frog populations and annual factors including precipitation and survey effort; between 2016 and 2021 the number of occupied sites in Arizona was as high as 155—a four-fold increase relative to 2007 (AGFD 2020). This progress is due to a multi-pronged recovery approach that includes translocations, bullfrog control, habitat restoration, conservation agreements with private landowners, building support through outreach, and application of research and monitoring through adaptive management (AGFD 2020) and we recommend that these continue into the future. 6. Disease is still major challenge for CLF conservation and recovery. We have learned that some CLFs coexist with Bd suggesting some avenue for immunity. There is also some support for the immunity hypothesis with MHC alleles, but could also be related to climatic differences with less severe winters in south. Overwinter survival of adult frogs remains a limiting factor related to Bd. We are having a lot of trouble getting frogs to persist at sites in northern areas where management actions have occurred. We recommend trying to release in more lotic systems that have less fluctuation in water temperature (not just warmer water), because die-offs seem to happen with drastic changes in water temp. We also recommend further evaluation of ranavirus, a FV3-like virus found in Arizona recently (Harris et al. 2022, Mihaljevic 2023). 7. Genetic management: There are small fragmented populations that exist and this can result in drift or loss of heterozygosity over time. Additionally, there are some populations that are genetic bottlenecks because they were started with few individuals. We recommend the continued analysis of genetics to determine the genetic makeup of effective population sizes at different sites so that we can prioritize areas that may need genetic mixing (USFWS, 2023).

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SPECIES ACCOUNT: *Necturus alabamensis* (Black Warrior waterdog)

Species Taxonomic and Listing Information

Listing Status: Candidate

Physical Description

The Black Warrior waterdog is a large, aquatic, nocturnal salamander that permanently retains a larval form and external gills throughout its life (Conant and Collins 1991, pp. 241-245; Petranka 1998, pp. 418-419). The maximum recorded length for this salamander is 248 millimeters (mm) (9.8 inches (in)) (Bart et al. 1997, p. 195). Its head and body are depressed, its tail is compressed laterally, and it has four toes on each of its four feet. Larval Black Warrior waterdogs (28 to 48 mm (1.1 to 1.9 in) total length) are dark brown or black on their dorsum (upper surfaces) and have two light stripes running along their sides (Bailey 2000, p. 1). Subadults (40 to 100 mm (1.6 to 3.9 in) total length) do not have the stripes present on larvae and are not conspicuously marked although they do have a dark stripe extending from the nostril through the eye to the gills. Adults are usually brown, may be spotted or unspotted, and retain the dark eye stripe (Bailey 2000, p. 1). The ventral surface of all age classes is plain white. The striped pattern of larvae closely resembles the mudpuppy, N. maculosus (Brode 1969, pp. 30, 121; Hecht 1958, p. 18).

Taxonomy

Viosca (1937, pp. 120-138) described the Black Warrior waterdog as Necturus alabamensis. In subsequent years, the name N. alabamensis was mistakenly applied many different ways within the peer-reviewed literature. The taxonomy of the Black Warrior waterdog has been clarified by Bart et al. (1997, pp. 192-201) and the original description by Viosca (1937, pp. 120-138) remains valid. The available taxonomic information on N. alabamensis has been carefully reviewed and we conclude that this species is a valid taxon.

Historical Range

Information on the Black Warrior waterdog is limited. There are a total of 11 historical records from sites in Blount, Tuscaloosa, Walker, and Winston Counties, Alabama. Potential waterdog habitat is expected to be similar to that of the threatened flattened musk turtle (Sternotherus depressus) which is also restricted to permanent streams above the Fall Line in the Black Warrior Basin (Mount 1975, p. 303). The waterdog received little attention between the time it was described in 1937 and the mid-1980s when it was found during surveys in the Tennessee-Tombigbee Waterway (Ashton and Peavy 1985, pp. 1-15). Bailey (2000, pp. 1-24) conducted a habitat assessment of the 11 sites verified as Black Warrior waterdog localities prior to 1993. Only 2 records were documented prior to the mid-1980s. These localities have since been inundated by impoundments. The historical waterdog records are sites from 10 streams or major segments: Sipsey Fork of the Black Warrior River and Brushy Creek (a tributary to Sipsey Fork) in Winston County; Locust Fork and Blackburn Fork of the Little Warrior River in Blount County; Mulberry Fork, Lost Creek, and Blackwater Creek in Walker County; and Yellow Creek, North River, and the Black Warrior River in Tuscaloosa County (Viosca 1937, pp. 120-122, 137-138;

Ashton and Peavey 1985, pp. 1-15; Bailey 1992, pp. 7-9, 16-27; Bailey 1995, pp. 16-27; Bart et al. 1997, pp. 194-195, 198-200; Guyer 1997, p. 9; Bailey 2000, pp. 3-5).

Current Range

At least 112 sites have been sampled for Black Warrior waterdogs since 1990 (Guyer 1997, pp. 19-21; Durflinger-Moreno et al. 2006, pp. 73-74). Survey sites included all stream localities within the range of the species that approached or intersected roads and had appropriate habitat. The species has been reported since 1990 from only 14 sites (12% success rate) despite surveys in 1990, 1991, 1992, 1994, 1996, 1997, 1998, 2008, 2009, 2011, 2012, and 2013 (Bailey 1995, pp. 16-27; Guyer 1997, pp. 19-21 and 1998, pp. 6-7; Durflinger-Moreno et al. 2006, pp. 73-74; Stoops et al. 2010, p. 6; Alabama Natural Heritage Program 2011, p. 4; Godwin 2012, p. 1; Godwin 2013a, p. 1; Godwin 2013b, p. 1). These sites are in Blount (Blackburn Fork of Little Warrior River), Marshall (Slab Creek, tributary to Locust Fork), Tuscaloosa (Yellow Creek, North River, Carroll Creek, Lye Branch, Mulberry Fork), Walker (Lost Creek, Little Blackwater Creek), and Winston (Sipsey Fork, Blackwater Creek, Browns Creek, Brushy Creek, Capsey Creek) Counties, Alabama. Field surveys were conducted between 2008 and 2013 at historical localities. Only one population, on the Sipsey Fork in Winston County and occurring partially on the William B. Bankhead National Forest, was found during these surveys (Stoops et al. 2010, pp. 1-6; Godwin 2012, p. 1; Godwin 2013a, p. 1; Godwin 2013b, p. 1). This site appears to be the stronghold for the species.

Critical Habitat Designated

Yes; 2/2/2018.

Life History

Food/Nutrient Resources

Food Source

Juvenile: small invertebrates and fish

Adult: small invertebrates and fish

Competition

Juvenile: Unknown

Adult: Unknown

Food/Nutrient Narrative

Juvenile: Larval and adult Black Warrior waterdogs are assumed to be opportunistic carnivores. Captive Black Warrior waterdogs have eaten small fish and earthworms (Bailey 2005, p. 867). Crayfish, isopods, amphipods, freshwater clams, and insects, including mayflies, caddisflies, dragonfly naiads, dytiscid beetles, and midges, have been reported as prey items in Gulf Coast waterdogs (Guyer 2005, p. 868).

Adult: Larval and adult Black Warrior waterdogs are assumed to be opportunistic carnivores. Captive Black Warrior waterdogs have eaten small fish and earthworms (Bailey 2005, p. 867). Crayfish, isopods, amphipods, freshwater clams, and insects, including mayflies, caddisflies, dragonfly naiads, dytiscid beetles, and midges, have been reported as prey items in Gulf Coast waterdogs (Guyer 2005, p. 868).

Reproductive Strategy

Adult: Sperm-storers; Internal fertilization; Oviparous

Breeding Season

Adult: Late spring or summer

Reproduction Narrative

Adult: Very little is known about the life history of the Black Warrior waterdog and data are generally limited for other species of southeastern Necturus as well. Reproduction in the Black Warrior waterdog is aquatic. Egg deposition sites and clutch sizes are unknown. In the closely related Gulf Coast waterdog (Necturus beyeri), females attach their eggs singly to the undersides of underwater substrates (summarized in Guyer 2005, p. 868). Sexually active Black Warrior waterdog adults have been found in rock crevices (Bailey 2005, p. 867) and thus egg deposition may occur at these sites. Clutch sizes ranging from 4 to 40 eggs were reported in a summary of research conducted on the Gulf Coast waterdog (Guyer 2005, p. 868). Ashton and Peavy (1986, p. 64) collected post-hatchling Black Warrior waterdog larvae in December; this suggests that nesting may occur in late spring or summer. Reproductive maturity is probably attained in the third winter or at 2.5 years of age (Bailey 2005, p. 867).

Habitat Type

Juvenile: streams

Adult: streams

Habitat Vegetation or Surface Water Classification

Juvenile: streams

Adult: streams

Spatial Arrangements of the Population

Juvenile: Clumped according to suitable resources

Adult: Clumped according to suitable resources

Environmental Specificity

Juvenile: Generalist

Adult: Generalist

Tolerance Ranges/Thresholds

Juvenile: Low

Adult: Low

Site Fidelity

Juvenile: Strong

Adult: Strong

Habitat Narrative

Adult: The Black Warrior waterdog inhabits streams above the Fall Line (the contact between the coastal plain and the adjacent upland provinces) within the Black Warrior River Basin (Basin) in Alabama including parts of the North River, Locust Fork, Mulberry Fork, and Sipsey Fork drainages and their tributaries. Rocks, submerged ledges, and other cover probably play an important role in determining habitat suitability (Ashton and Peavy 1986, p. 64). Semi-permanent leaf beds (where they exist) are likely visited frequently (Ashton and Peavy 1986, p. 64). Larvae and adult waterdogs are reliably found only in these submerged leaf beds and they may use them for both shelter and foraging habitat (Bailey 2000, p. 3). Guyer (1997, pp. 1-21) analyzed habitats to distinguish sites with waterdogs from those lacking the species. He found that Black Warrior waterdogs were associated with clay substrates lacking silt; wide and/or shallow stream morphology; increased snail and dusky salamanders (Desmognathus spp.) abundance; and decreased Asiatic clam (Corbicula fluminea) occurrence. Durflinger-Moreno et al. (2006, pp. 70-80) completed an additional assessment of 112 localities surveyed for waterdogs. At a regional scale, Black Warrior waterdogs were associated with stream depths of 1 to 4 meters (m) (3.3 to 13.1 feet (ft)), reduced sedimentation, and large leaf packs supporting mayfly (Ephemeroptera) and caddis fly (Trichoptera) larvae.

Dispersal/Migration

Motility/Mobility

Juvenile: Moderate

Adult: Moderate

Dispersal

Juvenile: Low

Adult: Low

Dispersal/Migration Narrative

Adult: Home ranges of Black Warrior waterdogs are likely small as in other species of southeastern Necturus. In a Gulf Coast waterdog mark-recapture study, all recaptures were within 64 m (210 ft) of the original capture and release site (summarized in Guyer 2005, p. 868).

Population Information and Trends

Population Trends:

Unknown

Species Trends:

Declining

Population Growth Rate:

Unknown

Number of Populations:

Six extant (USFWS, 2024)

Population Size:

Unknown

Minimum Viable Population Size:

Unknown

Resistance to Disease:

Unknown

Adaptability:

Unknown

Population Narrative:

Each of the 14 sites verified as a Black Warrior waterdog locality represents an individual population. Very little is known about the status of these populations. Only one or two animals were captured at survey sites with the exception of one site on the Sipsey Fork chosen for an in-depth study because waterdogs were most common there (Durflinger-Moreno et al. 2006, pp. 70-71). Fifty-two waterdogs were captured at the Sipsey Fork site over a 3-year period representing 173,160 trap hours (1 waterdog/3,330 trap hours). Thirty-five (67%) animals were adults, 5 (10%) were subadults and 12 (23%) were larvae. The number of adult males and females captured was not significantly different from an expected 1:1 sex ratio (Durflinger-Moreno et al. 2006, p. 79). The low number of subadults and larvae indicate that recruitment and survival rates of these age classes are low. This implies that high mortality at the egg, larval, or juvenile stage, migration of these age classes out of the population, or longevity of adult waterdogs are affecting the age class distribution of the population. The viability of any Black Warrior waterdog population, including the Sipsey Fork population, is unknown. The Black

Warrior waterdog is a large, aquatic salamander that retains well developed, feathered gills throughout its life. The Black Warrior waterdog is limited to the Black Warrior River watershed upstream of the Fall Line in northern Alabama. There are currently six extant and six presumed extirpated populations of the Black Warrior waterdog found in four subbasins in the Black Warrior River watershed. Of these six, the species can be found most consistently in two populations in the same subbasin (Sipsey Fork and Brushy Creek). However, available data suggests the species has low abundance even in the populations where they have been most consistently detected. Information on the genetics of the species indicates that there is overall low diversity; low genetic diversity, low abundance, and lack of connectivity continue to be a concern for this species (USFWS, 2024)

Threats and Stressors

Stressor: Water quality degradation
Exposure:
Response:
Consequence:
Narrative: Water quality degradation is the biggest threat to the continued existence of the Black Warrior waterdog. Bailey (2000, p. 19-20) considered water quality degradation to be the primary reason for the extirpation of this species over much of its historical range in the upper Black Warrior River system. Most streams surveyed for the Black Warrior waterdog showed evidence of water quality degradation and many appeared biologically depauperate (Bailey 1992, p. 2 and 1995, p. 11; Durflinger-Moreno et al. 2006, p. 78). Sources of point (point source discharge) and nonpoint (land surface runoff) pollution in the Black Warrior River Basin (Basin) have been numerous and widespread. Point pollution is generated from inadequately treated effluent from industrial plants, sanitary landfills, sewage treatment plants, and drain fields from individual private homes (U.S. Fish and Wildlife Service 2000, pp. 12-13). Nonpoint pollution originated from agricultural activities, poultry and cattle feedlots, abandoned mine runoff, construction, silviculture, failing septic tanks and contaminated runoff from urban areas (Deutsch et al. 1990, pp. 1-62, Upper Black Warrior Technical Task Force 1991, p. 1; ONeil and Shepard 2001, p. 2). These sources contribute pollution to the Basin via sediments, fertilizers, herbicides, pesticides, animal wastes, septic tank and gray water leakage, and oils and greases. Water quality, and the resident aquatic fauna, has declined as a result of this pollution which causes nitrification, decreased dissolved oxygen concentration, increased acidity and conductivity. These alterations have a direct effect on the survival of Black Warrior waterdogs, which, due to their highly permeable skin (Duellman and Trueb 1986, p. 197) and external gills, are very sensitive to declines in water quality and oxygen concentration. The large population centers of Birmingham, Tuscaloosa, and Jasper contribute substantial runoff to the Basin. The watershed occupied by these three cities contains more industrial and residential land area than any other river basin in Alabama. Streams draining these areas have a history of serious water quality problems. Species of fishes, mussels, and snails (Mettee et al. 1989, pp. 1, 14-16; Hartfield 1990, pp. 1-8), and populations of the flattened musk turtle (U.S. Fish and Wildlife Service 1990, p. 3), have been extirpated from large areas of the watershed due primarily to water quality degradation. Forestry operations and highway construction are also sources of nonpoint pollution when Best

Management Practices (BMPs) are not followed to protect streamside management zones (Hartfield 1990, pp. 4-6; U.S. Fish and Wildlife Service 2000, p. 13). Logging can cause erosion, siltation, and streambed structural changes from the introduction of tree slash. Highway construction and bridge replacements can also result in increased sedimentation and runoff may introduce toxic chemicals into streams. In addition, highway construction may reroute streams or change their shape. Surface mining represents another threat to the biological integrity of streams in the Black Warrior River system and has undoubtedly affected the distribution of the Black Warrior waterdog (Bailey 1995, p. 10). Strip mining for coal results in hydrologic problems (i.e., erosion, sedimentation, decline in groundwater levels, and general degradation of water quality) that affect many aquatic organisms (U.S. Fish and Wildlife Service 2000, p. 12). Runoff from coal surface mining generates pollution through acidification, increased mineralization, and sediment loading. Impacts are generally associated with past activities and abandoned mines, since presently operating mines are required to employ environmental safeguards established by the Federal Surface Mining Control and Reclamation Act of 1977 and the Clean Water Act of 1972 (U.S. Fish and Wildlife Service 2000, p. 12). Old, abandoned mines will continue to contribute pollutants to streams for the foreseeable future. Black Warrior waterdogs have probably experienced similar declines as the flattened musk turtle, which also occurs in the upper Black Warrior River system. Sedimentation in this system has negatively affected the flattened musk turtle by: (1) reduction of mollusks and other invertebrates used as food; (2) physical alteration of rocky habitats where the animals forage and take cover, and (3) accumulation of substrate in which chemicals toxic to animals and their prey persist (Dodd et al. 1988, pp. 1-61). The Sipsey Fork of the Black Warrior River is the best remaining locality for the Black Warrior waterdog (Guyer 1998, p. 2). Bailey and Guyer (1998, pp. 77-83) completed a study of the flattened musk turtle at this site. They found that the turtle population was declining and suggested that habitat quality is deteriorating at this site. Deteriorating habitat quality may also affect the Black Warrior waterdog. Black Warrior waterdogs are vulnerable to sedimentation, and the associated pollution concentrated in sediments, since they spend virtually all of their lives at the stream bottom and would be in almost constant contact with any toxic substances that may be present (Bailey 1995, p. 10). The skin of amphibians is highly permeable and water is exchanged readily with the environment. As a result, the respiration (breathing) and osmoregulation (balance of body fluids) of Black Warrior waterdogs would be negatively affected by toxic sediments. Excessive sediments also impact the hard stream and river bottoms by making the habitat unsuitable for feeding or reproduction of Black Warrior waterdogs. For example, sediments have been shown to affect respiration, growth, reproductive success, and survival of aquatic insects and fish (Waters 1995, pp. 173-175) that serve as food sources for the salamander (Bailey 2005, p. 867). Potential sources of pollution and associated sedimentation within a watershed include virtually all activities that disturb the land surface, and all localities currently occupied by the Black Warrior waterdog are affected to varying degrees by sedimentation (ONeil and Shepard 2001, Appendix B, p. 5). Sedimentation, or siltation, is one of the most severe threats to the Black Warrior River (Black Warrior Riverkeeper 2012, p. 1). The Black Warrior River watershed receives significant pollutant loadings from activities related to the human population and land-use activities including sedimentation from construction, forestry, mining, agriculture, and channelization of stream segments (Black Warrior River Watershed Management Plan 2012, p. 4.3). Creation of large impoundments, behind Bankhead, Lewis, and Holt dams, within the Basin has flooded thousands of square hectares (acres) of habitat previously considered appropriate for the Black Warrior waterdog. Hartfield (1990, p. 7) summarized the number of miles of streams affected by impoundments in the Basin. He found that the entire main channel of the Black Warrior River, over 272 kilometers (km) (170 miles (mi)), has been affected. Impoundments do not have the shallow, flowing water preferred by the species. As a result, they are likely marginal or unsuitable habitat for the salamander. The abundance of predatory fish in impoundments further renders these lakes unsuitable for the Black Warrior waterdog. Impoundments have been trapped for waterdogs. The question remains whether impoundments represent suitable habitat or are habitat sinks. Given the habitat requirements of the species, it seems unlikely that a viable population of Black Warrior waterdogs could be sustained in an impoundment. In summary, the historical loss of habitat is currently, and projected to continue to be, a significant threat to the Black Warrior waterdog. Habitat loss also amplifies threats from point and nonpoint source water and habitat quality degradation, accidental spills, or violation of permitted discharges. Due to the limited extent of habitat currently occupied by the species, and the severity and magnitude of this threat, we consider that the present or threatened destruction, modification, or curtailment of habitat and range represents a threat to the Black Warrior w

Stressor: Inadequate regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: Although regulatory mechanisms are in place to protect aquatic species, multiple stream reaches within the occupied habitat of the Black Warrior waterdog (Locust Fork, Mulberry Fork, Yellow Creek, and North River) fail to meet current regulatory standards. In addition, the lack of specific information on the sensitivity of the Black Warrior waterdog to common industrial and municipal pollutants limits their application; without these data, it is not possible to document harm to the species as a result of the pollutants. Therefore, we consider existing regulatory mechanisms, as currently applied, not fully protective of the BlackWarrior waterdog.

Stressor: Habitat fragmentation/Population Isolation
Exposure:
Response:
Consequence:
Narrative: The remaining Black Warrior waterdog populations are isolated from each other by unsuitable habitat created by impoundments, pollution, or other factors. Even in the best localities, waterdog population densities are apparently low. Low population densities combined with fragmentation of habitat renders populations extremely vulnerable to inbreeding depression (negative genetic effects of small populations) (Wright et al. 2008, p. 833) and catastrophic events such as flood, drought, or chemical spills (Black Warrior River Watershed Management Plan 2012, p. 4.4). In addition, if stream quality improves within areas of the Basin, impoundments and polluted reaches will act as barriers to re-establishment of Black Warrior waterdog populations. Therefore, we consider the Black Warrior waterdog vulnerable to other natural or manmade factors, such as droughts, floods, spills, and/or inbreeding.

Stressor: Disease (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: the increasing prevalence of novel diseases in other waterdog species (Glorioso et al. 2017, pp. 362) and amphibian taxa across North America (Rothmerel et al. 2008, p. 5) and the catastrophic consequences resulting from outbreaks of such diseases (Lips et al. 2006, pp. 3164-3166) indicate that this threat (Factor C) needs to be closely monitored (USFWS, 2024).

Recovery

Reclassification Criteria:
Not developed

Delisting Criteria:
Not developed

Recovery Actions:

- There are other listed aquatic species within the range of the Black Warrior waterdog. Activities to improve water quality conditions for these species will also improve conditions for the Black Warrior waterdog. Several nonprofit organizations are working to improve conditions in the Black Warrior Watershed. The Black Warrior Clean Water Partnership coordinates stakeholders to encourage basin restoration and protection through active on-the-ground projects and education. The Black Warrior Riverkeeper monitors river quality by collecting water samples and, if necessary, pursues legal action to encourage enforcement of the Clean Water Act.
- Analyze the watershed level water quality threats and develop a strategy to reduce pollution.
- Work with other governmental agencies and private landowners to develop partnerships to implement the strategy.
- The Forest Service includes the Black Warrior waterdog as a Regional Foresters Sensitive Species and analyzes potential effects of all Forest Service actions to Black Warrior waterdog and its potential habitat through a Biological Evaluation as part of the NEPA process (J.A. Cochran, U.S. Forest Service, pers. comm. 2013).
- This species has a Recovery Priority Number of 2 (USFWS, 2018)
- Recovery Strategy/Initial Action Plan 1. Education and Outreach: to inform and educate about various water quality issues. 2. Research: Continue monitoring the Black Warrior waterdog and the water quality in the Black Warrior Basin. 3. Implementation: Evaluate existing regulatory process. encourage development of laws/regulations protective of the species. Encourage community based watershed stewardship (USFWS, 2018).
- No conservation actions have been implemented or planned specifically for the Black Warrior waterdog (Godwin 2010, pers. comm.).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES This species does not have a final recovery plan. While completing this status review, we have identified the following potential recovery activities which are included below. Recovery Activities 1. Determine relative contribution of specific stressors to declines. 2. Identify and implement solutions for eliminating excessive sedimentation and restoring habitat quality. 3. Regularly monitor water quality parameters and identify and implement solutions to improve water quality into ranges suitable to the Black Warrior waterdog. 4. Protect and enhance habitat using available mechanisms including land acquisition programs, conservation agreements, and management agreements. 5. Conduct a comprehensive threats analysis in currently occupied streams. 6. Develop and initiate disease monitoring program and minimize effects of disease to the species. 7. Develop captive propagation plan that includes genetic conservation and release components. Monitoring and Research Activities 1. Conduct life history and demographic studies. 2. Continue research on the species population genetics. 3. Conduct research to inform whether and how habitat can be enhanced through active management. 4. Monitor populations to assess long-term trends while considering and minimizing negative effects to habitat. Population monitoring should include habitat assessments. 5. Conduct field surveys to identify whether additional populations exist and better define range extent and estimate abundance of existing populations using traditional and eDNA methods (USFWS, 2024).

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